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Ageing in Autism Spectrum Disorder

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**AGEING
IN
AUTISM SPECTRUM DISORDER**

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Abstract

This thesis aimed to investigate symptomatology, psychopathology, and neurocognitive characteristics of older adults with autism spectrum disorder (ASD). Given the limited research on ageing in ASD, the three studies presented in this thesis were primarily exploratory.

First, data on mental health and normative life outcome are reported from adults attending a tertiary referral clinic for a possible first diagnosis of ASD. Young (aged 18-38) and old (aged 50-70) adults were compared across two groups; those who did (N=58) versus did not (N=46) receive a final ASD diagnosis. Analyses revealed better life outcome in the old versus young group, although additional psychiatric diagnoses were common across ages in ASD.

In the second study, groups of older (N=29, aged 50-71 years) and younger adults (N=29, aged 19-48) with ASD, and comparison groups of neurotypical (NT) young (N=20, aged 20-44) and old (N=19, aged 52-71) adults, were recruited and tested in person by the author. The most striking finding was an age by group interaction in Theory of Mind (ToM) performance; ASD adults did not show the decrease in ToM performance with age, seen in the NT group.

The third and last study took a dimensional approach to ASD, examining social cognition, mental health and wellbeing in grandparents (N=43, aged 53-85) of individuals with ASD; a group expected to be enriched for the 'broad autism phenotype'. To tap ToM in this postal study, a novel task was designed. Again, few age effects were found within this sample, but mental health was a significant cause for concern and predictor of quality of life.

Overall, these findings, in an under-researched area, suggest that many aspects of mental health and wellbeing do not change greatly in older adulthood in ASD, perhaps remaining more stable than in NT adults. Limitations and directions for future research in this important area, are discussed.

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Abbreviations

Abbreviation	Meaning
AASP	Adult/Adolescence Sensory Profile
ABS-RC	Adaptive Behaviour Scale Part One
ADHD	Attention Deficit Hyperactivity Disorder
ADI-R	Autism Diagnostic Interview-Revised
ADOS-G	Autism Diagnostic Observation Schedule-Generic
AMT	Awkward Moments Test
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
APA	American Psychological Association
AQ	Autism-Spectrum Quotient
ASD	Autism Spectrum Disorder
ASRS	Adult ADHD Self-Report Scale
ASQ	Autism Screening Questionnaire
BAI	Beck Anxiety Inventory
BAP	Broader Autism Phenotype
BAPQ	Broad Autism Phenotype Questionnaire
BASIS	British Autism Study of Infant Siblings
BCS	Barkley ADHD Current Symptoms Scale
BDI	Beck Depression Inventory
BGC	Behavioural Genetics Clinic
CAM	Cambridge Mindreading Face–Voice Battery
CARS	Childhood Autism Rating Scale
CC	Central Coherence
CGH	Comparative Genomic Hybridization
CHAT	The Checklist for Autism In Toddlers
CI	Communication Impairments
CRI	Childhood Routines Inventory
CSRI	Client Service Receipt Inventory
CVLT	California Verbal Learning Test
DAS	Daily Assessment Schedule
DBT	Deceptive Box Task
DEX	Dysexecutive Questionnaire
DF	Describing Feelings
DISCO	Diagnostic Interview For Social And Communication Disorders
DS	Down’s Syndrome
DSM	Diagnostic And Statistical Manual Of Mental Disorders
DSSI-SAT	Duke Social Support Index – Satisfaction
DSSI-SI	Duke Social Support Index –Social Interaction
DZ	Dizygotic
EC	Empathic Concern
EF	Executive Function

EFT	Embedded Figures Test
EOT	Externally Orientated Thinking
F	Fantatising
F-HT	Frith-Happé Triangles Test
FHI	Family History Interview
fMRI	Functional Magnetic Resonance Imaging
FSIQ	Full-Scale Intelligence Quotient
GARS-2	Gilliam Autism Rating Scale - Second Edition
GHQ	General Health Questionnaire
HADS	Hospital Anxiety and Depression Scale
HRSS	Holmes and Rahe Stress Scale
ICD-10	International Classification of Diseases, 10th revision
ICI	Index of Community Activities
ID	Intellectual Disability
IF	Identifying Feelings
IPDL	Index of Participation in Domestic Life
IRI	Interpersonal Reactivity Index
IQ	Intelligence Quotient
KBIT	Kaufman Brief Intelligence Test
KMO	Kaiser-Meyer-Olkin
LD	Learning Disability
LOT-R	Life Orientation Test–Revised
MASC	Movie for the Assessment of Social Cognition
MCS	Mental Health Composite Scale score
MDFT	Moral Dilemmas Film Task
MHS	Mental Health Service
MINI	Mini International Neuropsychiatric Interview
MOS-SSS	Medical Outcome Study-Social Support Survey
MPAS	Modified Personality Assessment Schedule
MPAS-R	Modified Personality Assessment Schedule - revised
MR	Mental Retardation
MRC	Medical Research Council
MZ	Monozygotic
NART	National Adult Reading Test
NAS	National Autistic Society
NEO-PI	The NEO Personality Inventory
NICE	National Institute for Health and Care Excellence
NT	neurotypical
OCD	Obsessive-Compulsive Disorder
OCI-R	Obsessive-Compulsive Inventory-Revised
ONS	Office for National Statistics
OS	Others to Self
PCA	Principal Component Analysis
PCS	Physical Health Composite Scale score

PD	Personal Distress
PDD	Pervasive Developmental Disorder
PDDST-II	Pervasive Developmental Disorders Screening Test-II
PDD-NOS	Pervasive Developmental Disorder - Not Otherwise Specified
PHQ	Patient Health Questionnaire
PIQ	Performance Intelligence Quotient
PL	Pragmatic Language
PNM RESC	Psychiatry, Nursing and Midwifery Research Ethics Subcommittee
PPVT	Peabody Picture Vocabulary Test
PR	Perspective Taking
PRS	Pragmatic Rating Scale
PSS	Perceived Stress Scale
PST	Psychological State Talk
PT	Perspective Taking
QoL	Quality of life
RAADS-R	Ritvo Autism and Asperger Diagnostic Scale-Revised
RBS-R	Repetitive Behaviour Scale-Revised
RBQ	Repetitive Behaviour Questionnaire
PHQ	Patient Health Questionnaire
RMET	Reading the Mind from The Eyes Test
RMF	Reading the Mind in Films
PRIME-MD	Primary Care Evaluation of Mental Disorders
RRB	Restricted Interests and Repetitive Behaviour
RRBI	Restricted and Repetitive Behaviours And Interests
RT	Response Time
SCI	Social Communication and Interaction
SCQ	Autism Screening Questionnaire
SD	Standard deviation
SHS	Subjective Happiness Scale
SI	Social Impairments
SIB-R	Scales of Independent Behaviour-Revised
SO	Self to Others
SRRS	Social Readjustment Rating Scale
SRS	Social Responsiveness Scale
SS	Self to Self
SSFt	Strange Situations Film Task
SSP	Short Sensory Profile
STAI	State-Trait Anxiety Inventory
STAT	Screening Tool for Autism in Toddlers & Young Children
SWLS	Satisfaction with Life Scale
TAS	Toronto Alexithymia Scale
TASIT	The Awareness of Social Inference Test
TBC	Tuberous Sclerosis Complex
ToM	Theory of mind

ToM-CSt	Theory of Mind Cartoon Stories Task
TS	Tourette Syndrome
TV	Television
UOT	Unexpected Outcomes Test
VIQ	Verbal Intelligence Quotient
WAIS	Wechsler Adult Intelligence Scale
WASI	Wechsler Abbreviated Scales of Intelligence
WHO	World Health Organization
WHOQOL-BREF	World Health Organization Quality of Life Questionnaire
YoE	Years of education

Chapter 1 Introduction to Autism Spectrum Disorder

1.1 Introduction

This first chapter provides an overview of what is known about autism today, especially when adults are considered, and introduces cognitive theories of ASD. A more detailed review of ageing in autism and related concepts is presented in Chapter 2.

1.2 What is Autism Spectrum Disorder

1.2.1 Diagnosis and Symptoms

Autism Spectrum Disorder (ASD) is a lifespan developmental disorder, identified on the basis of impairments in three core areas: social impairments (SIs), communication impairments (CIs), and restricted and repetitive behaviours and interests (RRBIs). According to the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5; American Psychiatric Association (APA), 2013) core impairments can be grouped into two categories, combining communication and social impairments in one category, and RRBIs (including sensory abnormalities) in the other. Subgroups of autism (e.g. autistic disorder, pervasive developmental disorder not otherwise specified (PDD-NOS), and Asperger's syndrome) in the previous version of DSM (DSM-IV-TR; APA, 2000) are now collapsed into one diagnosis, ASD. The International Classification of Diseases, 10th revision (ICD-10; World Health Organization (WHO), 1993) has a number of categories, similar to DSM-IV: childhood autism, atypical autism, Rett's syndrome, other childhood disintegrative disorder, overactive disorder associated with mental retardation and stereotyped movements, Asperger syndrome, other PDD, and PDD unspecified (WHO, 1993). The new edition of ICD is currently in preparation and is expected to broadly resemble the DSM-5 (APA, 2013).

ASD is a complex and highly heterogeneous disorder (APA, 2013). Studies show that intellectual functioning of people with ASD varies widely, from low- (IQ < 70) or high-functioning (IQ=70 and over) (Chakrabarti & Fombonne, 2005; Fombonne, 2006; Wing, 1997). Whether there is a genetic association between autism and intellectual disability is still a controversial issue. Although a strong genetic correlation between IQ and autistic traits has been reported in clinical samples (e.g. Nishiyama et al., 2009), evidence from general population studies suggests only a moderate genetic correlation, mainly predicated by communication difficulties (Hoekstra, Happé, Baron-Cohen, & Ronald, 2009, 2010).

The so-called “the triad of impairments” (difficulties with social interaction, communication, and RRBIs) was identified in the first case descriptions of ‘autism’ (Asperger, 1944/1991; Kanner, 1943). Ritualistic utterances (or verbal rituals), use of inappropriate words and phrases, pronoun reversals, neologisms, and echolalia are frequently reported features of communication difficulties in ASD. There are also characteristic impairments in pragmatics, intonation, and stress. Perseveration on specific topics (e.g. special interests), deficits in understanding nonliteral language (e.g. irony, sarcasm, and metaphors), and non-verbal communication impairments (e.g. odd eye contact, appropriate facial expressions and gestures) are also common (Tager-Flusberg, 1999). Difficulties in social interaction are manifested in deficits in adjusting behaviour to different social contexts and a lack of social understanding; there are also problems in developing, and maintaining relationships (DSM-5; APA, 2013). It should be noted that deficits in communication and social interaction overlap (e.g. eye contact and non-verbal behaviours during social interaction), since communication abilities and social interaction skills naturally intertwine with each other. The third core symptom

area, restricted and repetitive behaviours and interests, can be manifested as stereotyped behaviours, repetitive self-injurious behaviours, resistance to change, narrow interests, rituals and routines and sensory hypo- or hyper-reactivity. Individuals with ASD often show multiple types of RRBIs, and the manifestation differs with age and ability, again contributing to the heterogeneous pattern within the autism spectrum.

1.2.2 History of Autism

Autism was initially described by Kanner (1943) who highlighted two main characteristics shared by 11 cases: avoidance of social contact and insistence on sameness. An Austrian psychiatrist, Hans Asperger, described a slightly different but similar condition to Kanner's autism in 1944. Although these were the first formal descriptions of autism, there were earlier accounts of children with similar characteristics (e.g. "childhood psychosis/schizophrenia"; Haslam, 1809; Maudsley, 1867; Potter, 1933). Since the late 1960s, autism (or "infantile psychosis" as it was first called) has increasingly become distinct from other similar conditions such as schizophrenia (Kolvin, 1971a, 1971b; Makita, 1966) and intellectual disability (ID) (Hermelin & O'Connor, 1970).

The theory of the autistic spectrum emerged in the late 1970s. In their epidemiological study, Wing and Gould (1979) investigated children (aged 2-18 years) who had at least one of the triad of impairments in autism and who lived in Camberwell in London. They reported that communication impairments and repetitive behaviours and interests were present in all of the children who were socially impaired. Also, these children did not differ on any of the triad of impairments. Their findings suggest that the triad of impairments clusters above chance. In line with Wing and Gould's findings (1979) diagnostic criteria in DSM-4, (APA, 2000) and ICD-10 (WHO, 1993) required

all three core-difficulties to be present in order to meet formal diagnostic criteria for autism. Since then the research agenda of autism aetiology mainly focused on looking for a possible single cause, at genetic, cognitive, or neural level. Heterogeneity of the manifestation was not ignored, yet it was assumed that this is due to a single cause differing from one individual to another.

An alternative view, the “fractionated triad” account of autism, has suggested that the three symptom domains are only moderately correlated, and that isolated deficits (e.g. social abnormalities alone) can be found (Happé & Ronald, 2008; Happé, Ronald & Plomin, 2006). The authors reviewed studies, which might be indicative of possible fractionation of the triad, and reported empirical studies (e.g., Booth, Wallace, & Happé, 2011; Robinson et al., 2012) suggesting that independent genetic, cognitive, and neural causes could influence different behavioural characteristics of autism. This proposal suggests an alternative approach for future research such that each domain of the triad can be independently investigated at the three levels (i.e. genetic, neural, and cognitive).

1.3 Prevalence of ASD and Diagnostic Challenges in Older Individuals

Fombonne (2009) reported that the prevalence of autism was about 1 in 150 children. He reviewed 43 recent (more than half of them were reported since 2000) epidemiologic surveys of autism. Although there was a significant correlation between year of survey and prevalence estimates, evidence was insufficient to confirm an actual increase in autism prevalence. The rise in diagnoses may be due to a broadened concept of autism, increased professional and public awareness, diagnostic substitution, changes in health and education services and regulations, and/or methodological differences between studies (Fombonne, 2009; King & Bearman, 2009).

The concept of autism was widened with the introduction of DSM-4 (APA, 1993) in which different manifestations of autism (e.g. Asperger syndrome and PDD-NOS) were included for the first time in the diagnostic criteria. With the introduction of DSM-5 (APA, 2013), these manifestations have been grouped under one category, 'Autism Spectrum Disorders'. These advancements are likely to increase the number of people in the population diagnosed with ASD compared to the past. Similarly, the widened description of autism has raised awareness in the public and among professionals. Health and education services have amended their regulations according to diagnostic changes of this condition and the number of referrals for a formal investigation of autism has increased. Exclusion criteria in psychiatric investigations have been reconsidered resulting in diagnostic substitutions of large number of individuals who then received ASD diagnosis (Fombonne, 2009; Leonard et al., 2010). Different methodological approaches (e.g. differences in case identification criteria and sample size) adopted in epidemiological surveys may also be responsible for the increase in estimated prevalence rates. However, it is still possible that there is an actual increase in the number of people having the condition.

The UK ONS Household Survey (Brugha et al., 2011), reported the prevalence of ASD in adults as 9.8 per 1000, a rate similar to that in children. In a more recent study, Brugha et al. (2016) showed that 11/1000 adults of all ages had autism in the UK. The widened concept of autism described above may have led to increases in the number of individuals who were first diagnosed with ASD in adulthood (Geurts & Jansen, 2012). These adults might also be high functioning so that they coped relatively well with daily life challenges and have not sought professional help so far (Lai et al., 2011; Tantam,

2014). Recent diagnostic substitutions of other mental health disorders in early life might be another reason.

Autism diagnosis at a later age is important since it is likely to enlighten the life-span trajectory of this neurodevelopmental condition and may also lead to an improvement in interventions (James, Mukaetova-Ladinska, Reichelt, Briel, & Scully, 2006). However, it is worth noting, here, considering some specific challenges for diagnosing ASD for the first time in later adulthood.

As indicated by van Niekirk and colleagues (2011), mental health professionals who work with the elderly, might have limited information about ASD as a life-span disorder. To reach a reliable diagnosis of ASD, a detailed developmental history, examination of cognitive skills, and standardized diagnostic procedures are needed (National Institute for Health and Care Excellence (NICE), 2012). However, finding respondents (e.g. close family members) to provide valid information about the developmental history of an elderly relative is a problem (Fombonne, 2009; Happé & Charlton, 2011). In addition, retrospective reporting might lead to incorrect or missing information due to memory bias or reduced cognitive abilities with age (van Niekirk et al., 2011).

Another difficulty is the limited number of diagnostic measures and screening tools suitable for older adults. Several screening and diagnostic instruments have been developed for diagnosing individuals at early ages. The Checklist for Autism in Toddlers (CHAT; Baird et al., 2000; Baron-Cohen, Allen, & Gillberg, 1992) was designed to screen children aged 18-24 months for a possible risk of ASD. The modified CHAT (M-CHAT; Dumont-Mathieu & Fein., 2005; Robins, Fein, Barton, & Green, 2001) and the Developmental Disorders Screening Test-II (PDDST-II; Siegel,

2004) Stage 1-Primary Care Screener are parent-report screening measures for children aged 12/16-48 months. The Pervasive Developmental Disorders Screening Test-II (PDDST-II; Siegel, 2004) and Stage 2-Developmental Clinic Screener and Screening Tool for Autism in Two-Year Olds (STAT; Stone & Ousley, 1997; Stone, Coonrad, & Ousley, 2000; Stone, Coonrod, Turner, & Pozdol, 2004) are for children at risk of autism aged 12-48 months and 24-35 months, respectively. The PDDST-II is a parent-reported questionnaire, whereas STAT is a direct assessment. Another measure, previously called the Autism Screening Questionnaire (ASQ; Berument, Rutter, Lord, Pickles, & Bailey, 1999), is the Social Communication Questionnaire (SCQ; Rutter, Bailey, & Lord, 2003) which is a parent-reported questionnaire based on items in the ADI-R for children aged 4 and older. The Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994) and the Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord et al., 2000) are well validated instruments developed for diagnosis in childhood, that can also be used with adults. There is also the Gilliam Autism Rating Scale - Second Edition (GARS-2; Gilliam, 1995) for people aged 3-22 years. However, the number of diagnostic measures and screening tools suitable for older adults is sparse. The ADOS Module 4 has been recently adapted for adults (i.e. Module 4) (Brugha et al., 2009; Bastiaansen et al., 2011). The Ritvo Autism and Asperger Diagnostic Scale-Revised (RAADS-R; Ritvo et al., 2011), and a shorter screener version (RAADS-14 Screen; Eriksson, Andersen, & Bejerot, 2013) and the Social Responsiveness Scale-Second Edition (SRS-2; Constantino & Gruber, 2012) are other screening tools suitable for using with older adults, although specific data from the elderly are lacking.

1.4 Aetiology of ASD

Autism is still diagnosed based on behavioural characteristics, as the principle causes of the condition remain unknown and multiple factors (i.e. genetic, cognitive, and environmental) play a role in aetiology.

There are several factors considered to influence the deficits seen in people with ASD. Studies have reported possible neuroanatomic and neurofunctional factors as well as some environmental contributors. Recently, research into the genetics and epigenetics of autism have contributed to the field. These studies have not only confirmed the genetic basis of autism, but also elucidate how multiple contributors of this condition work together (e.g., gene x environment interplay).

1.4.1 Environmental Factors

Although the fact that ASD is a neurobiological disorder is no longer in question, a number of environmental contributors have been suggested as possible triggers of autism. Theories that lack of parental warmth (e.g. the notion of ‘refrigerator mothers’; Kanner, 1949) contributes to autism have been abandoned. Other suggested factors, such as the measles-mumps-rubella vaccine and thimerosal, have also been found to have no causal relationship with autism (Fombonne, 2008; Parker, Schwartz, Todd, & Pickering, 2004).

A number of prenatal and perinatal risk factors, such as maternal gestational diabetes and exposure to toxins, drugs, and air pollution have been suggested (Becerra, Wilhelm, Olsen, Cockburn, & Ritz, 2013; Gardener, Spiegelman, & Buka, 2009). Increased paternal, maternal and grandparental age has also been reported to be linked with autism risk (Frans et al., 2013; Hultman, Sandin, Levine, Lichtenstein, & Reichenberg, 2011; Reichenberg, Gross, Sandin, & Susser, 2010; Sandin et al., 2012).

Immune dysfunction has been reported as another possible risk factors, and this is considered as indirect evidence for environmental influences on autism (Chaste & Leboyer, 2012). A different immune cell profile in individuals with ASD compared to neurotypical group was found with increased number of B cells, NK cells (i.e., specific types of white blood cells that are part of innate immune system) and specific cell activation markers (Ashwood et al., 2011). Elevated activation of microglia and astrocytes in the brain has been suggested as one of the possible contributory factors to autism (Morgan et al., 2010; Pardo, Vargas, & Zimmerman, 2005). These possible inflammatory factors have been investigated along with their potential genetic links, but the findings remain difficult to interpret (Ashwood, Wills, & van de Water, 2006; Comi, Zimmerman, Frye, Law, & Peeden, 1999; Connolly et al., 2006; Lee et al., 2007; Mouridsen, Rich, Isager, & Nedergaard, 2007; Torres et al., 2006; Warren et al., 1996; Wills et al., 2007).

1.4.2 Genetic Factors

Genetic studies have shown that ASD is highly heritable. Folstein and Rutter's first systematic twin studies (Folstein & Rutter, 1977a, 1977b) reported high concordance rates (i.e. up to ~90%) in monozygotic (MZ) twins and further research (Bailey et al., 1995; Lichtenstein, Carlström, Råstam, Gillberg, & Anckarsäter, 2010) has supported the findings; a genetic influence on autism is no longer a matter of debate. Although Hallmayer and colleagues (2011) reported a lower heritability rate in their recent study, which is the largest population-based twin study, others note methodological issues with the study; such as high odd-ratios, low participation rates and not considering de novo mutations and single copy number variations (CNVs) (Chaste & Leboyer, 2012; Rutter, 2013; Sealey et al., 2016).

Different genetic changes associated with autism indicate genetic heterogeneity in autism (Jeste & Geschwind, 2014; Walsh, Morrow, & Rubenstein, 2008). Studies investigating autistic traits in families support the contribution of multiple interacting genes and also suggested possible gene-environment interactions (Bishop, Maybery, Wong, Maley, & Hallmayer, 2006; Losh & Piven, 2007). Recent advances in genetic studies facilitated investigation of genetic alterations related to autism (Jeste & Geschwind, 2014). Understanding these genetic alterations explains how unaffected parents, usually fathers, pass on mutations to their offspring. It also explains the increased risk for older unaffected parents to have affected offspring (Klevzon, Gross, & Reichenberg, 2007; Rapin & Tuchman, 2008; Reichenberg et al., 2006).

Innovations in epigenetics research have also had an impact on our understanding of autism. Epigenetic effects of noncoding RNAs might be responsible for the deficits seen in autism (Mehler & Mattick, 2006; Schanen, 2006). Considering the impact of environment on microRNAs and their effects on early development of brain mechanisms, epigenetics might aid understanding of the heterogeneous nature of ASD. More advances in research methods applying gene-environment interaction models with both human and animal studies will move the conceptualisation of the underlying causes of autism further (Kim and Leventhal, 2015).

1.4.3 Neurocognitive Factors

Autism is associated with several neuroanatomic and neurofunctional abnormalities. Differences in cortical volume and thickness (e.g. Hazlett et al., 2005; Zielinski et al., 2014) and growth in head circumference (Courchesne, 2004; Dawson et al., 2007b; Hazlett et al. 2005; Webb et al., 2007) compared to neurotypical (NT) young children have long been reported. It is important to note that developmental trajectories

may differ with age. In their meta-analysis, Redcay and Courchesne (2005) suggested that differences in the trajectories of brain growth between NT and ASD people appear to be limited to young children. However, studies using advanced techniques and wider age ranges suggested that the differences in brain anatomy between ASD and NT are still present in adulthood and appear to follow a distinct pattern compared to the trajectories reported in preschool years (e.g. Raznahan et al., 2010). Studies of brain anatomy and function in elderly people with ASD have scarcely begun, although Koolschijn and Geurts (2016) recently reported a vertex-wise whole-brain and region-of-interest analyses of cortical volume, thickness, surface area, and gyrification index in adults aged 30 to 75, with (N=51) versus without (N=49) ASD. They found age-related cortical thinning and volume loss but no group differences between ASD and NT.

Neurofunctional differences between NT and ASD individuals further draw attention to the cognitive basis of this condition. The regional brain activation profile of people with ASD during cognitive tasks (e.g. theory of mind, understanding irony, facial emotion perception, set-shifting, weak central coherence) has shown under-activation of some brain areas that are activated in NT people, whereas there is abnormal over-activation of other areas (e.g. Castelli, Frith, Happé, & Frith, 2002; Di Martino & Castellanos, 2003; Lee et al., 2007; Wang, Lee, Sigman, & Depretto, 2006). Abnormal brain connectivity (i.e. under-connectivity of functional brain regions) has also been associated with ASD (Ecker & Murphy, 2014; Just, Keller, Malave, Kana, & Varma, 2012; Mostofsky & Ewen, 2011; Tyszka, Kennedy, Paul, & Adolphs, 2014).

1.5 ASD and Cognitive Theories

The specific cognitive characteristics of ASD have been a major focus for theories of autism. These theories can be grouped into social and non-social cognitive accounts.

The theory of mind (ToM) hypothesis (for review, see Frith, Morton, & Leslie, 1991), one of the most influential social cognitive accounts of autism, has been suggested as an explanation of the social and communicative deficits in people with autism. Other socio-cognitive theories are related to other processes, such as emotion recognition and social motivation. On the non-social side, theories include the weak central coherence (CC) account of autism (Happé & Booth, 2008; Happé & Frith, 2006), and executive function (EF) deficits (Hill, 2004). While the executive dysfunction account has been suggested to explain repetitive behaviours, CC has been hypothesized as an account for the restricted range of interests and special talents of individuals with ASD. Best and colleagues (2008) showed that each cognitive theory independently predicted ASD symptoms as assessed by the Social Communication Questionnaire (SCQ, Berument et al. 1999) (Best, Moffat, Power, Owens, & Johnstone, 2008). However, interrelations have also been reported between theories in relation to their association with ASD symptoms.

The following sections provide more details on three major cognitive theories of ASD and their relations to each other and to autism symptoms. Among them ToM and CC were also experimentally examined in the present thesis (please see relevant chapters: Chapter 6 and Chapter 7).

1.5.1 Theory of Mind (ToM)

Theory of mind (ToM) refers to understanding mental states, such as intentions, thoughts, and beliefs, of ourselves and others. It is a part of a larger set of abilities, social cognition, which also includes emotion recognition and empathy. ToM develops step by step, following stages at critical ages. First-order ToM, understanding mental state of a single third agent, develops by approximately age 5 (Leslie & Thaiss, 1992;

Wimmer & Perner, 1983; Zaitchik; 1990), although it was reported that evidence for 1st-order mental health understanding could be seen in younger children (e.g., who were 18 months-old) (Miller, 2012; Repacholi & Gapnik, 1997). Children are assumed to understand second-order ToM, which requires understanding mental states of multiple parties, between ages 5-7 (Astington & Hughes, 2013; Astington, Pelletier, & Homer, 2002; Miller, 2012). After this point, attribution of more complex mental states become easier for individuals, which represents a well-delineated developmental pattern of ToM (Moran, 2013).

ToM is a critical skill involved in almost all social interactions. Understanding what other people are thinking is important not only for developing friendships and managing all types of social relationships, but also for protecting oneself against being deceived by others. Due to its crucial role in our lives, social cognition (including ToM) was hypothesized to have a domain-specific module independent from general cognition (Leslie, 1994). However, alternatively it was suggested that ToM may predicate domain-general abilities, such as meta-representation (e.g., thinking about (a representation) a drawing of an object which is a representation itself) (Stone & Gerrans, 2006).

Poor mind-reading skills in autism were highlighted by Rutter (1983) who described a young adult who complained about not being able to read others' mind and was therefore struggling in social relationships. Baron-Cohen and colleagues (1985) showed that fewer children with ASD passed ToM tasks than their NT counterparts (Baron-Cohen, Leslie, & Frith, 1985). These difficulties in the attribution of mental states are hypothesized to hinder individuals with autism from understanding social situations (Frith, 1989, 1994). Although communication with other people and

imagination skills are also likely to be related to ToM ability, the ToM account has been found to be limited in terms of explaining the RRBIs (Frith, 1996), and special talents in a minority of individuals with ASD (Goode, Rutter, & Howlin, 1994).

Recent studies supported the association between socio-communicative ASD symptoms and difficulties in ToM (e.g., Bennett et al., 2013; Lerner, Hutchins, & Prelock, 2011; Nagar Shimoni, Weizman, Yoran & Raviv, 2012). However, there are some studies, which could not find a significant relationship between ToM ability and ASD symptoms, including social and communication difficulties (e.g. Loth, Happé, & Gómez, 2010). Besides, when Bennett and colleagues (2013) found a link between early ToM in late childhood and later communication skills in adolescence, they could not find such a relation between ToM and social skills. Considering these findings, ToM and its association with ASD symptoms should be further investigated and the possible influence of other cognitive mechanisms should be taken into account.

This chapter represents only a brief introduction to ToM. A detailed review of age-related differences in ToM can be found in Chapter 2. A novel ToM task suitable for older adults is introduced with a brief review of ToM assessment tools in Chapter 5.

1.5.2 Executive Function (EF)

Executive function is an umbrella term for a range of cognitive processes, such as planning, memory, inhibition, and generativity. Early studies found that people with autism performed poorly on tasks tapping these cognitive skills, such as planning and inhibition (Hughes, Russell, & Robbins, 1994; Ozonoff, Pennington, & Rogers, 1991).

The executive dysfunction hypothesis has been suggested to explain mainly RRBIs in ASD (Turner, 1997). Early work (Turner, 1995) and more recent studies supported this hypothesis, finding an association between RRBIs and EF difficulties in

people with autism (e.g. Mosconi et al., 2009; Yerys, Wallace, & Harrison, 2009). These studies and others (e.g. D'Cruz et al., 2013; Reed, Watts, & Truzoli, 2013) reported that EF deficits are related specifically to RRBI symptoms, but not to social and communication impairments. Moreover, when each cognitive skill was examined separately different findings emerged. For example, Lopez and colleagues (2005) investigated adults with ASD and found that while inhibition, working memory and flexibility were related to RRBI, planning and fluency were not (Lopez, Lincoln, Ozonoff, & Lai, 2005). Given that the association found between RRBI and EF difficulties may differ based on which component of EF is considered, researchers have also investigated whether a similar dissociation is valid for different manifestations of RRBI. LeMonda and colleagues (2012) showed that ASD children (N=22, aged 7 – 9 years) who exhibited a higher number of motor stereotypies performed poorly in EF tasks (LeMonda, Holtzer, & Goldman, 2012). Furthermore, poor EF performance predicted engagement in stereotypic motor behaviours (e.g. rocking) for a longer amount of time in the ASD group, but not in a control group with developmental language disorders.

Although these studies reported evidence for the association between EF and specifically RRBI symptoms of ASD, others have reported contradictory results. For instance, Dichter et al. (2009) found that generativity difficulties were related to communication impairments in people with ASD, but not to RRBI. Zandt and colleagues (2009) found a relation between generativity and compulsions in people with ASD and additional obsessive-compulsive disorder, but not with other RRBI symptoms (Zandt, Prior, & Kyrios, 2009). In contrast to studies reporting a link between RRBI and inhibition skills (e.g. Lopez et al., 2005), Bishop and Norbury (2005) did not find a

significant association between inhibition and any ASD symptom. These mixed findings might be due to statistical reasons (e.g. insufficient power due to small sample size), or different measures used and/or different aspects of EF assessed (Teunisse, Cools, van Spaendonck, Aerts, & Berger, 2001; White, 2013).

EF has also been hypothesized to play a role in social interactions. For example, working memory may explain the reported association between EF and socio-communicative skills (Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002; Dichter, Lam, Turner-Brown, Holtzclaw, & Bodfish, 2009; McEvoy, Rogers, & Pennington, 1993). Moreover, Kenworthy and colleagues (2009) found that semantic fluency was related to social and communication impairments in a sample of 89 children with ASD (Mean age=9 years), while divided auditory attention (i.e., requires attention to more than one stimuli simultaneously) was only associated with social difficulties and flexibility with RRBIs, when they controlled for age and verbal ability (Kenworthy, Black, Harrison, della Rosa, & Wallace, 2009). In a recent longitudinal study, Pellicano (2013) found that early EF performance (on planning, flexibility and inhibition) predicted social-communication impairments (assessed by the ADOS-G; Lord, Rutter, DiLavore, & Risi, 1999) and repetitive behaviours (measured by the Repetitive Behaviour Questionnaire, RBQ: a modified questionnaire version of Turner's (1997) Repetitive Behaviours Interview) of children with ASD (N=37, Mean age=67.9 months) 3 years later. These findings indicate the need for more detailed and integrative studies on EF and ASD symptoms.

1.5.3 Local/Global Processing (Weak Central Coherence - CC)

The term 'weak central coherence', first coined by Frith (1989), refers to an inability to draw together small pieces of information to reach a global picture or

meaning in context. Early evidence for local processing bias in autism showed that people with autism could not take advantage of the meaning or context in perception, memory and language tasks (Frith & Happé, 1994). Happé (1997) suggested that poor performance of people with autism in reading homographs was related to their weak central coherence, since they were unable to use preceding sentence context to disambiguate the meaning/pronunciation. A superior eye for detail (Plaisted, O'Riordan, & Baron-Cohen, 1998), high performance on the Block Design subtest of the Wechsler Scales (Shah & Frith, 1993), and memory for exact pitch (Bonnell et al., 2003) are indicative of a local processing style in ASD.

The weak CC hypothesis aims to provide an explanation for insistence on sameness and restricted range of interests, different thinking style and also special talents in individuals with ASD (Happé & Vital, 2009). Although the findings are mixed regarding a possible association between weak CC and ASD symptoms, there are some studies supporting this hypothesis. Chen and colleagues (2009) investigated the possible link between RRBI and CC in children and found that visual detail focus (measured on EFT, Witkin, 1971) was related to RRBI (assessed by Childhood Routines Inventory: CRI, Evans et al., 1997) but not to sensory processing styles on the Short Sensory Profile (SSP, Dunn, 1999) (Chen, Rodgers, & McConachie, 2009). Loth and colleagues (2008) showed that autistic people's ability to use context-related cues (i.e. based on its appropriateness in a specific scene) had only a moderate relation with their RRBI scores (Loth, Carlos Gómez, & Happé, 2008). However, some studies did not find a link between CC and RRBI, in children with ASD or NT children (South, Ozonoff & Williams, 2007; Drake, Redash, Coleman, Haimson, & Winner, 2010, respectively).

It is also important to note here that an association between weak CC and social-communication impairments in ASD was also reported (Noens & van Berckelaer-Omnes, 2005, 2008). However, other researchers have found no link between the two (e.g. Morgan, Maybery, & Durkin, 2003; Teunisse et al., 2001). Even though the weak CC account of autism was suggested for non-social symptoms of autism (Happé & Frith, 2006), an association reported by Russell-Smith and colleagues (2012) between detail-focus and difficulties in social skills in a NT population suggests that it may be worth investigating possible relations between weak CC and social and communication skills (Russell-Smith, Maybery, Bayliss, & Sng, 2012).

1.5.4 Inter-Relations among the Cognitive Accounts of Autism

Studies have reported mixed results regarding relations among ToM, EF, and CC. Some researchers suggested that EF is primary in child development and depending on its successful development, intact ToM abilities can be developed (Pellicano, 2007; Russell 1996, 1997). Pellicano (2010b) showed that EF performance predicted ASD children's later (3-year time) ToM skills. However, recent work by White (2013) indicated that impaired ToM might negatively influence EF in autism. Her hypothesis, which is called 'Triple I Impairment' (i.e. 'Inferring Implicit Information'), suggests that because of difficulties in mental state attribution, people with ASD find understanding experimenter's intentions complicated and perform poorly in some EF tasks. Some research shows better EF performance when an experimenter is not involved (Ozonoff, 1995), but Williams and Jarrold (2013) failed to find a difference. Williams and Happé (2009) suggested that difficulties with mentalizing own intentions/future actions (e.g., imaginatively rehearsing them) might lead to poor planning performance in autism.

The relationship between ToM and CC is less clear (see Brunsdon & Happé, 2014 for a more detailed review). It was not always possible to find a link between ToM and CC in children with ASD (e.g. Burnette et al., 2005; Happé, 1994, 1997; Pellicano, Maybery, & Durkin, 2006 but Jarrold, Butler, Cottington, & Jimenez, 2000). Happé and Booth (2008) have suggested that local processing bias and deficits in global processing can be regarded as two distinct cognitive styles. This hypothesis might indicate a possible relation between ToM and poor global processing. Since social situations are complex in nature individuals with autism might have difficulties in integrating all parts of the social contexts and understanding it as an entity (Brunsdon & Happé, 2014). However, other hypotheses have suggested that local processing bias may also be related to ToM difficulties (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; Mottron, Dawson, Soulières, Hubert, & Burack, 2006). Besides evidence for possible relations between ToM and EF, and ToM and CC, it should be noted that studies have also provided complementary evidence for the independence of EF and CC (Booth, Charlton, Hughes, & Happé, 2003; Booth & Happé, 2010; Pellicano, 2010a, 2010b; Pellicano et al., 2006).

1.6 Summary

In this chapter an introduction to ASD has been provided. Although the main behavioural symptoms of autism are well established, research into prevalence within populations across ages still continues. Investigations into genetic, neural and environmental bases of autism have increased in recent years. Along with the findings from these studies, primary cognitive theories have also helped with understanding the core features of autism. ASD is a life-long condition, yet studies investigating developmental trajectories in adulthood have not been conducted until recently. In the

next chapter, age-related changes in the main cognitive features relevant to autism are described, in addition to changes in ASD symptoms, life outcome, and additional mental health conditions with age.

Chapter 2 Ageing in ASD and Relevant Cognitive Processes

2.1 Introduction

In this chapter, the concept of ageing in autism is introduced. Studies on ASD symptoms, quality of life (QoL), additional mental health disorders, and ASD related cognitive skills of older adults with autism are reviewed. Given the limited number of studies of older adults (i.e. mean age ≥ 50 years, see Totsika, Felce, Kerr, & Hastings, 2010, which is set as a cut-off age between younger and older adulthood in the literature), studies examining developmental changes in younger adults are also reviewed in later sections of this chapter. These studies are introduced in a specific order in each section: (i) studies specifically investigating the elderly (age ≥ 50 years) with ASD, (ii) studies including the elderly with ASD but with the mean age of the sample < 50 , (iii) studies including only young adults with ASD (mean age < 50).

2.2 Ageing and Autism Spectrum Disorder (ASD)

Autism Spectrum Disorder (ASD) is considered a life-long disorder; however, there are very few studies investigating age-related changes in older adults and elderly people with ASD, although there have been many studies examining developmental trajectories in children and adolescents, and some in young adults (see Howlin & Moss, 2012; Magiati, Tay, & Howlin, 2014; Seltzer, Shattuck, Abbeduto, & Greenberg, 2004 for reviews). The number of publications on ASD across age groups between 1946 and 2011 (see Figure 2-1) shows the gap in the literature and emphasizes the need for research on elderly people with autism (Mukaetova-Ladinska, Perry, Baron, & Povey, 2012).

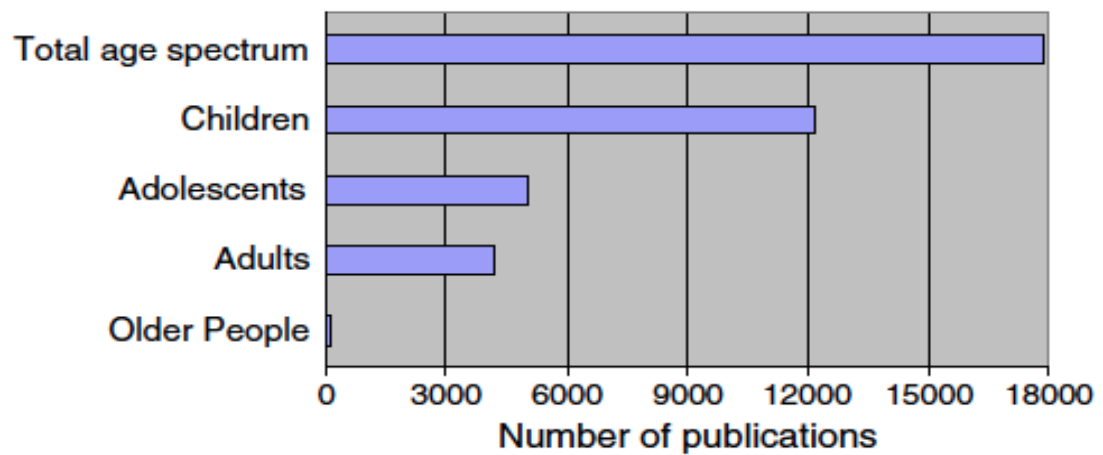


Figure 2-1 Number of publications (1946-2011) by age of ASD participants (Mukaetova-Ladinska et al., 2012)

Since then there has been an increased interest in this research field. However, when similar systematic search was conducted in PubMed, up to the 1st December 2016 with the following search items: ('ASD*' or 'autis*' or 'Asperger*') and ('old adult*' or 'elderly*' or 'old age*' or 'aged 50 and over*'), the search resulted in only 211 papers.

What we know about old age and ASD mainly comes from case studies (James et al., 2006; Naidu et al., 2006; van Niekerk et al., 2011), discussion papers (Mukaetova-Ladinska et al., 2012; Piven & Rabins, 2011; Povey, Mills, & Cuesta, 2011), and reviews (Happé & Charlton, 2011). Limited empirical research with older people with ASD indicates that the elderly with ASD are still suffering from ASD-associated difficulties in addition to poor quality of life, additional psychiatric disorders (especially anxiety and depression) and loneliness (Geurts & Vissers, 2012; van Heijst & Geurts, 2015; Stuart-Hamilton et al., 2009; Totsika et al., 2010).

Longitudinal and cross-sectional designs are the main two methods used in ageing studies. Studies adopting longitudinal designs are considered to lead to better results compared to cross-sectional methods in ageing research. This is mainly due to the

possible confounding effect of cohort differences on results (e.g., Hofer & Sliwinski, 2001; Kraemer, Yesavage, Taylor, & Kupfer, 2000; Payne & Payne, 2004). However, once the time and expenses are considered, longitudinal studies may not be always feasible. Besides, practice effects may distort the results when longitudinal methods are adopted in studies investigating cognitive performance (Salthouse & Nesselroade, 2002).

2.2.1 Ageing and ASD Symptoms

Since ASD is a lifespan developmental disorder, its symptoms should be investigated across a wide range of ages including older adults.

To our knowledge, there is no systematic research on ageing and symptom profile of the elderly with ASD. However, studies examining age-related changes in young adults may be an indicate of the ASD symptom profile in later life. These studies, adopting longitudinal and cross-sectional methods, sometimes included older adults who aged 50 years and over in their sample, yet the mean age remained below 50 years old.

Follow-up studies have documented that ASD related impairments continue into adulthood. Howlin and colleagues (2004) investigated 68 individuals with ASD (aged 21-48 years, $M_{age}=29.33$ years), who were first diagnosed when they were around 7 years old (age range 3-15 years), and reported that these individuals were still suffering from social and communication impairments, and restricted and repetitive behaviours in adulthood (Howlin, Goode, Hutton, & Rutter, 2004). Similarly, Billstedt and colleagues (2007) investigated 105 individuals (aged 17-40 years; $M_{age}=25.5$ years) who were first diagnosed in childhood (Billstedt, Carina Gillberg, & Gillberg, 2007). They revealed

that the majority of adults were still impaired and continued to meet the diagnostic criteria for ASD at follow-up, 13-22 ($M=17.8$) years after the diagnosis.

An abatement in ASD symptoms with advanced age was also reported in adults with ASD. Howlin et al. (2013) reported a decrease in symptom severity with increasing age in a group of adults with ASD ($M_{age}=44$) first diagnosed in childhood in a clinic. Improvements in autism symptoms were also found in a cohort (aged 17-35 years; $M_{age}=24.8$ years) followed up over 18 years from childhood to young adulthood, (Gray et al., 2012). Shattuck et al. (2007) showed that in a sample of 241 people with ASD (aged 10-52 years, $M_{age}=22$ years) overall change (in a 4.5 year period) in the core symptoms mostly reflected an improvement (i.e. in verbal communication, social reciprocity, and repetitive behaviours and stereotyped interests domains). However, impairments in nonverbal communication did not improve significantly. Cross-sectional analyses within the same study showed that being 31 years old and older, in contrast to 10-21 years old, predicted more impairment in nonverbal communication, but less impairment in repetitive behaviours and stereotyped interests. Similarly, Woodman and colleagues (2015) reported that ASD symptoms improved over 8.5 years in a community-based sample of adolescents and adults (aged 10-49 years; $M_{age}=21.72$ years, $SD=9.45$) (Woodman, Smith, Greenberg, & Mailick, 2015).

Overall age-related abatement in the core symptoms of ASD was also evident in other studies using a cross-sectional design. Seltzer et al. (2003) found age-related decline in symptom severity ($N=405$, aged 10-53 years), but also that the improvement in reciprocal social interaction domain was less profound than in communication domain. They revealed evidence for a dynamic and heterogeneous age-related change in symptoms. The greatest improvement was in “speaking minimum three-word phrases”

among all other difficulties and the poorest improvement was in friendships. Comparison across age cohorts, revealed that adolescents (aged 10-21 years; $M_{age}=15.71$) were less likely to meet current diagnostic cut-off in social interaction domain than adults (aged 22-53 years; $M_{age}=31.57$). However, similar to previous findings, adults were less impaired in all subdomains of RRBIs for current ratings. Also, adults displayed more improvement in overall language skills, and unusual preoccupations and complex mannerisms from ADI-R lifetime to ADI-R current scores than the younger cohort; improvements in other areas did not differ between groups. Similarly, Esbensen and colleagues (2009) found a significant negative correlation between age and the Repetitive Behaviour Scale-Revised (RBS-R: Bodfish, Symons, Parker, & Lewis, 2000; Lam & Aman, 2007) scores of individuals with ASD aged 2-62 years, suggesting that with increasing age individuals with ASD show less RRBIs, independent of the presence of ID, use of psychotropic medication, or gender (Esbensen, Seltzer, Lam, & Bodfish, 2009). Although the decrease was evident in each subscale, “restricted interests” and “stereotyped movements” showed the steepest drops. Results suggest that despite a relatively stable pattern of age-related change, heterogeneity of RRBIs is still present, especially when evaluated on the subtype-level. However, taking account of the limitations of the study (e.g. potential cohort effect due to the use of cross-sectional design and data used from different sources), further studies employing a longitudinal design are needed to corroborate the findings.

Although not traditionally considered one of the core symptoms of ASD, sensory abnormalities are now included in DSM-5 (APA, 2013). Kern and colleagues (2006) examined sensory abnormalities in a group of autistic individuals aged 3-56 years ($M_{age}=20$ years, $N=104$) using the Sensory Profile (Dunn, 1999) and the Childhood

Autism Rating Scale (CARS; Schopler, Reichler, & Renner, 1994). In their cross-sectional study, comparison between individuals with autism and gender and age-matched controls (i.e. community sample) showed that individuals with autism were significantly different in terms of their sensory abnormalities (in both low and high threshold categories). However, further analyses revealed that with increasing age this abnormal sensory profile (low and high threshold sensory processing of auditory, visual, and oral stimuli, and high threshold sensory processing of touch) of individuals with autism became more similar to controls, suggesting possible improvement with years (Kern et al., 2006). However, because of the wide age-range, it is not clear whether the improvement occurred in adulthood or childhood.

In contrast to studies reporting age-related improvement in ASD symptoms, two studies, Bastiaansen et al. (2011) in a group of high-functioning male adults with ASD ($N=38$, $M_{\text{age}}=31.82$ years recruited mainly via mental health organisations) and Bishop and Seltzer (2012) in 65 adults with ASD ($M_{\text{age}}=24.97$ years, $SD=8.22$, age-range: 18-52 years), reported no significant association between age and ASD symptoms (on the Autism Diagnostic Observation Schedule (ADOS) Module 4; Lord et al., 1999; 2000 and Autism-Spectrum Quotient: AQ; Baron-Cohen et al., 2001). Similarly, Crane and colleagues (2009) showed that age was not related to sensory sensitivity (on the Adult/Adolescence Sensory Profile: AASP; Brown & Dunn, 2002) in a small group of adults with ASD ($N=18$, aged 18-65 years, $M_{\text{age}}=41.78$, $SD=15.24$) (Crane, Goddard, & Pring, 2009).

In a recent cross-sectional study ($N=237$, $M_{\text{age}}=46.00$, $SD=13.8$ recruited through clinical sources and adverts on the client organization websites), Lever and Geurts (2016a) reported a non-linear age-related pattern. This showed that older adults with

ASD had more ASD symptoms (on the Autism-Spectrum Quotient: AQ; Baron-Cohen et al., 2001; Hoekstra, Bartels, Cath, & Boomsma, 2008) compared to young adults with ASD and middle-aged adults had more ASD symptoms compared to both young adults and old adults with ASD.

It is important to note that these improvements reported above usually represent a decline in terms of the severity of the symptoms, which, however, does not cancel out the pervasive effect of this neurocognitive disorder in affected people's lives, suggesting that their ASD related impairments continue into adulthood (Howlin et al., 2004). Nevertheless, it should also not be dismissed that some individuals with ASD, although representing a small number, may no longer meet the diagnosis when they become adults (Seltzer et al., 2003; 2004).

2.2.1.1 Predictors of Age-Related Differences in ASD Symptoms

Another point, which is as substantial as (maybe more than) the investigation of age-related changes of ASD symptoms, is understanding possible factors contributing or limiting their improvement with age. Intellectual functioning and language skills are the two most commonly suggested predictors of ASD symptom change. Mawhood and colleagues (2000) and Howlin et al. (2000) compared ASD-related impairments in male individuals first assessed at age 7-8, and then at age 23-24 years old with autism (N=19; M_{age}=23 years 9 months) versus those with developmental receptive language disorder (N=20; M_{age}=24 years 10 months) (Howlin, Mawhood, & Rutter, 2000; Mawhood, Howlin, & Rutter, 2000). Results indicated more improvement in the autism group, which was best predicted by the Peabody Picture Vocabulary Test (PPVT; Dunn, Dunn, Whetton, & Pintilie, 1982) scores in childhood. Similarly, Howlin and colleagues (2004) revealed that having a performance IQ score of 70 and over in childhood

($M_{age}=7.24$) was related to overall language competence (i.e. assessed by ADI) in adulthood ($M_{age}=29.33$). However, there was no significant group difference between childhood performance IQ-bands (i.e. ≥ 70 versus 50-69) in terms of their current abnormal use of language and the average number of RRBIs. Early verbal IQ scores were not associated with the symptom profile in adulthood, except for use of language. Similarly, employing a longitudinal regression analysis (i.e. 4.5 year-period), Shattuck et al. (2007) found that intellectual disability (ID) and overall language level were the significant predictors of symptom change. Thus, having ID predicted more impairments in verbal and nonverbal communication, social reciprocity, and repetitive behaviours and stereotyped interests domains; higher overall language levels predicted less impairment in social reciprocity. In line with other studies in the literature, Billstedt et al. (2007) reported speech before age 5 (for social interaction, reciprocal communication and limited pattern of self-chosen activities), childhood IQ (for social interaction and limited pattern of self-chosen activities) as significant childhood predictors for ASD impairments in adulthood (i.e. measured on items in the Diagnostic Interview for Social and Communication Disorders - DISCO; Wing, Leekam, Libby, Gould, & Larcombe, 2002). Esbensen et al. (2009) found that individuals having both ID and ASD showed less age-related improvements in stereotyped movements subscale scores on the Repetitive Behaviour Scale-Revised (RBS-R; Bodfish et al., 2000) than individuals with ASD only.

Other suggested predictors of ASD symptoms include gender and additional medical disorders such as fragile X syndrome and neurofibromatosis. Being female significantly predicted poorer social interaction skills in adulthood (Billstedt et al., 2007), and more self-injurious behaviours (Esbensen et al., 2009; but see also Gray et

al., 2012). Although to a lesser degree than gender, other medical disorders in childhood were reported to be negatively predictive of reciprocal communication ability in adulthood. Also, having epilepsy before 5 years of age was also significantly associated with adult social interaction and reciprocal communication skills, although the correlation was weaker compared to other predictors such as IQ and early language skills (Billstedt et al., 2007).

The on-going difficulties in the core symptoms of ASD demand further investigation due to heterogeneity of the manifestations, possible confounding factors, and interactions with changes caused by healthy aging. Despite an overall abatement of symptom severity with increasing age, this age-related change appears to be more dynamic for some affected individuals, suggesting heterogeneity of prognosis as well as symptom profile. This was demonstrated in an early study by Gillberg and Steffenberg (1987) in which 35 % of the individuals (aged 6-11 through 16-23 years) with infantile autism experienced a short period of increment in some of their behavioural symptoms (e.g., insistence on sameness).

In addition to these possible factors, some authors (e.g. Kanner, 1973; Perkins & Berkman, 2012) suggested that increasing self-awareness with age might influence the improvement in older individuals with ASD. Quality of mother-child relationship and maternal praise were also found as significant predictors of ASD symptoms in adulthood (Woodman et al., 2015). Therefore, factors influencing the functioning of older adults with ASD comprise an essential part of understanding life-span outcome for affected individuals. This multi-faceted approach requires investigation of other domains of adult functioning in the spectrum, such as quality of life and other life outcomes (e.g. education, employment, and independence).

2.2.1.2 Summary of Findings from Studies of ASD Symptoms in Older Adults with ASD

To sum up, ASD symptoms continue to be pervasive for adults with ASD when they age, although some improvements can be seen especially in terms of RRBIs. Intellectual ability and language skills are the most reported two possible predictors of symptom improvement. However, more research needed for examining other possible factors alleviating ASD symptom severity in adults and age-related symptom change in the elderly with ASD.

2.2.2 Ageing and Life Outcome in ASD

Age-related changes in life outcome of individuals with ASD is also of critical importance, especially for a better understanding of their later functioning and quality of life (QoL). The limited number of existing studies have reported various results; although, considered overall, the data suggest that the majority of young (e.g. Stuart-Hamilton & Morgan, 2011) and old (e.g. van Heijst & Geurts, 2015; Totsika et al., 2010) adults have poor life outcome. Life outcome assessment is usually based on independence, employment, and social relationships (Howlin & Moss, 2012); however, the World Health Organization defines QoL as a broader concept that includes also satisfaction, expectations, and goals in life (WHO, 1995).

2.2.2.1 Age-Related Differences in Adaptive Skills

Given that adaptive skills are also related to individuals' daily functioning, it is important to know developmental trajectories and age-related differences in these skills for a better understanding of later life outcome in ASD. Although poorer adaptive skills were reported in elderly people with ASD and ID compared to people with ID-only (Matson, Rivet, Fodstad, Dempsey, & Boisjoli, 2009; Totsika et al., 2010),

developmental trajectories in older ages with ASD remain unknown. In addition to evidence for less adaptive skills and more behaviour problems in older adults with both ID and ASD (aged 50+ years), Totsika and colleagues (2010) found age-related differences between young and old groups in terms of behaviour problems and amount of staff attention required, with more problems in the younger group, suggesting a decrease in problem behaviours with age. However, these findings should be considered carefully since the ASD status was determined by evaluating the triad of impairments based on participants' scores on a screening tool (the Daily Assessment Schedule; DAS, Holmes, Shah, & Wing, 1982) rather than a clinical diagnosis. It is important too, to note that these studies are cross-sectional; longitudinal studies are needed in order to eliminate possible "healthy survivor effect", i.e. the elderly investigated in the study might be a group of skilled individuals who were able to reach older ages (Totsika et al., 2010, p.1176).

Smith and colleagues (2012) examined daily living skills of individuals with ASD (N=397, aged 10-52 years, $M_{age}=21.84$ years) over a 10-year period and found that although their daily living skills improved in adolescence and early 20s, they plateaued during their late 20s and declined in their early 30s (Smith, Maenner, and Seltzer, 2012). Shattuck et al. (2007) found that maladaptive behaviours (assessed by the Problem Behaviour scale of the Scales of Independent Behaviour-Revised; SIB-R: Bruininks, Woodcock, Weatherman, & Hill, 1996) of individuals with ASD (N=241, aged 10-52 years, $M_{age}=22$ years) decreased over time (in a 4.5 year-period). A subgroup of cross-sectional analyses in this study also showed that being 31 or older predicted more improvement in maladaptive behaviours in 4.5 year-period (Time 1-4)

and fewer maladaptive behaviours at Time 1 than those aged 10-21 (Shattuck et al., 2007).

Similar results were reported in young adult studies showing decreases in maladaptive behaviours (e.g. Anderson, Maye, & Lord, 2011) and increased adaptive functioning (e.g. Gillespie-Lynch et al., 2012) since childhood. Jacobson and Ackerman (1990) also found that adults with ASD (aged 22-35 years, $M_{age}=26.33$ years) had poorer adaptive skills compared to adults with ID, although children with ASD had superior adaptive skills than their counterparts with ID. Similarly, Woodman et al. (2015) found improvements in maladaptive behaviours (on the Problem Behaviour subscale of the Scales of Independent Behaviour-Revised; Bruininks et al., 1996) in a period of 8.5 years in a group of high-functioning male adults with ASD ($N=38$, $M_{age}=31.82$ years recruited mainly via mental health organisations).

2.2.2.2 Age-Related Differences in QoL

To our knowledge only two cross-sectional studies investigated age group differences among specifically old adults with autism in terms of QoL. Totsika and colleagues (2010)¹ examined quality of life, in addition to adaptive skills and behaviour problems as reported above, in a group of older people ($N=282$; aged 50 years and over) with ID and with ($N=87$) versus without ($N=195$) ASD who were drawn from 5 different studies (Baxter et al., 2006; Felce, Jones, Lowe, & Perry, 2003; Felce, Lowe, & Jones, 2002; Jones et al., 2001; Perry & Felce, 2005). Results showed that people

¹ ASD status was determined by evaluating the triad of impairments based on participants' scores on a screening tool (the Daily Assessment Schedule; DAS, Holmes et al., 1982) rather than a clinical diagnosis.

with both ID and ASD symptoms had poorer QoL scores (except for the “Index of Community Activities (ICI)”, modified by Felce et al., 1998), which was a function of their poorer adaptive skills. Comparisons between younger and older adults with ID and ASD revealed that the ICI, the Index of Participation in Domestic Life (IPDL; Raynes, Wright, Shiell, & Pettipher, 1994), and time spent in activities did not differ between the young and older group, suggesting that QoL is independent from age. Van Heijst and Geurts (2015) drew similar conclusion when they examined 24 elderly people (aged 58-83 years, $M_{age}=63.7$) with ASD, showing that their QoL was independent from how old they are.

Although the mean age remained below 50 years, studies examining young adults with autism, sometimes including older adults with ASD in their sample, have provided evidence for developmental trajectories of QoL in autism. Howlin and colleagues (2013) investigated life outcome (e.g. independent living, employment, and social relations) assessed by a composite outcome measure (Howlin et al., 2004), in a group of adults with ASD ($N=60$, aged 29-64 years, $M_{age}=44$) who were first diagnosed in childhood (aged 2-13 years, $M_{age}=6$ years). They found that social outcomes became worse with increasing age. 60% of the adults had “poor” or “very poor” outcomes, while only 17% had “good” or “very good” outcomes, indicating on-going difficulties in life outcome. Although using a cross-sectional design, Orsmond and colleagues (2004) showed that adolescents ($M_{age}=15.48$ years) with ASD are more likely to have peer relationships than young adults ($M_{age}=30.74$ years), suggesting poorer relationships with age (Orsmond, Krauss, & Seltzer, 2004). However, this might be due to environmental contributors, such as school support, that are more readily available for adolescents. Renty and Roeyers (2006) examined 58 high-functioning young adults with

ASD (Full-scale IQ=70-139) aged 18-53 years ($M_{age}=28.34$ years) and revealed that age was not associated with individuals' quality of life.

2.2.2.3 Predictors of Age-Related Differences in Life Outcome

Commonly suggested factors contributing to age-related differences in life outcome of young adults with ASD are IQ (Gillespie-Lynch et al., 2012; Howlin et al., 2013; Kobayashi, Murata, & Yoshinaga, 1992) and language skills (Ballaban-Gil, Rapin, Tuchman, & Shinnar, 1996; Eaves & Ho, 2008; Gillespie-Lynch et al., 2012; Howlin et al., 2013), similar to the main predictors of ASD symptom differences with age. Farley and colleagues (2009) followed up 41 individuals with ASD with a minimum full-scale IQ of 70 and showed that early ($M_{age}=7.2$ years) full-scale IQ moderately predicted the overall social outcome (estimated by Howlin et al. (2004)'s method) of adults ($M_{age}=32.5$), while verbal and nonverbal IQ scores did not. Also, the change in IQ scores between the two time points was associated with social outcome score, suggesting that increased global IQ was associated with a better outcome. Similarly, Cederlund and colleagues (2008) showed in a group of individuals with Asperger's syndrome ($M_{age}=21.5$ years) followed up more than 5 years after the original diagnosis, that sub-groups with "Good" and "Poor", "Good" and "Fair", and "Restricted" and "Poor" outcome (i.e. assessed by Lotter's (1978) criteria) differed in terms of their Full-scale and Verbal IQ scores, suggesting a higher Full-scale and verbal IQ are associated with better outcome with age (Cederlung, Hagberg, Billstedt, Gillberg, & Gllberg, 2008).

Orsmond et al. (2004) investigated 185 adults (aged 22-47 years; $M_{age}=30.74$ years) and 50 adolescents (aged 10-21 years; $M_{age}=15.48$ years) with autism. Regression analyses showed that, for the overall group, having peer relationships was predicted by

both age and current social skills. This might be an indication of how social skills might be affecting age-related changes in life outcome. Although in an early study Szatmari and colleagues (1989) did not find any correlation between the two (Szatmari, Bartolucci, Bremner Bond, & Rich, 1989), Howlin and colleagues (2013) did show that early social skills predicted better life outcome in young adulthood.

2.2.2.4 Summary of Findings from Studies of Life Outcome in Older Adults with ASD

To summarise, old adults with ASD have poor QoL, which is similar to what was found in young adult studies. The most common two predictors of better QoL in adulthood are IQ and language skills. Social skills were also suggested as a factor contributing a better life outcome in adults with ASD. Further research is needed to examine QoL and its possible predictors in the elderly with ASD.

2.2.3 Ageing and Additional Mental Health Disorders in ASD

The majority of individuals with ASD suffer from at least one comorbid psychiatric disorder (Eaves & Ho, 2008; Ghaziuddin & Zafar, 2008; Simonoff et al., 2008; Stewart, Barnard, Pearson, Hasan, & O'Brien, 2006). Although high rates of additional mental health problems were frequently reported in clinical samples (recruited upon a referral to psychiatric services; e.g. Ghaziuddin & Zafar, 2008; Lainhart, 1999; Mouridsen, Rich, & Isager, 2008; Stewart et al., 2006), community based and follow up studies investigating people with ASD showed fewer additional psychiatric disorders, affecting around 25%-30% (Brugha et al., 2011; Hutton, Goode Murphy, Le Couteur, & Rutter, 2008; Underwood, McCarthy, & Tsakanikos, 2010).

Additional psychiatric disorders appear to have a negative impact on adaptive skills of young and old adults with autism (e.g. Matson et al., 2009). These additional

conditions, mostly attention deficit hyperactivity disorder (ADHD), anxiety, depression and obsessive-compulsive disorder (OCD), have been widely reported in adult studies which included the elderly in their sample, but when the mean age remained below 50 years (Bakken et al., 2010; Buck et al., 2014; Croen et al., 2015; Ghazuiddin & Zafar, 2008; Gillot & Standen, 2007; Hofvander et al., 2009; Hutton et al., 2008; Joshi et al., 2013; Roy, Prox-Vagedes, Ohlmeier, & Dillo, 2015; Stuart-Hamilton & Morgan, 2011).

Reflecting the gap in the literature, to our knowledge only three systematic studies investigated additional psychiatric disorders in older adults with mixed findings. Totsika and colleagues (2010)² found that older adults (aged 50+ years; $M_{age}=59.1$ years) with ID and ASD did not differ significantly from older adults (aged 50+; $M_{age}=61.3$ years) with ID alone in terms of psychiatric caseness, when groups were matched on adaptive behaviour scores (on the Adaptive Behaviour Scale Part One-ABS-RC: 2; Nihira, Leland, & Lambert, 1993). Comparison of two adult groups, younger (aged 18-49 years) and older adults (aged 50+ years) with ID and ASD, revealed that psychiatric disorders were significantly fewer in older than younger adults (31.7% vs. 49.7%). Similarly, Lever and Geurts (2016b) found that older adults ($N=45$, $M_{age}=63.9$ years) had fewer psychiatric conditions (lifetime rates on the Mini International Neuropsychiatric Interview Plus: MINI-Plus; van Vliet, Leroy, & van Megen, 2000), especially social phobia, compared to middle-aged ($N=47$, $M_{age}=47.2$ years) and young adults ($N=46$, $M_{age}=28.8$ years).

² ASD status was determined by evaluating the triad of impairments based on participants' scores on a screening tool (the Daily Assessment Schedule; DAS, Holmes et al., 1982) rather than a clinical diagnosis.

Other studies, however, suggest that older adults show more psychiatric symptoms than young adults with ASD. Davis and colleagues (2011) investigated age-related changes in anxiety symptoms of people with autistic disorder (many with ID). They compared four different age groups: toddlers (aged 17-36 months), children (3-16 years), young adults (20-48 years), and old adults (49-65 years). The anxiety symptoms of different age groups showed a cubic trend, suggesting that the level of anxiety increases from toddlerhood to childhood, then decreases until young adulthood, and finally increases again from young adulthood to older adulthood. The authors indicated that the cubic trend of anxiety symptoms might be associated with a similar trend that was found for RRBIs. According to this suggestion, RRBIs might be a way of alleviating anxiety, when individuals with ASD are unable to deal with it through other ways. However, this suggestion does not seem to fully explain the trajectory, especially for the elderly, since elderly people with ASD are usually found to have reduced RRBIs relative to younger people. It should also be noted that different instruments were used in the different age groups in this study, which might limit the results.

To our knowledge, studies investigating possible factors contributing to age-related differences in mental health in adults with ASD have not been published yet. However, there are studies showing associations with mental health problems in young adulthood with ASD. For example, intellectual functioning has been suggested as a possible contributor to additional mental health disorders in ASD, although the findings are inconsistent. Thus, while some studies could not find differences between groups with different IQ levels (e.g. Hutton et al., 2008), others suggest that people with ASD and an average/over average level of IQ are more likely to have comorbid psychiatric disorders than adults of lower IQ (Buck et al., 2014; Ghaziuddin, Ghaziuddin, &

Greden, 2002; Sterling, Dawson, Estes, & Greenson, 2008). Other possible contributors to comorbid mental health problems in adults with ASD might be dealing with ASD-related difficulties, negative life events (e.g. restricted social support), or genetic liability (Ghaziuddin, Ghaziuddin, & Greden, 2002). Studies investigating these possible risk factors for additional psychiatric conditions in older adults are needed.

2.2.3.1 Summary of Findings from Studies of Mental Health Functioning in Older Adults with ASD

Overall, results showed that additional mental health conditions are common in old adults with ASD, similar to young adults. However, findings are mixed in terms of age-related changes in additional mental health symptoms in old adults with ASD. Higher IQ was suggested as a possible predictor of having mental health condition in young adults with ASD, but lack of difference between different IQ bands was also reported. Further research is needed to examine co-occurrence of mental health symptoms in the elderly with ASD.

2.2.4 Ageing and Cognitive Abilities in ASD

Understanding neurocognitive accounts of ASD across all stages of life-span is important for exploring developmental trajectories in ASD, and thus helping with planning future provision of learning opportunities and targeted interventions for older adults with ASD. To date there are only two published experimental studies about possible age-related effects on core cognitive features of autism: Geurts and Vissers (2012) compared executive functions of older and younger adults with ASD. This study showed that high-functioning older adults with ASD ($N=23$, aged 51-83 years, $M_{age}=63.6$ years) had impaired fluency, attention and working memory compared to healthy controls. Results also indicated different developmental trajectories between

neurotypical (NT) and autistic individuals in terms of their cognitive skills. Compared to healthy individuals, ageing seems to affect fluency less in older adults with ASD, while bigger impact is seen on their visual memory skills (Geurts & Vissers, 2012). In a larger group of older adults with ASD ($N=57$, $M_{\text{age}}=60.8$ years, $SD=6.9$, age-range: 50-79 years), Lever and Geurts (2015) examined a group of cognitive skills, including ToM and generativity, compared to a matched NT group ($N=56$, $M_{\text{age}}=61.5$ years, $SD=7.2$, age-range: 50-77 years). They found that older adults with and without ASD had similar ToM performance, but more generativity problems were found in the ASD group. Effect of age and age by study group interaction were not significant for both skills (Lever & Geurts, 2015). To our knowledge there is no published research investigating age-related differences in detail-focused cognitive style in old adults with ASD.

Using advanced ToM tasks, studies showed that difficulties with attribution of mental states persisted among adults with ASD (e.g. Baron-Cohen et al., 2001; Beaumont & Newcombe, 2006; Lever & Geurts, 2015; Happé, 1994; Heavey, Phillips, Baron-Cohen, & Rutter, 2000; Rutherford, Baron-Cohen, & Wheelwright, 2002). A limited number of studies on local processing in adults with autism indicated that local processing bias also continued in adulthood (e.g. Jolliffe & Baron-Cohen, 1997, 1999, 2000; Rumsey & Hamburger, 1988; Pring, Hermelin, & Heavey, 1995, but e.g. Beaumont & Newcombe, 2006). Age-related effects in adulthood were reported to be parallel with NT adults (i.e. a decline) in a number of cognitive abilities including generativity and ToM (Lever & Geurts, 2015) or to be reduced in working memory (Lever, Werkle-Bregner, Brandmaier, Ridderinkhof, & Geurts, 2015). However, individuals in these studies were mainly aged below 50 years. Further studies are needed to understand how age-related changes in cognitive domains manifest in the

elderly with ASD and whether cognitive developmental trajectories in ASD may differ from healthy ageing. In the next part, age-related effects on cognitive domains relative to ASD in healthy ageing have been reviewed.

2.2.4.1 Healthy Ageing and Cognitive Abilities Relevant to ASD

Studies examining neurocognitive profiles in healthy ageing in relation to the cognitive accounts of autism should be taken into account in order to consider and predict developmental cognitive trajectories of older adults with ASD. Healthy ageing studies investigating changes in cognitive abilities have reported declines as well as stability in some cognitive skills. Also, performance in some cognitive behaviours starts to decline later in life, rather than a continuous decrement throughout adulthood. Studies are mostly on EF, although there is some research on social cognition. Age-related changes in cognitive abilities that are relevant in autism, namely theory of mind (ToM), weak central coherence (CC), and executive functions (EF), are discussed below. Since EF is beyond the scope of this thesis, work on healthy ageing and EF is only briefly discussed.

2.2.4.1.1 Theory of Mind (ToM) in Healthy Ageing

Initial work by Happé and colleagues (1998) found that older people ($N=19$, $M_{age}=73$ years; age-range: 61-80 years) had better ToM abilities than younger people ($N=67$, $M_{age}=21$ years; age-range: 16-30 years) on a verbal task (the Strange Stories; adapted from Happé, 1994) (Happé, Winner, & Brownell, 1998). In this task, there are two groups of stories: ToM stories and control stories that do not require mental state attributions. Results showed that although young and old groups did not differ in their understanding of the control stories, older people performed better on the ToM stories than the young group. However, IQ and other demographics were not measured in the

study and it is possible that the results reflect cohort effects; the older group was comprised volunteers in a university subject pool, while the young group were undergraduate students taking part for course credit. It may be, therefore, that the older volunteers were a selected sample with unrepresentatively good intellectual or social functioning.

Indeed, subsequent research has not replicated ToM superiority in older adults. Most studies have reported either a decline with age (e.g. Charlton, Barrick, Markus, & Morris, 2009; Maylor, Moulson, Muncer, & Taylor, 2002) or similar performance between young and old adults in ToM skills (MacPherson, Phillips Della Sala, 2002; Saltzman, Strauss, Hunter, & Archibald, 2000). Comparing three different age groups (N=25 in each group): young adults ($M_{\text{age}}=19$ years; age-range: 16-29 years), young-old adults ($M_{\text{age}}=67$ years; age-range: 60-74 years) and old-old adults ($M_{\text{age}}=81$ years; age-range: 75-89 years), Maylor et al. (2002) examined age-related effects in ToM performance (on the Strange Stories; Happé, 1994; Happé et al., 1998). Different to Happé and colleagues' (1998), they found that older adults' performance on the Strange Stories battery was poorer than that of young adults. The poorer performance of older adults remained even when a subgroup of 35 old adults ($M_{\text{age}}=70.7$, age range: 61-80 years) were matched on age to the old group in the former study (Happé et al., 1998) and separately examined.

Using a visual task (the Reading the Mind from The Eyes Test³: RMET; Baron-Cohen et al., 2001) that involves real photos of people's eye region, from which participants should guess their thoughts and feelings by choosing one of the options given, Pardini and Nichelli (2009) found that both late middle-aged (N=30, age range: 55–65 years) and elderly (N=30, age range: 70–75 years) groups were impaired on the RMET (Baron-Cohen et al., 2001) relative to young adult group (N=30, age range: 20–25 years). Since differences between early middle-aged (N=30, age range: 45–55 years) and late middle-aged adults were subtler, and no significant difference was detected between young and early middle-aged adults, the authors suggested that age-related ToM differences possibly become more obvious after age 55. However, two recent studies (Castelli et al., 2010; Li et al., 2013) found equal performance in young and old adults on the same task. One possible reason for not detecting differences between age groups might be using a short version of the task (24 items instead of 36). Despite similar performance across age groups, Castelli and colleagues (2010) revealed that different brain regions (young adults: superior frontal gyrus, the lingual gyrus bilaterally and the anterior cingulate cortex; old adults: the bilateral precentral gyrus, the inferior frontal gyrus, the superior temporal gyrus and the claustrum bilaterally) were activated in the older group (N=12, M_{age}=65.2, age-range: 60–78 years) compared to young group

³Although the RMET (Baron-Cohen et al., 2001) is reported here as a ToM task, it should be acknowledged that the task does not only requires attribution of mental states but also emotional states. Since it has been widely used in the literature as a ToM task, the same way was followed in the current chapter.

($N=12$, $M_{age}=25.2$, age range: 21-30 years) during the RMET, suggesting possible differences in brain functions in cognition due to healthy ageing.

There were also some studies (German & Hehman, 2006; Keightley, Winocur, Burianova, Hongwanishkul, & Grady, 2006) that could not find ToM-specific decline with age; age-related decline occurred in both ToM and control items (i.e. which did not require mental state attributions). In contrast, Keightley and colleagues (2006) showed that older people ($N=30$, $M_{age}=72.5$ years) differed significantly from young adults ($N=30$, $M_{age}=25.7$ years) on both ToM and control conditions using stories (Fletcher et al., 1995) and cartoons (Gallagher et al., 2000). Similarly, German and Hehman (2006) found that younger adults ($N=27$, $M_{age}=20$, age-range: 18-26 years) had a superior performance than old adults ($N=20$, $M_{age}=78$, age-range: 62-90 years) not only in ToM stories but also in control stories (on a verbal belief-desire reasoning task that they developed).

Different age-related effects were reported depending on the type and complexity of mental state reasoning. Phillips et al. (2011) found that older adults ($N=36$, $M_{age}=74$; $SD=73.67$ years, $SD=5.06$, age-range: 65-88 years) performed poorly on false belief videos (and stories), but not on true belief videos and stories (the Tom videos task and the ToM stories task; Phillips et al., 2011) compared to young ($N=52$, $M_{age}=25.81$ years, $SD=5.45$, age-range: 18-39 years) and middle-aged ($N=41$, $M_{age}=51.80$ years, $SD=8.73$, age-range: 40-64 years) adults, indicating that age-related effects on true and false-belief reasoning might differ. Castelli et al. (2010) found that old adults were successful on first-order ToM (the Deceptive Box Task: DBT; Perner, Leekam & Wimmer, 1987), but impaired in second-order ToM skills (the look-prediction and say-prediction task; Antonietti, Liverta-Sempio & Marchetti, 1999; Perner & Wimmer, 1985; Sullivan,

Zaitchik & Tager-Flusberg, 1994) similar to McKinnon and Moscovitch (2007) (on a stories task that they developed).

Some of these discrepancies in findings might be due to methodological considerations, such as ceiling effects on task performance (e.g. in German & Hehman, 2006; Keightley et al., 2006; MacPherson et al., 2002; Saltzman et al., 2000), small number of items used to measure ToM (e.g. in German & Hehman, 2006; Keightley et al., 2006; Maylor et al., 2002), small sample size (i.e. 8-20 people in old groups especially: e.g. in Happé et al., 1998; German & Hehman, 2006; McKinnon & Moscovitch, 2007; Saltzman et al., 2000). Also, ToM in older adulthood is rather more complicated since ToM performance in old age might be affected by age-related decline in other cognitive skills (e.g. EF). In the next section, studies testing/controlling possible effects of other cognitive skills on age-related effects on ToM performance are reviewed.

2.2.4.1.1.1 Effects of Other Cognitive Abilities on Age-Related Differences in ToM Performance

Some studies directly and indirectly attempted to control for the interfering effect of other cognitive abilities (e.g. IQ and EF) on ToM task performance, either by matching sample groups on these cognitive abilities or by investigating correlations and mediation effects and sometimes manipulating cognitive demands on ToM tasks. Although demands on some other cognitive skills are assumed to be reduced in visual tasks relative to verbal ToM tasks, studies using both types of task separately investigated possible effects of a range of cognitive abilities, including EFs, on age-related ToM differences.

IQ and language skills have been suggested as possible factors affecting age-related changes in ToM in adulthood, although results were mixed especially for verbal tasks. Charlton et al. (2009) showed, in a large ($N=106$) group of elderly participants ($M_{age}=69$, age-range=60-85 years), that verbal intelligence partially and performance IQ fully mediated the negative association between ToM (on the Strange Stories; Happé et al., 1998) and age. In a recent study, Li et al. (2013) did not find a significant difference in ToM performance (on the False-Belief; Perner & Wimmer, 1985 and Faux-Pas tasks; Li et al., 2013) between young ($N=27$, $M_{age}=22.67$, age-range: 19-28 years) and old ($N=20$, $M_{age}=73.30$, age-range: 60-91 years) adults when matched on (high) educational level, whereas old adults with low education performed significantly worse than these groups, suggesting that educational level, which may be considered as a proxy of intellectual functioning, might have an effect on age-related differences in ToM story performance. However, given that there was no young group with low educational level for comparison in the study, the results must be interpreted with caution.

Unlike the studies above, it was also reported that age-related decline in ToM performance on verbal tasks was independent from verbal and fluid intelligence. Slessor and colleagues (2007) reported an age-related decline in ToM performance (on a modified multiple-choice stories task based on Channon & Crawford, 2000; Happé et al., 1998; Stone, Baron-Cohen & Knight, 1998) when they controlled for vocabulary differences between young ($N=40$, $M_{age}=20.08$ years, $SD=4.64$, age-range: 16-40 years) and old groups ($N=40$, $M_{age}=66.95$ years, $SD=4.31$, age-range: 60-74 years) (Slessor, Phillips, & Bull, 2007). Maylor et al. (2002) also showed that poorer ToM performance (on the Strange Stories, Happé et al., 1998) with age was independent from vocabulary

skills. Halberstadt and colleagues (2011) reported that group differences in crystallized intelligence (tested on the first two subtests of the Culture Fair IQ Test, Cattell & Cattell, 1959) and fluid intelligence (assessed by the Peabody Picture Vocabulary Test, Dunn & Dunn, 2007) did not account for the age-related differences in faux pas understanding (a task using short videos taken from a famous TV series devised for the study) between old ($N=61$, $M_{age}=70.5$, age-range=60-85 years) and young ($N=60$, $M_{age}=20.5$, age-range=18-35 years) adults (Halberstadt, Ruffman, Murray, Taumoepeau, & Ryan, 2011).

Using both verbal and video ToM tasks, Sullivan & Ruffman (2004b) found that younger adults' ($N=24$, $M_{age}=30$, age range=20-46 years) better performance on ToM stories (assessed by Strange Stories task: Happé et al., 1998) than that of older adults ($N=24$, $M_{age}=73$, age range=60-82 years) did not co-vary with differences in crystallized abilities (measured on the National Adult Reading Test: NART, Nelson and Willison, 1991), but did relate to fluid intelligence (measured on the AH4; Heim, 1970). They also reported that poorer performance by older adults on a task involving short and silent videos about real-life situations (13 short videos taken from TV programmes, news, and movies: see Sullivan & Ruffman, 2004b for more details) was independent of both fluid and crystallized intelligence. This indicated that the effect of verbal and performance IQ might differ depending on the modality of ToM tasks.

In parallel with this finding, direct age-related decline in ToM performance on visual/videos task has widely been found. Similar to Sullivan and Ruffman (2004b), in a recent study using the same video task (Sullivan & Ruffman, 2004b), Rakoczy and colleagues (2012) found that poorer ToM performance in older adults, was independent from crystallized intelligence (which was matched across groups) (Rakoczy, Harder-

Kasten, & Sturm, 2012). Bailey and Henry (2008) also found that fluid intelligence did not affect the age-related decrement in ToM performance on visual and video ToM tasks (the RMET; Baron-Cohen et al., 2001, and the Reality–Known task; Samson, Apperly, Kathirgamanathan, & Humphreys, 2005) comparing young adults ($M_{age}=19.5$, age range=18-26 years) and old adults ($M_{age}=72.2$, age range=62-82 years). Phillips et al. (2002) showed that older adults ($N=30$, $M_{age}=69.2$, age range=60-80 years) performed worse than younger adults ($N=30$, $M_{age}=29.9$, age range=20-40 years) on the RMET (Baron-Cohen et al., 2001), when differences in years of education, crystallized and fluid intelligence were taken into account (assessed by the Wechsler Adult Intelligence Scale-3 subtests vocabulary and matrix reasoning, respectively, Wechsler, 1997) (Phillips MacLean, & Allen, 2002). Similarly, Slessor et al. (2007) showed in a larger sample ($N=40$) that controlling vocabulary levels revealed an age-related decline in older adults ($M_{age}=67$ years) in the RMET and ToM videos that could also not be explained by differences in vocabulary performance (assessed by the Mill Hill Vocabulary Scale; Raven, Raven, & Court, 1998). However, this was also the case for control photos and videos that did not require mental state attribution (e.g. just guessing the gender and the age of the person in photos). The authors suggested that age-related declines might not be specific to mental state attributions, and rather reflect a more general decline in cognition.

Memory, processing speed and EF (e.g. inhibition) are other main cognitive factors that might interfere with ToM performance and affect its age-related changes, although age-related decline in ToM independent from these cognitive skills has also been reported. Maylor et al. (2002) showed that memory had a direct effect on ToM performance (on the Strange Stories; Happé, 1994; Happé et al., 1998); young-old

adults ($M_{\text{age}}=67$ years, age-range: 60-74 years) performed worse than young adults ($M_{\text{age}}=19$ years; age-range: 16-29 years) under a memory load condition (in which they were not allowed to refer back to the printed story, so had to remember it), but not so when the load was removed. However, old-old adults ($M_{\text{age}}=81$ years; age-range: 75-89 years) performed worse than young adults even when the memory load was removed, suggesting that ToM may be impaired at older ages independent of memory skills. Also, the age-related performance decline on the ToM stories remained significant when processing speed and measures of executive functioning (i.e. flexibility and excluded verbal fluency) were taken into account (Maylor et al., 2002). Similarly, in a more recent study using the same ToM task, Rakoczy et al. (2012) found in a group of old ($N=20$, $M_{\text{age}}=73.30$, age-range: 60-91 years) and young people ($N=27$, $M_{\text{age}}=22.67$, age-range: 19-28 years) that age-related decline in ToM performance was still significant when processing speed and EF (i.e. switching and inhibition) were co-varied.

In contrast to studies reporting that age-related decline in ToM ability is independent of processing speed, EF or memory, other authors have reported a possible interaction between these domain-general processes and age in ToM performance. In a recent study, Li and colleagues (2013) found that false belief performance (on the False-Belief Task; Perner & Wimmer, 1985) differences by age in a group of adults ($N=80$, $M_{\text{age}}=55.92$ years, age range: 19-86 years) were fully mediated by memory span and processing speed and partially mediated by inhibition, while faux pas differences were fully mediated by inhibition, updating, memory span, and processing speed. German and Hehman (2006) also reported that processing speed and inhibition skills (especially when response time was considered) predicted age-related decline in a verbal belief-desire reasoning task (German & Hehman, 2006). Similarly, Charlton et al. (2009)

found that processing speed and EF fully mediated the negative relationship between age and false belief understanding (on the Strange Stories; Happé et al., 1998) in a group of old adults ($N=106$, $M_{age}=69$ years, age-range: 50-90 years). Using the same task, Rakoczy et al. (2012) found that the difference between ToM task performance in old people ($N=20$, $M_{age}=73.30$, age-range=60-91 years) and young people ($N=27$, $M_{age}=22.67$, age-range=19-28 years) is mediated by only EF (i.e. switching and inhibition), but not by processing speed.

Results of studies using visual ToM tasks were also mixed. Bailey and Henry (2008) found that inhibition assessed by the Hayling Sentence Completion Test (Burgess & Shallice, 1997) and the Stroop task (Trenerry, Crossen, De Boe, & Leber, 1989) mediated reduced ToM performance (on the RMET, Baron-Cohen et al., 2001 and the Reality-Known task, Samson et al., 2005, respectively) in old age ($M_{age}=72.2$, age range: 62-82 years) compared to young adults ($M_{age}=19.5$, age range: 18-26 years). Also, manipulating inhibitory control demands within a set of false-belief video clips (i.e. low-inhibition in the Reality-Unknown task, Apperly, Samson, Chiavarino, & Humphreys, 2004; Samson, Apperly, Chiavarino, & Humphreys, 2004, and high-inhibition in the Reality-Known task, Samson et al., 2005) yielded the same results. Unlike inhibition, memory (short-term), mental flexibility, and cognitive speed did not affect the age-related differences in ToM performance on either task. However, Rakoczy et al. (2012) found that the difference between ToM task performance on the videos task (Sullivan & Ruffman, 2004b) in old people ($N=20$, $M_{age}=73.30$, age-range=60-91 years) and young people ($N=27$, $M_{age}=22.67$, age-range=19-28 years) was mediated by EF (i.e. switching and inhibition) and also processing speed. Duval et al. (2011) also found that there was an indirect effect of age on old adults' ($M_{age}=70.14$,

age range: 61-83 years) performance compared to middle-aged ($M_{\text{age}}=52.55$, age range: 45.59 years) and young ($M_{\text{age}}=23.80$, age range: 21-34 years) groups, which was through executive functions (i.e. shifting, updating and inhibition), on both performance on the Attribution of Intention Task (a task with short comic strips; derived from Brunet, Sarfati, Hardy-Bayle, & Decety, 2000) and 1st-order false belief performance (a visual-and-verbal ToM task with comic strips and scenarios; Duval, Piolino, Bejanin, Eustache, & Desgranges, 2011) (Duval et al., 2011). However, a direct effect of age remained for 2nd-order false belief ToM performance (a visual-and-verbal ToM task with comic strips and scenarios; Duval et al., 2011). This finding may be indicative of either a specific module of 2nd-order ToM, which may decline with age (Miller, 2009) independently of other cognitive abilities (e.g. EF) or performance might depend on other aspects of EF (e.g. reasoning) that were not tested in the study.

One problem with interpreting the results from standard ToM tasks is that scores often do not allow examination of the degree of impairment. Individuals pass or fail the test or their performance is recorded as the number of correct answers. Although the number of successful answers gives an idea about the level of ToM difficulty, tasks that allow calculation of continuous scores are needed for understanding subtle differences in ToM ability (Moran, 2013). Bernstein and colleagues (2011) used a continuous false-belief task (the Sandbox Task; Sommerville, Bernstein, & Meltzoff, 2013) to examine age-related effects on ToM performance (Bernstein, Thornton, & Sommerville, 2011). Using a sandbox, participants were asked about a false belief of the protagonist (i.e. where the protagonist would look for an object) and answers were recorded based on the distance away from the false place (the correct answer) toward the real place. For further details of this assessment see Bernstein et al. (2011); Sommerville et al. (2013).

It was found that middle-aged ($N=20$, $M_{age}=56.3$, age-range=51-59 years) and old ($N=37$, $M_{age}=67.6$, age-range=60-85 years) adults showed poorer ToM performance relative to young adults ($N=37$, $M_{age}=19.2$, age-range=17-22 years), independent from their language ability (Vocabulary measured with the ETS kit, Ekstrom, French, Harman, & Derman, 1976), EF (mental set shifting, cognitive inhibition, and response monitoring, Delis, Kramer, Kaplan, & Ober, 2000), processing speed (Digit Span subtest of WAIS-III, Wechsler, 1997), and verbal memory (California Verbal Learning Test-II: CVLT-2, Delis et al., 2000). This result might be indicative of the fact that subtle ToM impairments may be seen irrespective of general cognitive declines. However, Bernstein et al. (2011) did not investigate possible effects of word knowledge ability (a total score of V1 and V2 subtests of the ETS; Ekstrom et al., 1976 and Verbal Fluency; Delis, Kaplan, & Kramer, 2001), which have been found to be correlated with false belief performance in young adults only and working memory performance (on the Letter-Number Sequencing subtest of the WAIS-III, Wechsler, 1997) with performance on the control condition (i.e. no belief condition) in the ToM task in the old group. This study was unique in the way the authors assessed ToM ability on a continuum.

In addition to intelligence and EF, two studies reported that decoding social cues and emotion recognition were also likely to mediate age-related effects on ToM performance. Phillips et al. (2011) reported that updating skills in working memory and decoding social cues from biological motion both partially mediated poorer false belief understanding (total score combining false belief videos and stories that were devised for the study) in older adults ($N=36$, $M_{age}=73.67$ years, $SD=5.06$, age-range: 65-88 years) compared to young adults ($N=52$, $M_{age}=25.81$ years, $SD=5.45$, age-range: 18-39 years) for false-belief videos and to both young adults and middle-aged adults ($N=41$,

$M_{\text{age}}=51.80$ years, $SD=8.73$, age-range: 40-64 years) for false-belief stories. Halberstadt et al. (2011) also showed that emotion recognition measured on facial, vocal and bodily stimuli (selected from Sullivan & Ruffman, 2004a; Ruffman, Halberstadt, & Murray, 2009; Young, Perrett, Calder, Sprengelmeyer & Ekman, 2002) mediated elderly participants' ($N=61$, $M_{\text{age}}=70.5$, age-range: 60-85 years) poorer understanding of faux pas scenarios taken from a famous TV series (a task devised for the study) compared to the younger group ($N=60$, $M_{\text{age}}=20.5$, age-range: 18-35 years).

These studies overall show that age-related ToM declines on at least some tests are partially dependent on processing speed, EF, and general cognitive skills, and perhaps that these declines can be compensated for by high vocabulary skills and also by higher education level. However, it is also important to note that subtle ToM impairments with age may be independent from these cognitive skills. Neuroimaging studies using advanced techniques hold promise for understanding ageing and developmental trajectories of ToM skills. In the next part a brief documentation of studies using neuroimaging techniques to investigate age-related ToM changes in old age is provided.

2.2.4.1.1.2 Neuroimaging Research and Age-Related Effects in ToM

Neuroimaging studies corroborate reduced ToM performance with advancing age and the possible confounding effects of other cognitive skills on the ToM performance of elderly adults. For example, Charlton et al. (2009) showed that ToM performance was associated with white matter integrity across the whole brain. This association was also mediated by other cognitive abilities, especially verbal intelligence.

Structural brain studies point out possible association between changes in white matter integrity, which declines with age, and reduced ToM abilities in old adulthood.

Since these age-related effects on ToM ability appear to be mediated by other cognitive abilities (crystallized and fluid intelligence, EF, and processing speed), it is not clear to what degree reduced white matter integrity has any direct role in changes in ToM ability (Charlton et al., 2009). FMRI studies reported underactivation of established brain regions that were associated with ToM performance and activation of other brain regions, which are not linked to ToM, indicating possible compensation effects in old age. Moran and colleagues (2012) showed that old adults ($N=17$, $M_{age}=72$ years) performed more poorly than young adults ($N=31$, $M_{age}=23$ years) on a ToM battery, but not on tests that did not require attribution of mental states (matched for verbal and working memory demands) (Moran, Jolly, & Mitchell, 2012). The ToM battery had a false belief task (Zaitchik, 1990; Saxe & Kanwisher, 2003) and an animated video task (Heider & Simmel, 1944; Martin & Weisberg, 2003) in addition to a moral judgment task (Young, Cushman, Hauser, & Saxe, 2007). During these tasks old adults showed less activation of the dorsal medial prefrontal cortex compared to young adults. The dorsal medial prefrontal cortex was reported to be activated during social cognition tasks but not during control tasks in young adults (Kelley et al., 2002; Mitchell, Macrae, & Banaji, 2005). The results suggested an age-related decline in mentalizing ability in old adults. However, it should be noted that reduced activation might indicate a faulty brain network rather than reduced cognitive skills. Moreover, they did not test whether other cognitive skills co-vary. Possible compensation effects on impaired ToM in old adults were suggested by Castelli et al. (2010). They showed that during the RMET older adults activated left inferior frontal gyrus more than young adults did. This also helps to elucidate reported protective effects of verbal ability on ToM in old age, since the left inferior frontal gyrus has been found to be associated with verbal memory

(Kelley et al., 1998) and retrieval of semantic information (Thompson-Schill, D'Esposito, Aguirre, & Farah, 1997).

In general, research on healthy ageing and ToM revealed an age-related decline. However, possible effects of other cognitive skills (e.g. EF) have sometimes been reported to mediate the age-related change in ToM.

2.2.4.1.2 Local and Global Processing in Healthy Ageing

For most NT individuals, the whole is usually more salient than the parts or details. Gestalt psychologists have documented, for example, the Global precedence phenomenon (i.e. to identify global features first, when global and local features of a stimulus (e.g. hierarchical figures / Navon figure) were presented simultaneously) first established by Navon (1977), in the 1980s (Palmer, 1980; Palmer & Bucher, 1981). How this global precedence of information processing changes in healthy ageing provides a point of comparison when interpreting age-related effects in older adults with ASD.

Studies investigating age-related effects on directed/divided attention using global/local paradigms have provided direct evidence for intact global precedence in old age (e.g. Bruyer & Scailquin, 2000, Bruyer, Scailquin, & Samson, 2003; Georgiou-Karistianis et al., 2006; Roux & Ceccaldi, 2001). Studies have typically found that older people, similar to younger groups, more easily recognise items at a global than local level. Moreover, global processing often interfered with local processing when items differed, leading to worse performance in incongruent conditions. Georgiou-Karistianis and colleagues (2006) showed that young ($N=20$, $M_{\text{age}}=28.10$ years, $SD=6.29$, age-range: 20-40 years), middle ($N=20$, $M_{\text{age}}=50.55$ years, $SD=5.58$, age-range: 41-60 years) and old ($N=20$, $M_{\text{age}}=70.35$ years, $SD=6.10$, age-range: 61-80 years) adult groups

were comparable regarding their error percentages in incongruent and neutral conditions compared to congruent conditions.

In contrast to the studies cited above, reduced global processing bias in elderly people, and even a local precedence at later ages (e.g. over 65-year-old), compared to young adults (Lux, Marshall, Thimm, & Fink, 2008; Oken, Kishiyama, Kaye, & Jones, 1999) have also been reported. These studies showed that elderly people were able to detect local items more quickly than younger adults. Although indirect evidence, some early neuropsychological studies examining people with neurocognitive diseases may lend support to this finding. They reported a reduced global processing advantage and sometimes increased local processing bias in their healthy control groups (e.g. Coslett, Stark, Rajaram, & Sa Rajaram, 1995; Delis et al., 1992; Lamb, Robertson, & Knight, 1989, 1990; Polster & Rapczak, 1994; Slavin, Mattingley, Bradshaw, & Storey, 2002).

These mixed findings might be due to use of different size of stimuli and presentation locus. Lux and colleagues (2008) suggested that elderly people might have difficulties in expanding their attention, which may cause them to perform worse on local processing tasks when the stimuli are small and presented peripherally. Indeed, studies that found reduced global and increased local precedence have used larger (Lux et al., 2008; Oken et al., 1999; Slavin et al., 2002) and more centrally presented stimuli (Lamb et al., 1990; Robertson, Lamb, & Knight, 1988; Slavin et al., 2002), while others who found no age-related effects (Bruyer & Scailquin, 2000; Roux & Ceccaldi, 2001) used the opposite.

Several explanations have been suggested for reduced global precedence in healthy ageing, such as compensation effects (e.g. focusing on narrow parts to improve otherwise poor quality of recognition of objects, Kosslyn, Brown, & Dror, 1999),

slower degeneration of the left hemisphere, which is related to local processing (e.g. Delis, Robertson, & Efron, 1986; Doyon & Milner, 1991; Lamb et al., 1990; Robertson et al., 1988; Sergent, 1982 but Oken et al., 1999) and visuospatial task performance (Jenkins, Myerson, Joerding, & Hale, 2000), compared to the right hemisphere (Goldstein & Shelley, 1981; Raz et al., 2004; Sowell et al., 2003).

2.2.4.1.3 Executive Function (EF) in Healthy Ageing

The Executive dysfunction hypothesis is one of the most influential theories of non-social deficits in autism (see Chapter 1 for more details). In order to understand how these cognitive abilities change with age in the older population with ASD, a comparative interpretation of healthy ageing in these skills is helpful. This is a very large topic and beyond the scope of this thesis, but EF has usually been reported to decline in healthy ageing. For example, inhibition and mental shifting has been reported to be poorer in old age (Hasher, Lustig, & Zacks, 2007). Also, age-related decline in EF has been suggested to be a reason for various cognitive abilities (e.g. memory deterioration with age, Friedman, Nessler, Cycowicz, & Horton, 2009; Salthouse, 2004).

2.2.4.2 Summary of Findings from Studies of Cognitive Functioning in Older Adults with ASD

Even though cognitive differences continue to present difficulties in older adults with ASD, only a few studies on the elderly with ASD are available in the literature. Findings suggest that age-related changes differ in different cognitive domains: e.g., while ageing had less effect on fluency, it had an aggravated effect on visual memory skill in the elderly with ASD compared to NT ageing groups. Further research is needed

for investigation of age-related effects on different cognitive skills in the elderly with ASD.

2.3 Summary

This chapter has reviewed the literature on age-related effects on ASD symptoms, QoL, and additional psychiatric conditions in old adults with ASD, expanding the review to young adults where relevant. Overall, results showed that ASD symptoms and co-occurrence of psychiatric symptoms continue to be difficulties in the lives of the elderly with ASD, although some abatement in these difficulties was also reported. Similarly, QoL was also reported be poor in late adulthood. The few studies to date examining cognitive skills in the elderly with ASD showed distinct age-related patterns in some cognitive domains, compared to NT elderly. Cognitive abilities central to cognitive theories of autism were also reviewed in the NT ageing literature, with a specific focus on ToM. Results typically showed a decline in ToM with advanced age in late NT adulthood. In the next chapter, an investigation of outcome and mental health in a diagnostic clinic sample of older ASD adults, is presented.

Chapter 3 Autism Spectrum Disorder (ASD) Symptom Severity, Life Outcome and Additional Mental Health Conditions in a Diagnostic Clinic Sample

3.1 Introduction

ASD is a life-long neurodevelopmental condition, yet age-related effects in older adults with ASD are still largely unknown. A limited number of studies, which are mainly case studies, reviews or discussion papers (Happé & Charlton, 2011; James et al., 2006; Mukaetova-Ladinska et al., 2012; Naidu et al., 2006; van Niekerk et al., 2011; Piven & Rabins, 2011; Povey et al., 2011), reported that ASD-related difficulties continue into old adulthood. Additional mental health conditions and poor quality of life (QoL) have also been suggested as ongoing problems for the ageing population with ASD (Geurts & Vissers, 2012; van Heijst & Geurts, 2015; Stuart-Hamilton et al., 2009; Totsika et al., 2010).

To our knowledge, age-related effects on ASD symptoms in old adults with ASD have not been systematically examined. Studies working on ageing and ASD symptom severity found that ASD-related difficulties continue into young adulthood (Billstedt et al., 2007; Howlin et al., 2004). However, recent follow-up studies on young adults with ASD reported that ASD symptoms decrease with age (Howlin et al., 2013; Shattuck et al., 2007). Results from research groups investigating age-related effects in cross-sectional groups mostly supported these findings (Esbensen et al., 2009; Kern et al., 2006; Seltzer et al., 2003, Shattuck et al., 2007, but see Shattuck et al., 2007).

In addition to continuing ASD-related difficulties, additional psychiatric conditions and poor quality of life have also been reported adults with ASD. Additional mental health conditions reported in adults with ASD are diverse but depression,

anxiety, and obsessive-compulsive disorder (OCD) are the most commonly reported types (e.g. Eaves & Ho, 2008; Ghazuiddin & Zafar, 2008). To our knowledge, only two studies examined age-related effects on additional mental health conditions in old adults with ASD. Results were somewhat contradictory; Totsika and colleagues (2010) found fewer additional mental health conditions in old adults compared to young adults, while Davis et al. (2011) showed the opposite. Quality of life (QoL) of adults with ASD has been shown to be decreasing with age (Howlin et al., 2004; Orsmond et al., 2004). However, studies examining specifically age-related effects in older adults reported that QoL is independent from age (van Heijst and Geurts, 2015; Totsika et al., 2010).

Language and intellectual skills are the main predictors for age-related effects on ASD symptoms and QoL in adulthood (Billstedt et al., 2007; Esbensen et al., 2009; Howlin et al., 2004; Howlin et al., 2013; Shattuck et al., 2007). Other possible factors of an increase in ASD symptoms are gender (being female), and having additional psychiatric problems (Billstedt et al., 2007; Esbensen et al., 2009). ASD symptoms, QoL, and additional mental health problems also inter-correlate with each other. Having more severe ASD symptoms and additional psychiatric conditions were reported to be associated with poorer QoL and adaptive skills (Howlin et al., 2013; Totsika et al., 2010).

A more detailed literature review about ASD symptoms, additional psychiatric conditions and QoL can be found in the Chapter 2.

3.2 Aim

The aim of this study is to explore age-related effects on ASD symptoms, life outcome and additional mental health conditions in a group of adults who were first

diagnosed with ASD in adulthood compared to a clinic control group attending a specialist ASD diagnostic clinic but not receiving a final diagnosis of ASD.

Analyses were mainly exploratory; primary research questions and objectives were as follows:

1. To examine age-related effects on ASD symptoms in adults with ASD compared to non-ASD group
2. To examine age-related effects on life outcome in adults with ASD compared to non-ASD group
3. To explore predictors of life outcome as a function of age

No specific prediction is made regarding above objectives.

3.3 Method

3.3.1 Ethics

Ethical Approval for the analysis of data for this study was conferred by the local research ethics committee (12/LO/07990). Only the records of patients who gave consent for their data to be used were examined.

3.3.2 Design

Group comparisons between adults with ASD and adults who were referred to the ASD specialist clinic but did not receive a final ASD diagnoses were made on ASD symptoms, life outcome and other psychiatric diagnoses. Size of each group should be approximately 20 to be able to reach a statistical power of .80 to avoid a type II error, and the group numbers in the current work were above this requirement.

3.3.3 Participants

A total of 132 patients' clinic records were investigated. There were 90 adults ($M_{age}=40.21$ years, $SD=17.21$) with ASD and 46 adults ($M_{age}=40.39$ years, $SD=16.45$)

who did not get an ASD diagnosis. Age groups were determined on the basis of past research, with those aged 50 and over included in old group. First, old adults with ASD were chosen from the clinic database. There were 53 adults aged 50 and over in the clinic database; of those, 5 old adults did not have consent recorded and the records of 3 others were incomplete. The remaining 45 old adults were included in the research sample. An equal number of young adults with consent and complete records was chosen randomly with a relatively matched age-range (18-38 years). Non-ASD group was chosen with same rationale. There were 30 old adults without a final ASD diagnosis in the clinic database. Clinic records of 4 were incomplete and 3 people did not give consent for their records to be used, which resulted in a final group size of 23. Similar to ASD group, an equal number of young adults to old adults were chosen with a balanced age-range (18-38 years). Table 3-1 shows final group sizes, age ranges and mean ages. Age differences between study groups within young and old groups were not significant and of very small effect size: $t(66) = 0.50$, $p = 0.59^a$, $d = 0.13$ and $t(56.33) = -0.29$, $p = 0.77^a$, $d = 0.07$, respectively.⁴

Table 3-1 Young and old adults in study groups (ASD/Non-ASD): Mean (SD)

	Young			Old		
	N	Age (years)		N	Age (years)	
		Range	Mean (SD)		Range	Mean (SD)
ASD	45	18-38	24.07 (5.86)	45	50-70	56.36 (5.59)
Non-ASD	23	18-38	24.78 (5.09)	23	50-70	56 (4.23)

^a Bootstrap derived

3.3.4 Measures

3.3.4.1 ASD symptoms

ASD symptoms were rated in the clinic using ICD-10 criteria (see Appendix A for ICD-10 symptom sheet). Individuals were given 1-point for each symptom judged present by the clinical team under each impairment category (i.e. social impairments, communication impairments and restricted and repetitive behaviours and interests) as noted on the ICD-10 symptom sheet. This method was used to create a symptom score that was comparable across age groups, since the ICD-10 symptom sheet was available for all participants, whereas most of the young adults had only ADI/ADI-R scores, while older adults had ADOS scores only.

3.3.4.2 Life Outcome

Life Outcome ratings were assigned based on the relevant information in the patient reports. Scores for four different life outcome domains (i.e. independence, employment, close relationship and friendship) were assessed using an adapted rating system from Howlin et al. (2004; 2013). In addition, a composite life outcome score was calculated (as in the original scoring system), which was derived from the sum of ratings for the four domains. The adapted rating system was created after multiple discussions, blind scorings and reviews among three raters, one of whom is the developer of the original system. Please see Appendix B for the life outcome scoring system used in the current work.

Since life outcome was rated subjectively according to agreed criteria, an inter-rater reliability analysis using the Kappa statistic was conducted to determine consistency among raters. Life outcome scores for 20% of participants in each study group (i.e. young ASD, old ASD, young non-ASD, old non-ASD) were double-rated by

two independent raters who were blind to group. Given good agreement between the independent raters, the first rater's ratings were used for the subsequent analyses (see Table 3-2).

Table 3-2 Inter-rater reliability results of life outcome scores of young and old adults in ASD and non-ASD groups: Weighted Kappa

		ASD		Non-ASD	
		Young N = 9	Old N = 9	Young N = 5	Old N = 5
Life Outcome Scores	Independence	0.87	1.00	1.00	1.00
	Friendship	1.00	0.88	1.00	1.00
	Close Relationships	0.91	1.00	1.00	1.00
	Current Employment	1.00	0.77	1.00	1.00

3.3.4.3 Mental Health Service History, Forensic Service Use History and Risk Assessment

History of use of mental health and forensic services were examined based on patient records. Similar to life outcome, a rating system was created after multiple discussions, blind scorings and reviews among three raters, one of whom is the developer of the original system of rating life outcome. Please see Appendix C for the life outcome scoring system used in the current work.

An inter-rater reliability analysis using the Kappa statistic was conducted to determine consistency among raters in terms of mental health and forensic services history ratings. Scores for 20% of participants in each study group (i.e. young ASD, old ASD, young non-ASD, old non-ASD) were double-rated by two independent raters who were blind to group. Given good agreement between the independent raters, the first rater's ratings were used for the subsequent analyses (Table 3-3).

Table 3-3 Inter-rater reliability results of mental health and forensic services history scores of young and old adults in ASD and non-ASD groups: Weighted Kappa

	ASD		Non-ASD	
	Young N = 9	Old N = 9	Young N = 5	Old N = 5
MHS His.	0.84	0.86	1.00	1.00
For. Ser. His.	1.00	1.00	1.00	1.00

Risk assessment scores were assigned based on risk assessments done by clinicians as a part of clinical assessment. Risk assessments were done in three different categories: risk from self to self, risk from self to others and risk from others to self. Assessment results range from no risk to high risk. Based on these results, a risk assessment score was assigned to each category. Scores range from 0 – 5, with minimum score indicated no risk and maximum score indicated a high risk. In addition to category scores, a total risk score was derived from the sum of ratings for the three categories (please see Appendix D).

3.3.4.4 Additional Psychiatric Disorders

Information related to additional mental health disorders was acquired by reviewing patient reports, in which formal diagnoses given by clinicians were available accompanied by related ICD-10 and DSM-IV diagnostic criteria. Only current and definite diagnoses were considered as comorbid psychiatric disorders; symptoms not meeting the diagnostic criteria, previous diagnoses (which did not represent the current mental health status of the individual), and “possible” diagnoses were not included.

3.3.5 Procedure

Patient reports for 136 individuals were investigated by using the clinic database of the Behavioural Genetics Clinic, at the Maudsley Hospital in London. Due to the confidentiality, patient reports were reviewed and relevant data were examined on a

highly protected electronic database at BGC office in the Maudsley Hospital with supervision. Effort was focused on getting information for all old (aged 50 and over) adults seen, then creating a comparable (matched on age and gender) set of younger cases, including those who were not given an ASD diagnosis at the end.

3.3.6 Statistical Analyses

Parametric tests were employed throughout the statistical analysis, where assumptions allow. Homogeneity of variance was measured using Levine's test. Normality of data distribution was checked in several ways: the Nonparametric Kolmogorov-Smirnov test, the Nonparametric Saphiro-Wilk test, histograms, Q-Q plots, and examination of skewness and kurtosis scores. Bootstrap analysis was performed to test whether the results were robust against deviations from parametric assumptions (Chong & Choo, 2011), when at least three of the above indicators suggested deviation from the normal distribution. The independent bootstrap test is nonparametric. Thus 95% mean difference confidence intervals obtained from the bootstrap test were reported alongside such cases to support outcomes of the test statistic. All bootstrap tests were based on 1000 samples.

Two-way ANOVA was used to investigate the influence of having ASD or not and age group (young vs. old) on outcome measures. Results of multiple group comparisons along with effect sizes were also presented for exploratory purposes. Since analyses were exploratory, original *p* values were used rather than more conservative *p* values (e.g. at .0125 level of significance with the Bonferroni correction) when multiple tests were run. For the correlation analysis either a Spearman's or Pearson's correlation coefficient was calculated depending on parametric status of the variables'. Only variables showing a significant correlation with the outcome variable were included

when possible predictors were tested through regression analysis. Forward stepwise method was used for all regression analyses, with confirmatory check using backward elimination method in order not to miss any significant correlates. Categorical data were examined using a point-biserial correlation (r_{pb}) and Pearson Chi Square statistic, as relevant.

3.4 Results

3.4.1 Study and Age Group Differences in Autism Symptoms, Life Outcome and Risk Assessment Scores

Factorial ANOVA was used to investigate group differences in autism symptom severity, life outcome, risk assessment, mental health services history and forensic services history scores by study group and age group. Diagnostic group and age group included two levels each: ASD vs. non-ASD and young vs. age, respectively.

3.4.1.1 Group differences in ASD symptoms

Table 3-4 shows ASD symptom scores in each study and age groups.

Table 3-4 Mean total ASD (T-ASD), social impairments (Soc. Imp.), communication impairments (Com. Imp.) and restricted and repetitive behaviours and interests (RRBI) scores of young and old adults in ASD and non-ASD groups: Mean (SD)

		ASD		Non-ASD		F^1	p -value	effect size: η^2
		Young N = 45	Old N = 45	Young N = 23	Old N = 23			
ASD Symptom Scores	Soc. Imp.	3.00 (0.93)	2.82 (0.72)	0.39 (0.58)	0.57 (0.90)	277.49^{group***} <.001 ^{age} 1.45 ^{agexgroup}	<.001 ^{group} .99 ^{age} .23 ^{agexgroup}	.68 ^{group} <.001 ^{age} .01 ^{agexgroup}
	Com. Imp.	2.04 (0.88)	1.84 (0.71)	0.26 (0.54)	0.22 (0.52)	171.42^{group***} 0.87 ^{age} 0.36 ^{agexgroup}	<.001 ^{group} .35 ^{age} .55 ^{agexgroup}	.57 ^{group} .01 ^{age} .003 ^{agexgroup}
	RRBI	1.64 (1.05)	1.27 (0.91)	0.22 (0.52)	0.35 (0.57)	56.27^{group***} 0.63 ^{age} 2.64 ^{agexgroup}	<.001 ^{group} .43 ^{age} .11 ^{agexgroup}	.30 ^{group} .01 ^{age} .02 ^{agexgroup}
	T-ASD	6.69 (2.16)	5.93 (1.54)	0.87 (1.18)	1.13 (1.52)	289.40^{group***} 0.63 ^{age} 2.65 ^{agexgroup}	<.001 ^{group} .43 ^{age} .11 ^{agexgroup}	.69 ^{group} .01 ^{age} .02 ^{agexgroup}

¹ All $df_M s = 1$ and $df_{RS} = 132$

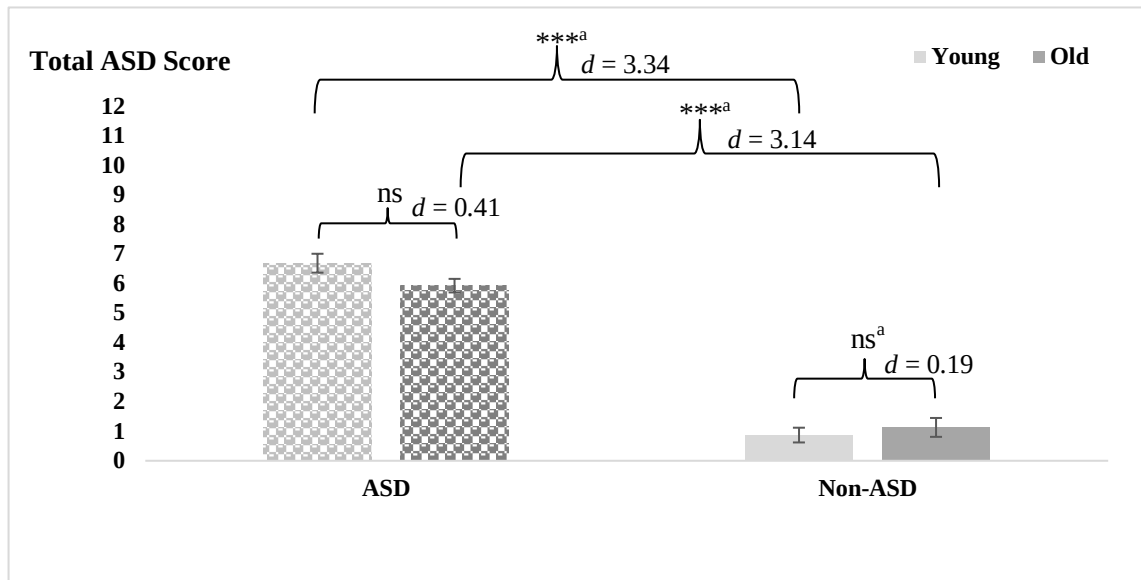
^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group

*** $p < .001$

A two-way analysis of variance was conducted on the influence of study group and age group on the total ASD score. There was a significant main effect of study group on total ASD score, with a non-significant main effect of age group. The interaction between age group and study group was also non-significant (Table 3-4 and Figure 3-1).

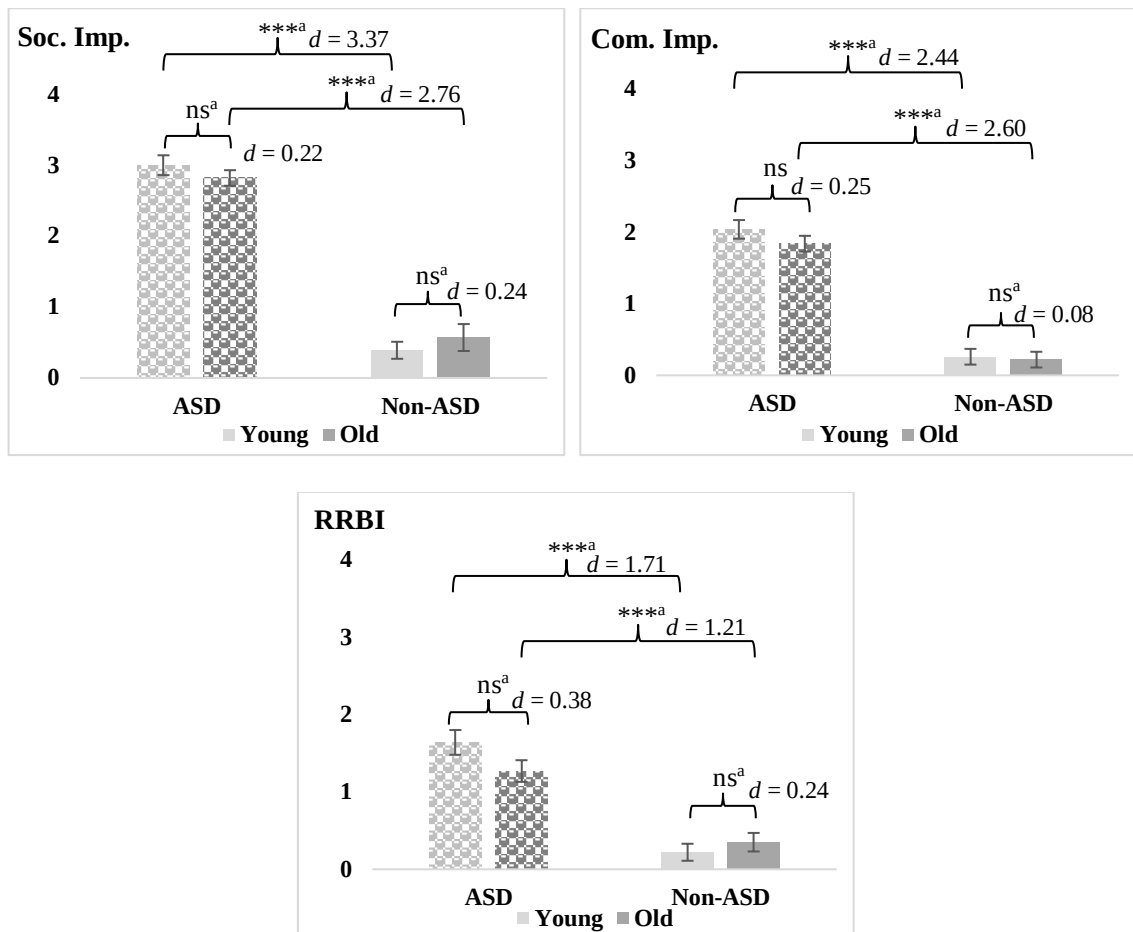


^{ns} $p > .05$, *** $p < .001$.

^a Bootstrap derived

Figure 3-1 Mean total ASD score (T-ASD) of young and old adults in ASD and non-ASD groups with effect sizes marked for information

Further analysis was carried out to investigate the influence of study group and age group on each ASD symptom domain score (Table 3-4 and Figure 3-2). There was a significant main effect of study group on social impairments, communication impairments and RRBI scores. However, main effect of age group on social impairments, communication impairments or RRBI scores was non-significant. The interaction effect between study group and age group was also non-significant for all domain scores.



^{ns} $p > .05$, *** $p < .001$.

^a Bootstrap derived

Figure 3-2 Mean social impairments (Soc. Imp.), communication impairments (Com. Imp.) and restricted and repetitive behaviours and interests (RRBI) scores of young and old adults in ASD and non-ASD groups, with effect sizes marked for information.

3.4.1.2 Group Differences in Life Outcome and Total Years of Education

Table 3-5 shows mean total years of education and life outcome scores in each study and age groups.

Table 3-5 Mean total years of education (YoE) and life outcome scores (composite life outcome, independence, friendship, close relationship, and current employment scores) of young and old adults in ASD and non-ASD group: Mean (SD)

		ASD		Non-ASD		F^2	p -value	effect size: η^2
		Young N = 45	Old N = 45	Young N = 23 ¹	Old N = 23			
YoE		13.48 (1.89)	14.02 (2.65)	13.41 (1.99)	13.43 (2.21)	0.64 ^{group} 0.48 ^{age} 0.40 ^{agexgroup}	.43 ^{group} .49 ^{age} .53 ^{agexgroup}	.01 ^{group} .004 ^{age} .003 ^{agexgroup}
Life Outcome Scores	Independence	1.53 (0.94)	1.02 (1.16)	0.87 (1.01)	0.57 (0.95)	8.99^{group**} 4.76^{age*} 0.31 ^{agexgroup}	.003 ^{group} .03 ^{age} .58 ^{agexgroup}	.06 ^{group} .04 ^{age} .002 ^{agexgroup}
	Friendship	1.40 (0.89)	1.80 (0.94)	0.65 (0.83)	0.91 (0.85)	25.56^{group***} 4.18^{age*} 0.19 ^{agexgroup}	<.001 ^{group} .04 ^{age} .67 ^{agexgroup}	.16 ^{group} .03 ^{age} .001 ^{agexgroup}
	Close Relationship	1.42 (1.39)	0.80 (1.27)	0.83 (1.30)	0.26 (0.86)	6.17^{group*} 6.75^{age*} 0.02 ^{agexgroup}	.014 ^{group} .0104 ^{age} .90 ^{agexgroup}	.05 ^{group} .05 ^{age} <.001 ^{agexgroup}
	Current Employment	1.47 (1.20)	0.49 (0.51)	0.91 (1.20)	0.43 (0.51)	3.32 ^{group} 19.03^{age***} 2.24 ^{agexgroup}	.07 ^{group} <.001 ^{age} .14 ^{agexgroup}	.02 ^{group} .13 ^{age} .02 ^{agexgroup}
	Composite Life Outcome	5.09 (2.17)	4.11 (2.22)	3.13 (2.70)	2.17 (1.75)	23.38^{group***} 5.77^{age*} 0.001 ^{agexgroup}	<.001 ^{group} .02 ^{age} .98 ^{agexgroup}	.15 ^{group} .04 ^{age} <.001 ^{agexgroup}

¹N-1 for YoE

²All $df_M s = 1$ and $df_{RS} = 132$, except for YoE: $df_M s = 1$ and $df_{RS} = 130$

^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group

* $p < .05$, ** $p < .01$, *** $p < .001$

Influence of study group and age group on total years of education and life outcome scores were examined using a two-way ANOVA analysis. All effects on years of education were non-significant (Table 3-5). There was a significant main effect of study group (ASD worse than non-ASD) and age group (Young worse than Old) on composite life outcome score. The interaction between age group and study group was not significant (Table 3-5 and Figure 3-3).

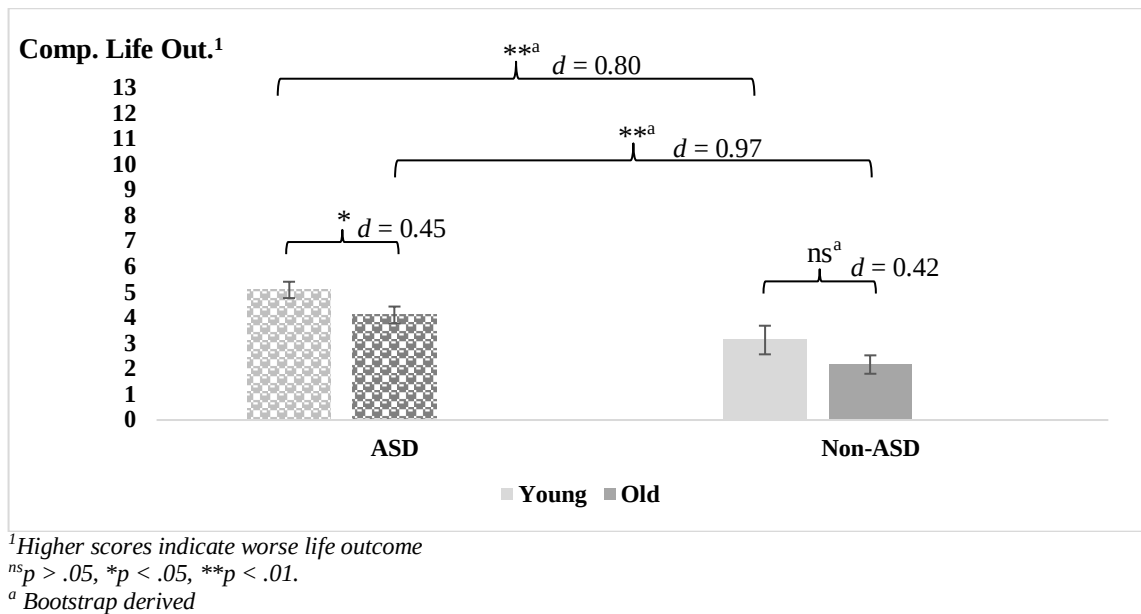
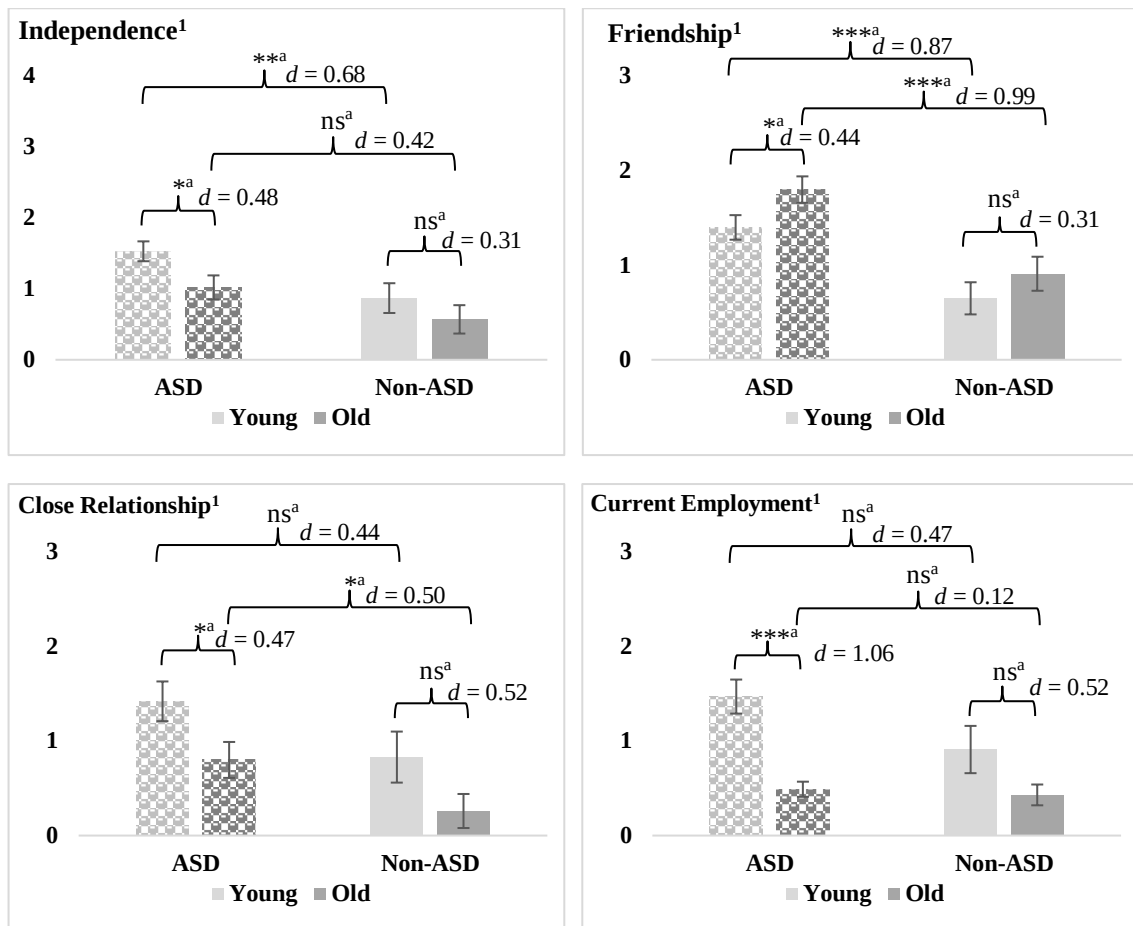


Figure 3-3 Composite life outcome score of young and old adults in ASD and non-ASD groups, with effect sizes marked for information

Given the significant main effects on total life outcome scores, further analysis was carried out to investigate the influence of study group and age group on each subdomain of life outcome. There was a significant main effect of both study group and age group on independence, friendship, and close relationship scores. In current employment score, there was a significant main effect of age group but no significant effect of study group. The interaction effect between age group and study group was non-significant for all life outcome domains (Table 3-5 and Figure 3-4).



¹Higher scores indicate worse life outcome

ns^a $p > .05$, * $p < .05$, ** $p < .01$ *** $p < .001$.

^a Bootstrap derived

Figure 3-4 Independence, friendship, close relationship and current employment scores of young and old adults in ASD and non-ASD groups, with effect sizes marked for information

3.4.1.3 Group Differences in Mental Health Services History, Forensic Services History and Risk Assessment Scores

Table 3-6 presents the mean mental health services history and forensic services history scores in each study and age group. There was no significant main effects of study group or age group on mental health services and forensic involvement history scores. The interaction effect between study group and age group was also non-significant for both scores (Table 3-6 and Figure 3-5).

Table 3-6 Mental health services history and forensic services history scores of young and old adults in ASD and non-ASD groups: Mean (SD)

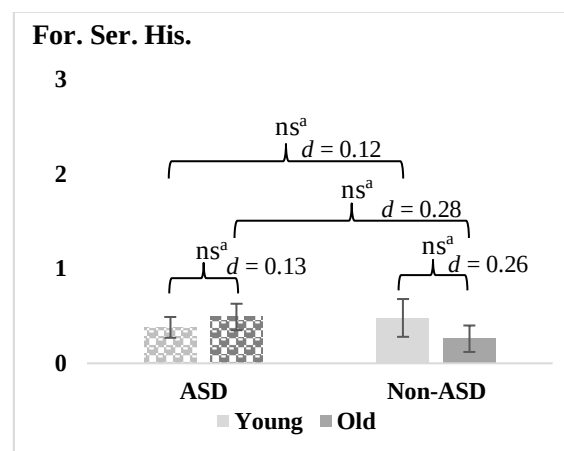
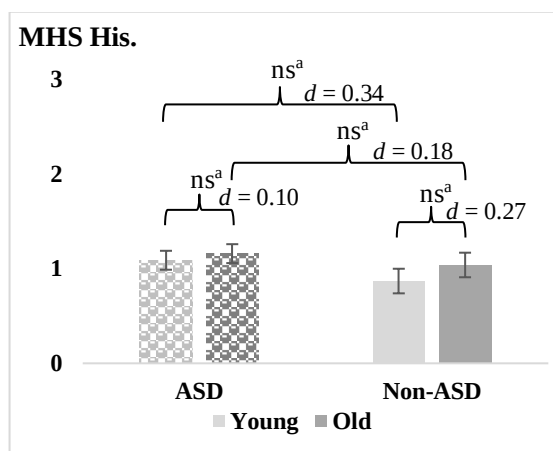
	ASD		Non-ASD		F^1	p -value	effect size: η^2
	Young N = 45	Old N = 45	Young N = 23	Old N = 23			
Mental Health Services History	1.09 (0.67)	1.16 (0.67)	0.87 (0.63)	1.04 (0.64)	1.93 ^{group} 1.02 ^{age} 0.20 ^{agexgroup}	.17 ^{group} .32 ^{age} .65 ^{agexgroup}	.01 ^{group} .002 ^{age} .002 ^{agexgroup}
Forensic Services History	0.38 (0.75)	0.49 (0.92)	0.48 (0.95)	0.26 (0.69)	0.18 ^{group} 0.12 ^{age} 1.18 ^{agexgroup}	.67 ^{group} .73 ^{age} .28 ^{agexgroup}	.001 ^{group} .001 ^{age} .01 ^{agexgroup}

¹ All $df_M s = 1$ and $df_{RS} = 132$

^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group



MHS His.: Mental health services history

For. Ser. His.: Forensic services history

^{ns} $p > .05$.

^a Bootstrap derived

Figure 3-5 Mean mental health services and forensic services history scores of young and old adults in ASD and non-ASD groups, with effect sizes marked for information

Table 3-7 and Figure 3-6 represent the mean total risk assessment score in each study and age groups. There was a significant main effect of study group and age group on total risk assessment score. The interaction between age group and study group was non-significant.

Table 3-7 Risk assessment scores of young and old adults in ASD and non-ASD groups: Mean (SD)

		ASD		Non-ASD		F^1	p -value	effect size: η^2
		Young N = 45	Old N = 45	Young N = 23	Old N = 23			
Risk Assessment Scores	Total	4.03 (4.04)	2.5 (3.55)	2.52 (3.44)	1.04 (2.50)	5.29^{group*} 5.45^{age*} 0.002 ^{agexgroup}	.02 ^{group} .02 ^{age} .97 ^{agexgroup}	.04 ^{group} .04 ^{age} <.001 ^{agexgroup}
	Self-to-self	1.10 (1.39)	0.93 (1.38)	1.04 (1.37)	0.48 (1.08)	1.11 ^{group} 2.27 ^{age} 0.67 ^{agexgroup}	.29 ^{group} .13 ^{age} .41 ^{agexgroup}	.01 ^{group} .02 ^{age} .01 ^{agexgroup}
	Self-to-others	0.99 (1.38)	0.66 (1.20)	0.74 (1.25)	0.35 (0.93)	1.56 ^{group} 2.64 ^{age} 0.02 ^{agexgroup}	.21 ^{group} .11 ^{age} .90 ^{agexgroup}	.01 ^{group} .02 ^{age} <.001 ^{agexgroup}
	Others-to-self	1.94 (2.12)	0.91 (1.74)	0.74 (1.18)	0.22 (0.74)	9.72^{group**} 6.52^{age*} 0.71 ^{agexgroup}	.002 ^{group} .012 ^{age} .40 ^{agexgroup}	.07 ^{group} .05 ^{age} .01 ^{agexgroup}

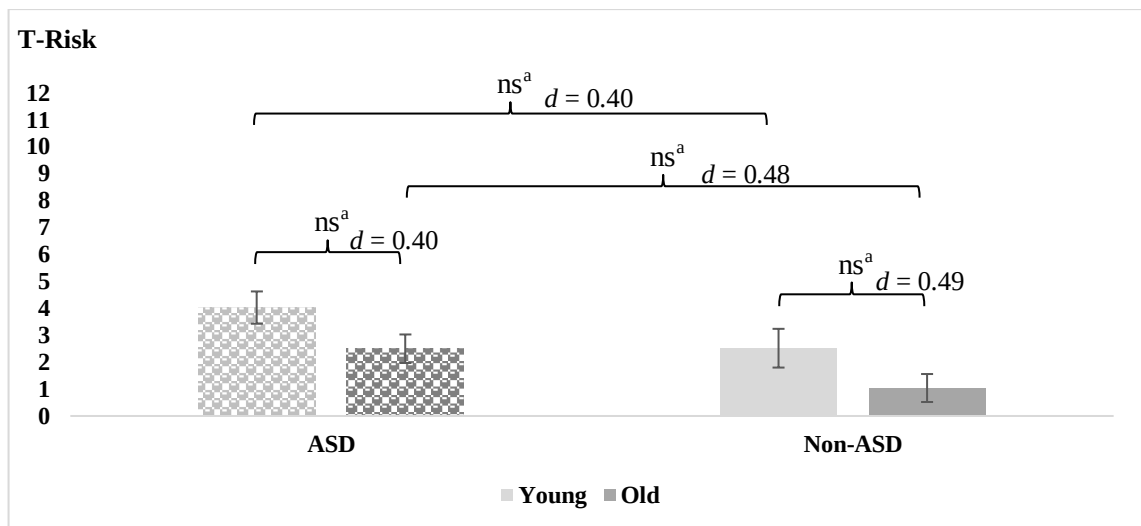
¹ All $df_M s = 1$ and $df_R s = 132$

^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group

* $p < .05$, ** $p < .01$



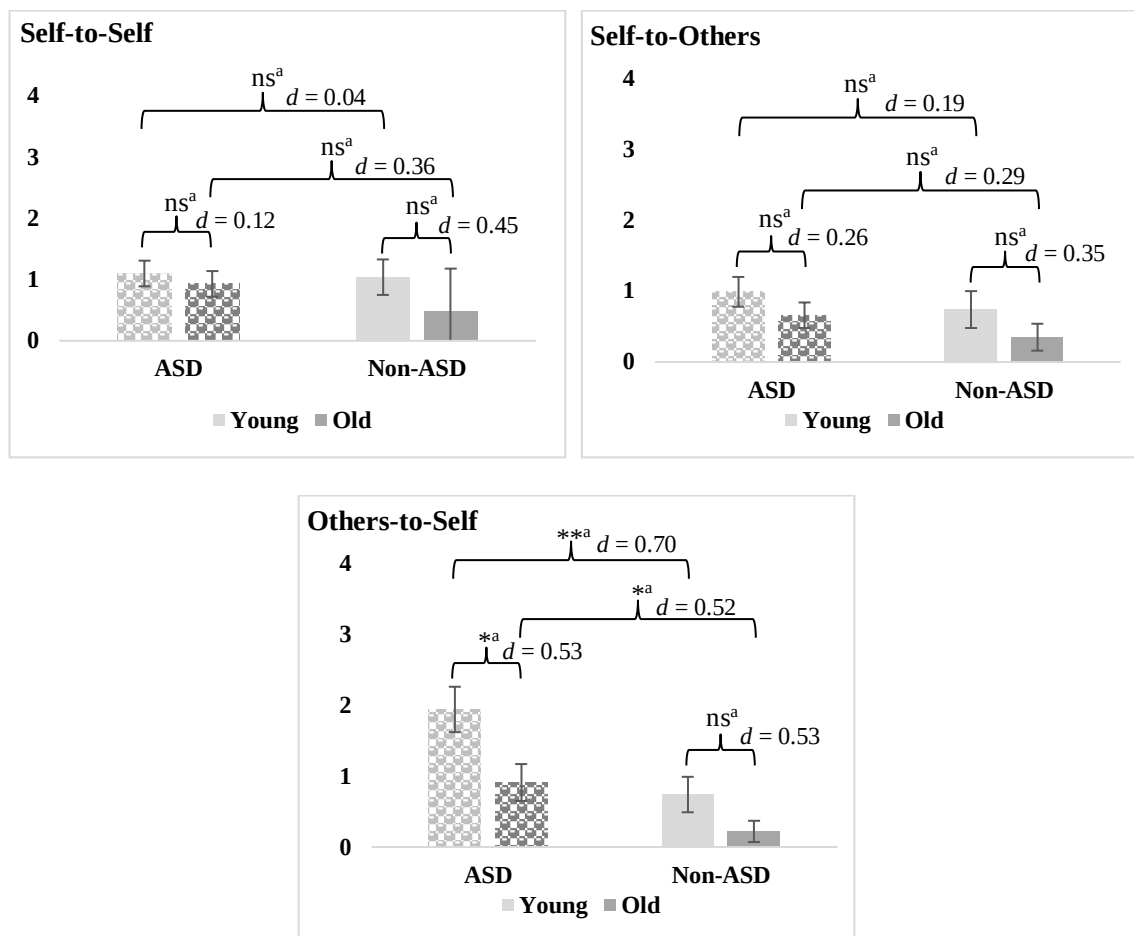
^{ns} $p > .05$.

^a Bootstrap derived

Figure 3-6 Mean total risk assessment score (T-Risk) of young and old adults in ASD and non-ASD groups, with effect sizes marked for information

Further analysis was conducted on subdomains of risk assessment score (i.e. self-to-self, self-to-others, and others-to-self). All effects were non-significant on self-to-self and self-to-others risk assessment scores. However, there was a significant main effect

of study group and age group on others-to-self score, with a non-significant interaction between study group and age group (Table 3-7 and Figure 3-7).



^{ns} $p > .05$, * $p < .05$, ** $p < .01$.

^a Bootstrap derived

Figure 3-7 Risk assessment subscores of young and old adults in ASD and non-ASD groups, with effect sizes marked for information

3.4.2 Predictors of Life Outcome in ASD and Non-ASD Groups

3.4.2.1 ASD Group

Correlations between composite life outcome score and possible predictors (i.e. total years of education, ASD symptom severity, risk assessment, mental health services history and forensic services history scores) were examined prior to regression analysis. Note that although the usual terminology for such regression analyses refers to

‘predictors’, the current design does not allow for causal interpretation, and hence predictors should be read as synonymous with associates.

Composite life outcome score was significantly correlated with social impairments score ($r_s = .28, p < .01$), total years of education ($r_s = -.25, p < .05$) and other-to-self risk assessment score ($r_s = .21, p < .05$). Higher total years of education, less severe social impairments and less vulnerability potential risks from other people were significantly associated with better⁵ life outcome in the ASD group. These three variables were therefore included as predictors of life outcome in a multiple regression analysis. A significant regression equation was calculated ($F(2, 86) = 5.77, p < .01$), with an R^2 of .12 (Table 3-8). It was found that both total years of education and social impairments score significantly predicted composite life outcome score ($\beta = -.25, p < .05$ and $\beta = .24, p < .05$, respectively), but others-to-self risk assessment score did not make a significant contribution over and above these variables.

⁵ Higher scores = worse outcome.

Table 3-8 Multiple regression results to predict composite life outcome score based on social impairments score (Soc. Imp.), total years of education (YoE) and others-to-self risk assessment score (OS-Risk)

Step 1	B	SE B	β
(Constant)	7.84	1.40	
YoE	-0.24	0.10	-.25*
Step 2			
(Constant)	5.96	1.58	
YoE	-0.24	0.10	-.25*
Soc. Imp.	0.65	0.27	.24*

Dependent Variable: Composite Life Outcome

Note: $R^2 = .06$ for Step 1, $\Delta R^2 = .06$ for Step 2 ($p < .05$), * $p < .05$.

In order to examine significant associates of sub-scores of life outcome (i.e. independence, friendship, close relationship and current employment), correlations between each of these sub-scores and other variables (i.e. total years of education, ASD symptom scores, risk assessment scores, mental health service history and forensic services history scores) were explored in the ASD group.

Independence was significantly correlated with total years of education ($r_s = -.26$, $p < .05$), and total risk assessment score ($r_s = .21$, $p < .05$). Further associations were examined between each sub-group of the total risk assessment score (i.e. self to self, self-others, and others to self) and independence score in the ASD group. The only sub-score significantly related to independence was risk others-to-self-risk assessment score ($r_s = .29$, $p < .01$). Therefore, a multiple linear regression analysis was run to predict independence score based on others-to-self-risk assessment score and total years of education. A significant multiple regression equation was found ($F(1, 87) = 7.72$, $p < .01$, with an R^2 of .08 (Table 3-9). It was found that only others to self-risk assessment score was a significant associate of independence score ($\beta = .29$, $p < .01$), indicating that being a vulnerable adult is a strong associate of worse independence in the ASD group.

Table 3-9 Multiple regression results to predict independence score based on others-to-self-risk assessment score (OS-Risk) and total years of education (YoE)

Step 1	B	SE B	β
(Constant)	1.04	0.13	
OS-Risk	0.15	0.06	.29**

Dependent Variable: Independence

Note: $R^2 = .08$, ** $p < .01$.

Only age was significantly correlated with friendship score, $r_s = .29$, $p < .01$, showing that friendship was rated as worse in the older versus younger ASD group.

Close relationship score was significantly associated with age ($r_s = -.29$, $p < .01$), severity of social impairments ($r_s = .29$, $p < .01$), current employment score ($r_s = .23$, $p < .05$) and forensic services history score ($r_s = -.22$, $p < .05$). A multiple regression analysis was run to test the relative role of these variables in predicting close relationship score in ASD. A significant multiple regression equation was calculated ($F(2, 87) = 8.25$, $p < .001$) with an R^2 of .16 (Table 3-10). It was found that severity of social impairments and age were both strong associates of close relationship score ($\beta = .27$, $p < .01$ and $\beta = -.25$, $p < .05$, respectively), indicating that older adults and adults with less severe social impairments had better close relationship in the ASD group.

Table 3-10 Multiple regression results to predict close relationship score based on age, social impairments (Soc. Imp.), current employment and forensic services history scores

Step 1	B	SE B	β
(Constant)	-0.40	0.50	
Soc. Imp.	0.52	0.17	.32**
Step 2			
(Constant)	0.59	0.63	
Soc. Imp.	0.45	0.16	.27**
Age	-0.02	0.01	-.25*

Dependent Variable: Close Relationship

Note: $R^2 = .10$ for Step 1, $\Delta R^2 = .06$ for Step 2 ($p < .05$), * $p < .05$, ** $p < .01$.

Current employment score was significantly correlated with age ($r_s = -.53$, $p < .001$), close relationship score ($r_s = .24$, $p < .05$) and total years of education ($r_s = -.22$, $p < .05$). A multiple regression analysis was conducted to find whether any of these variables were strong associates of current employment score. Results showed a

significant multiple regression equation ($F(1, 87) = 43.45, p < .001$) with an $R^2 = .33$ (Table 3-11). It was found that only age was a strong associate of current employment score ($\beta = -.58, p < .001$), indicating that older adults with ASD had better current employment scores.

Table 3-11 Multiple regression results to predict current employment score based on age, close relationship score and total years of education (YoE)

Step 1	B	SE B	β
(Constant)	2.38	0.23	
Age	-0.04	0.01	-.58***

Dependent Variable: Current Employment

*Note: $R^2 = .33$, *** $p < .001$.*

3.4.2.2 Non-ASD Group

Correlations between composite life outcome score and possible associates (i.e. total years of education, total ASD, risk assessment, mental health services history and forensic services history scores) were examined prior to regression analysis.

Composite life outcome score was significantly correlated with total ASD score ($r_s = .29, p < .05$). When its association with each sub-score of ASD symptom severity was tested, it was found that only social impairment score was significantly related to composite life outcome score ($r_s = .30, p < .05$).

Correlations between subscores of life outcome and other variables were further investigated. The only significant correlate to independence score was current employment score ($r_s = .35, p < .05$), if adults in the non-ASD group had better employment score, they had better independence score as well.

Friendship score was significantly associated with total ASD score ($r_s = .37, p < .05$), age ($r_s = .31, p < .05$) and mental health services history score ($r_s = .32, p < .05$). Further analysis was performed to examine associations between different symptom/trait types (i.e. social impairments, communication impairments, and RRBI) and friendship score. It was found that only social impairment score was significantly

correlated with friendship score in the nonASD sample ($r_s = .34, p < .05$). A multiple regression equation was calculated to predict friendship score based on social impairments, mental health services history scores and age ($F(1, 44) = 5.89, p < .05$) with an R^2 of .12 (Table 3-12). It was found that only social impairments score was a strong associate of friendship score in the non-ASD group ($\beta = .34, p < .05$), adults in the non-ASD group had better friendship score if they had less severe social impairments.

Table 3-12 Multiple regression results to predict friendship score based on social impairments score (Soc. Imp.), mental health services history score and age

Step 1	B	SE B	β
(Constant)	0.60	0.14	
Soc. Imp.	0.38	0.16	.34*

Dependent Variable: Friendship

Note: $R^2 = .12, *p < .05$.

No significant associates of close relationship scores were detected in the non-ASD group.

3.4.3 Other Mental Health Conditions in Diagnostic and Age Groups

Table 3-13 presents the number of individuals with mental health conditions other than ASD in study and age groups.

Table 3-13 Number of young and old adults in ASD and non-ASD groups with other mental health conditions

	N	%
Young ASD	34	76
Old ASD	30	67
Young non-ASD	13	57
Old non-ASD	15	65

These other mental health conditions were regarded as “additional mental health conditions” in the ASD group. However, they were main diagnosis of some adults in the non-ASD group. Table 3-14 shows numbers of adults with more than one diagnosis.

Table 3-14 Number of young and old adults in ASD and non-ASD groups with more than one diagnosis

	Yes	No
Young ASD	34	11
Old ASD	30	15
Young non-ASD	2	11
Old non-ASD	8	7

Figure 3-8 shows the percentages of adults with each mental health condition, with actual numbers presented next to each (note that %s total >100 because of multiple diagnoses).

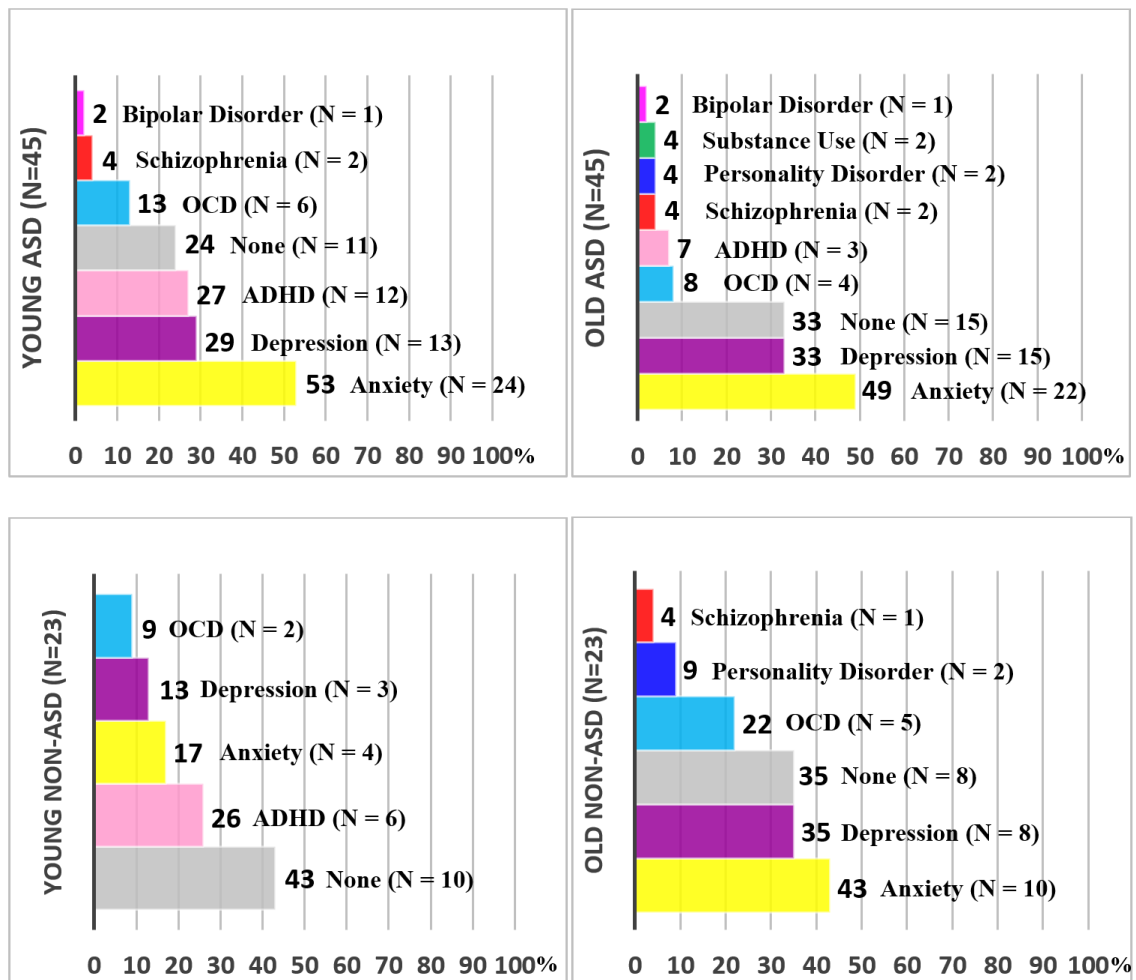


Figure 3-8 Numbers and percentages of young and old adults with other mental health conditions in ASD and non-ASD groups

Due to small numbers of young and old adults with mental health problems in the non-ASD group, other mental health conditions were investigated based on only study

group (not age group) using a chi-square analysis. There was a significant association between ASD status and having anxiety, $\chi^2(1) = 5.28, p < .05$. This indicated that having anxiety was about 2 times more likely in the ASD group than in the non-ASD group. Associations between ASD status and having depression, ADHD and OCD, on the other hand, were not significant, $\chi^2(1) = 0.77, p = .43$, $\chi^2(1) = 0.31, p = .63$, and $\chi^2(1) = 0.47, p = .59$, respectively.

3.4.3.1 Age group differences in additional mental health conditions in the ASD group

Since the number of young and old adults with mental health conditions in the non-ASD group did not allow for age-group analyses, associations between young and old adults were examined only in the ASD group. A chi-square analysis was conducted to find associations between age groups and having additional mental health conditions.

First, age groups were examined in terms of having or not having additional mental health conditions. The association between age group and having additional mental health condition was not significant, $\chi^2(1) = 0.87, p = .49$. Further investigations of associations between age groups and having anxiety and depression were also non-significant, $\chi^2(1) = 0.18, p = .83$ and $\chi^2(1) = 0.21, p = .82$, respectively.

3.4.3.2 Associations of Additional Mental Health Conditions with ASD Symptom Severity and Life Outcome in the ASD and Non-ASD Groups

3.4.3.2.1 ASD Group

Associations between having additional mental health conditions and total ASD severity and total life outcome scores were examined; results showed that neither of the correlations were significant, $r_{pb} = .18, p = .08$ and $r_{pb} = -.03, p = .75$, respectively.

When associations with total ASD and life outcome scores were investigated with having anxiety, depression, ADHD and OCD separately, the only significant association was between having OCD and both total ASD score ($r_{pb} = .22, p < .05$) and composite life outcome score ($r_{pb} = .27, p < .05$). Further analysis examined associations between having OCD and the severity of ASD symptom type (i.e. social impairments, communication impairments, and RRBI) in the ASD group. Having OCD was significantly associated with only RRBI score ($r_{pb} = .23, p < .05$), and not with social impairments score ($r_{pb} = .17, p = .11$) nor communication impairments score ($r_{pb} = .07, p = .52$).

Associations between having OCD and sub-scores of life outcome (i.e. independence, friendship, current employment and close relationship) were further examined. Having OCD was significantly associated with worse independence ($r_{pb} = .25, p < .05$), close relationship ($r_{pb} = .24, p < .05$), and current employment ($r_{pb} = .23, p < .05$) scores, but not with friendship score ($r_{pb} = -.04, p = .72$) in the ASD group.

Since having additional OCD diagnosis was significantly correlated with life outcome scores, regression analyses for those were rerun including having OCD as one of the covariates in addition to the previously examined associate/s. A significant multiple regression equation was calculated for composite life outcome score ($F(3, 85) = 5.47, p < .01$) with an R^2 of .16 (Table 3-15). It was found that total years of education, having OCD and severity of social impairments were all strong associates of composite life outcome score in the ASD group, $\beta = -.22$, $\beta = .21$ and $\beta = .21$, respectively with all $ps < .05$. Adults with ASD who had less education, additional OCD diagnosis and more severe social impairments had poorer life outcome in general.

Table 3-15 Multiple regression results to predict composite life outcome score based on social impairments score (Soc. Imp.), having additional OCD and total years of education (YoE)

Step 1	B	SE B	β
(Constant)	4.35	0.24	
OCD	1.95	0.73	.28**
Step 2			
(Constant)	7.21	1.39	
OCD	1.75	0.72	.25*
YoE	-0.21	0.10	-.21*
Step 3			
(Constant)	5.70	1.55	
OCD	1.50	0.72	.21*
YoE	-0.21	0.10	-.22*
Soc. Imp.	0.55	0.27	.21*

Dependent Variable: Composite Life Outcome

Note: $R^2 = .08$ for Step 1, $\Delta R^2 = .04$ for both Step 2 and 3, * $p < .05$.

A significant multiple regression equation was calculated for independence score ($F(2, 87) = 6.64, p < .01$) with an R^2 of .13 (Table 3-16). It was found that both others-to-self risk score and having OCD were strong associates of independence ($\beta = .28, p < .01$ and $\beta = .21, p < .05$, respectively), indicating that adults with ASD who were more vulnerable and had additional OCD had poorer independence.

Table 3-16 Multiple regression results to predict independence score based on others-to-self risk assessment score (OS-Risk) and having additional OCD

Step 1	B	SE B	β
(Constant)	1.05	0.14	
OS-Risk	0.16	0.06	.30**
Step 2			
(Constant)	0.98	0.14	
OS-Risk	0.15	0.05	.28**
OCD	0.72	0.34	.21*

a Dependent Variable: Independence

Note: $R^2 = .09$ for Step 1, $\Delta R^2 = .04$ for Step 2 ($p < .05$), * $p < .05$, ** $p < .01$.

A significant multiple regression equation was calculated for close relationship score ($F(3, 86) = 7.02, p < .001$) with an R^2 of .20 (Table 3-17). It was found that severity of social impairments, age and having OCD were all strong associates of close relationship ($\beta = .24, p < .05$, $\beta = -.23, p < .05$ and $\beta = .20, p < .05$, respectively). This

indicated that old adults, adults with less severe social impairments and who didn't have OCD had better close relationships in the ASD group.

Table 3-17 Multiple regression results to predict independence score based on others-to-self risk assessment score (OS-Risk) and having additional OCD

Step 1	B	SE B	β
(Constant)	-0.40	0.50	
Soc Imp.	0.52	0.17	.32**
Step 2			
(Constant)	0.59	0.63	
Soc. Imp.	0.45	0.16	.27**
Age	-0.02	0.01	-.25*
Step 3			
(Constant)	0.60	0.62	
Soc. Imp.	0.40	0.16	.24*
Age	-0.02	0.01	-.23*
OCD	0.85	0.42	.20*

Dependent Variable: Close Relationship

Note: $R^2 = .10$ for Step 1, $\Delta R^2 = .06$ for Step 2 and $.04$ for Step 3 (both $ps < .05$), $*p < .05$.

A significant multiple regression equation was calculated for current employment score ($F(2, 87) = 27.19, p < .001$) with an R^2 of .39 (Table 3-18). It was found that both age and having OCD were strong associates of current employment ($\beta = -.55, p < .001$ and $\beta = .23, p < .01$, respectively), indicating that young adults and adults who had had additional OCD in the ASD group had poorer current employment.

Table 3-18 Multiple regression results to predict current employment score based on age and having additional OCD

Step 1	B	SE B	β
(Constant)	2.38	0.23	
Age	-0.04	0.01	-.58***
Step 2			
(Constant)	2.24	0.23	
Age	-0.03	0.01	-.55***
OCD	0.76	0.28	.23**

Dependent Variable: Current Employment

Note: $R^2 = .33$ for Step 1, $\Delta R^2 = .05$ for Step 2 ($p < .01$), $**p < .01$, $***p < .001$.

3.4.3.2.2 Non-ASD Group

Associations of having additional mental health conditions with total ASD and life outcome scores were examined; results showed that neither of the correlations were

significant, $r_{pb} = .08$, $p = .61$ and $r_{pb} = .03$, $p = .82$, respectively. These associations were not significant also when they were investigated for having anxiety, depression, ADHD and OCD separately. Further analysis was carried out to examine associations between having additional mental health conditions and severity of each sub-group of the triad traits (i.e. social impairments, communication impairments, and RRBI). The only significant correlation detected was between having OCD and RRBI score ($r_{pb} = .51$, $p < .001$).

Associations between having additional mental health conditions and sub-scores of life outcome (i.e. independence, friendship, current employment and close relationship) score were further examined. The only significant association that was found was between having ADHD and friendship score ($r_{pb} = -.38$, $p < .01$) in the non-ASD group. The multiple regression analysis was rerun for the friendship score with including having ADHD as one of the covariates. A significant multiple regression equation was calculated ($F(2, 43) = 9.55$, $p < .001$) with an R^2 of .31 (Table 3-19). Both having ADHD and social impairments score were strong associates of friendship score in the non-ASD group ($\beta = -.44$, $p < .01$ and $\beta = .43$, $p < .01$, respectively); adults in the non-ASD group who had ADHD and less severe social impairments had better friendship.

Table 3-19 Multiple regression results to predict friendship score based on having ADHD and social impairments score (Soc. Imp.)

Step 1	B	SE B	β
(Constant)	0.90	0.13	
ADHD	-0.90	0.35	-.36*
Step 2			
(Constant)	0.70	0.13	
ADHD	-1.09	0.32	-.44**
Soc. Imp.	0.48	0.14	.43**

Dependent Variable: Friendship

Note: $R^2 = .13$ for Step 1, $\Delta R^2 = .18$ for Step 2 ($p < .01$), ** $p < .01$.

3.4.4 Results Summary Table

Variable		Age Group Effect	Study Group Effect	Age Group x Study Group Effect	Other Significant Correlates
ASD symptoms (ICD-10 checklist)	Total	Ns.	ASD > Non-ASD (large effect)	Ns.	• Friendship (+) (Non-ASD group) • Close relationships (+) (ASD group)
	Social impairments	Ns.	ASD > Non-ASD (large effect)	Ns.	• Composite life outcome (+) • Friendship (+) (Non-ASD group) • Close relationships (+) (ASD group)
	Communication impairments	Ns.	ASD > Non-ASD (large effect)	Ns.	None
	RRBI	Ns.	ASD > Non-ASD (large effect)	Ns.	• OCD diagnosis (+)
YoE (total years of education)		Ns.	Ns.	Ns.	• Composite life outcome (-) (ASD group) • Independence (-) (ASD group) • Current employment (-) (ASD group)
Mental health service history		Ns.	Ns.	Ns.	• Friendship (+) (Non-ASD)
Forensic service use history		Ns.	Ns.	Ns.	• Close relationship (-) (ASD group)
Risk Assessment	Total Risk	y > 0 (medium effect)	ASD > Non-ASD (medium effect)	Ns.	• Composite life outcome (+) (ASD group)
	Self-to-self	Ns.	Ns.	Ns.	None
	Self-to-others	Ns.	Ns.	Ns.	None
	Others-to-self	y > 0 (medium effect)	ASD > Non-ASD (medium effect)	Ns.	• Composite life outcome (+) (ASD group) • Independence (+) (ASD group)

Table continued on the next page

Variable		Age Group Effect	Study Group Effect	Age Group x Study Group Effect	Other Significant Correlates
Life Outcome (adapted from Howlin et al., 2004; 2013)	Composite life outcome	y > o (medium effect)	ASD > Non-ASD (medium effect)	Ns.	• Social impairments (+) • YoE (-) (ASD group) • Others-to-self risk (+) (ASD group) • OCD diagnosis (+) (ASD group)
	Independence	y > o (medium effect)	ASD > Non-ASD (small effect)	Ns.	• YoE (-) (ASD group) • Others-to-self risk (+) (ASD group) • Current employment (+) (Non-ASD group) • OCD diagnosis (+) (ASD group)
	Friendship	y > o (medium effect)	ASD > Non-ASD (medium effect)	Ns.	• age (+) (ASD group) • Social impairments (+) (Non-ASD) • Mental health service history (+) (Non-ASD) • ADHD (-) (Non-ASD)
	Close relationship	y > o (medium effect)	ASD > Non-ASD (medium effect)	Ns.	• age (-) (ASD group) • Social impairments (+) (ASD group) • Current employment (+) (ASD group) • Forensic service use history (-) (ASD group) • OCD diagnosis (+) (ASD group)
	Current employment	y > o (medium effect)	Ns.	Ns.	• age (-) (ASD group) • YoE (-) (ASD group) • Independence (+) (Non-ASD group) • Close relationship (+) (ASD group) • OCD diagnosis (+) (ASD group)
Psychiatric Conditions (based on current clinical diagnosis)	Anxiety	Ns. ¹	ASD > Non-ASD ²	N/A	None
	Depression	Ns. ¹	Ns.	N/A	None
	OCD	N/A	Ns.	N/A	• Composite life outcome (+) (ASD group) • Independence (+) (ASD group) • Close relationship (+) (ASD group) • Current employment (+) (ASD group) • RRBI (+)
	ADHD	N/A	Ns.	N/A	• Friendship (-) (Non-ASD group)

y: Young and o: Old

(+) positive association; (-) negative association

¹ Tested only in the ASD group

² Effect sizes were N/A

Unless identified effect size is small or less

It should be noted that higher scores indicate worse outcome except for total years of education

3.5 Discussion

Unsurprisingly, adults with ASD had more severe ASD symptoms than adults in the non-ASD group. When the triad of symptoms were investigated separately, it was found that adults with ASD were more impaired in all three symptom domains. There was no significant age group effect on symptoms in either study group, or no interaction. Results partly fit with existing literature showing no age effects on ASD symptoms in general (e.g., Bastiaansen et al., 2011 and Bishop & Seltzer, 2012), but not with studies reporting age-related abatement in RRBI (e.g., Esbensen et al., 2009; Gray et al., 2012; Howlin et al., 2013; Seltzer et al., 2003; Shattuck et al., 2007; Woodman et al., 2015).

Years of education did not differ between groups, showing that all groups were of a similar level of education. Life outcome of adults with ASD was poorer than adults in the non-ASD group. Young adults' life outcome was significantly poorer than old adults' in general. Findings did not support either old adult studies showing no age-related effect on QoL (e.g., van Heijst & Geurts, 2015; Totsika et al., 2010) or young adult outcome studies showing decrease in life outcome (e.g., Howlin et al., 2013; Orsmond et al., 2004, but see Renty & Roeyers, 2006). Discrepancies might be because of including different age groups and/or using different methods to assess QoL. Future studies should include both subjective and objective QoL assessment methods to explore age-effects.

Young and old adults in both ASD and clinic control groups had a similar history of mental health and forensic service use. However, adults with ASD were rated by clinicians as more vulnerable to potential risks from other people compared to adults in the non-ASD group. Also, young adults were considered at a higher risk than old adults

in general. There were no differences by age or group in ratings of risk to others and/or risk to self.

Poor social skills, from symptom summary sheets, were related to poor life outcome in both ASD and non-ASD groups. Years of education was also a strong associate of life outcome in the ASD group. However, it should be noted that the present study could not establish whether this relationship is causal. In the literature, IQ was reported as a strong predictor of adult ASD outcome (e.g., Gillespie-Lynch et al., 2012; Howlin et al., 2013; Kobayashi et al., 1992). IQ data were not available to be used in the analyses for this study group; however, if total years of education can be considered as a proxy of intellectual ability, results fit the literature. Although, current (rather than early) social skills were assessed in the present study, results can be considered as in line with other studies that reported that early social skills predicted better life outcome (e.g., Howlin et al., 2013).

A closer look at each subdomain of life outcome suggested that vulnerability to risks from other people was associated with poor independence in the ASD group only. Although causal link cannot be tested in these data, it can be speculated that vulnerability may prevent adults with ASD from pursuing an independent life. Higher level of education was also related to being more independent in the ASD group. However, in the non-ASD group, only better current employment was significantly associated with higher independence. Advanced age was the strongest associate of better current employment score in the ASD group only. Also, having higher years of education was related to better employment. With the current assessment tools and results it cannot be tested whether employment naturally increase with age. However, in the non-ASD group the strongest associate of employment was independence only.

Further studies are needed with ideally longitudinal design to explore age-related effects on employment.

Age was the only significant associate of friendship in the ASD group. Younger adults with ASD reported having more reciprocal friends compared to old adults. However, it should be noted that with the current scoring system it was not possible to separate ‘not wanting’ versus ‘not being able to’ have friends. Younger age, in addition to having better mental health service history, was also related having friends in the non-ASD group, where however the strongest associate of friendship was social skills. Adults with ASD seem to have more stable close-relationships if they have better social skills and more advanced age. Having better employment was also associated with having better close relationships in the ASD group. A negative correlation was found between close relationships and forensic service use history suggesting that better score in romantic relationships went with a worse forensic record. Since, with the current scoring system, quality of intimate relationships cannot be assessed, this finding should be further investigated with different scoring systems that allow examining quality of close relationships and reasons for forensic service involvement to further explore this unexpected association.

For co-occurring psychopathology, adults with ASD were more likely to have mental health conditions, especially anxiety disorders compared to adults in the non-ASD group. ASD status was not associated with depression, OCD and ADHD significantly. This result should be interpreted with caution due to small number of people with mental health conditions in the non-ASD group. Young and old adults with ASD did not differ in terms of having additional mental health disorders. Unfortunately, age effects could not be tested in the non-ASD group due to age groups’ being small.

In both ASD and non-ASD groups, having OCD was associated with higher RRBI. This might be due to the similarity between RRBI items and OCD symptoms. Future research is needed to disentangle this relationship, maybe with examining RRBI in groups with ASD only, OCD only and both OCD and ASD.

In the ASD group, having OCD was found to be a strong associate of independence, close relationships and current employment. This indicates that in addition to vulnerability to risks from others (as stated above) having OCD was associated with limited independence, only in the ASD group. Similarly, having OCD in addition to younger age (and social impairments for close relationship) was associated with poorer current employment and close relationships. In the non-ASD group, in addition to good social skills having ADHD was found to be associated with having better friendship. Although being highly speculative, the latter relationship might be because adults who were referred to the clinic for an ASD assessment and diagnosed rather with ADHD might have fewer problems with peer-relationships.

3.5.1 Limitations

Results of the present study should be considered with its limitations. Cross-sectional design was used to assess age-effects, which makes findings subject to possible cohort effects. Longitudinal studies are needed to replicate these results.

Small sample size did not allow further analyses due to reduced statistical power, especially testing age group effects on additional mental health conditions in the control group was not possible.

Adults with ASD in this study were compared to a clinical control group rather than healthy controls. Although, using a clinical control group of adults who were referred for an ASD assessment can be of value showing how these adults receiving and

not receiving an ASD diagnosis in the end differ in a number of aspects of functioning, future studies need to include different control groups.

Data used in analyses were based on patient reports. This limited not only controlling differences in data collection (although patient reports are usually collected in a standard format), but also the use of data for analyses. For example, ASD symptoms were scored based on ICD-10 symptom checklist, because only available data to compare ASD and non-ASD groups and young and old adults were the diagnostic checklist.

3.6 Conclusion

This study examined ASD symptoms, normative life outcome and co-occurring psychopathology in young and old adults with ASD in comparison to a clinical control group of adults who were referred for an ASD assessment but did not received a final diagnosis of ASD. It becomes evident that difficulties with ASD-related impairments and poor life outcome (especially social) are still problematic for old adults with ASD, although the latter being less severe compared to young adults. Co-occurring psychopathology, especially anxiety and depression, is also common in both young and old adults with ASD.

Chapter 4 Autism Spectrum Disorder (ASD) Severity, Self-Reported Mental Health Difficulties and Quality of Life in Young and Old Adults with ASD

4.1 Introduction

Research examining age-related effects on adult-outcome in ASD populations from different sources is important to be able to generalise findings. To complement the clinic-based study of adults coming for first diagnosis of ASD, reported in the previous chapter, this chapter and the following will present findings from older and younger ASD adults recruited from multiple sources. In the previous study the control group was adults referred for but not receiving an ASD diagnosis; as such they may be a conservative comparison group. For the study reported in Chapter 4 and Chapter 5, a control group of older and younger neurotypical (NT) adults were recruited. Since this chapter focuses on age effects on ASD traits, additional mental health difficulties and quality of life, which were examined in Chapter 3's clinic-based study, the relevant literature is reviewed in Chapters 2 and 3.

4.2 Aim

The study presented in this chapter aimed to investigate age-related effects on ASD traits, symptoms of additional mental health difficulties and quality of life (QoL) in young and old adult groups with ASD compared to NT counterparts.

Analyses were mainly exploratory; primary research questions and objectives were as follows:

1. To examine age-related effects on ASD traits in adults with ASD compared to NT controls
2. To examine age-related effects on QoL in adults with ASD compared to NT controls

3. To explore predictors of QoL (IQ, ASD traits, self-reported mental health difficulties) as a function of age

Although analyses were mainly exploratory, tentative hypotheses for the research objectives detailed above were as follows:

Hypotheses for aim 1 and 2:

No specific prediction is made regarding the association with age; these analyses were exploratory.

Hypotheses for aim 3:

1. QoL will be negatively correlated with ASD traits self-reported mental health difficulties
2. QoL will be negatively correlated with ASD traits self-reported mental health difficulties

4.3 Method

4.3.1 Ethics

Ethical Approval for Study 2 was granted by the Psychiatry, Nursing and Midwifery Research Ethics Subcommittee (PNM RESC) at King's College London (PNM/13/14-26). Information sheets were provided to all participants and written consent was taken before the study took place (copies of study information sheet, consent form and the letter of ethics approval can be found in Appendix F).

4.3.2 Design

Group comparisons between young and old adults with ASD and young and old neurotypical adults without known psychiatric conditions were made on a range of measures assessing symptoms of ASD and other mental health difficulties (e.g. depression and anxiety), quality of life (QoL), and cognitive skills. Because, at the time

of study design and planning, no published studies had examined these variables in old age in ASD samples, the exact effect sizes could not be predicted from the literature. Sample size was therefore set at minimum 20 per group, i.e., 80 participants in total across the four groups (young/old, ASD/NT) giving estimated 80% power to detect a medium effect size (Field, 2009).

4.3.3 Participants

A group of 97 adults were recruited into the study, of which 58 had a diagnosis of ASD ($M_{age} = 43.66$, $SD=16.11$) and 39 were neurotypical adults (NT) ($M_{age} = 44.95$, $SD=17.54$). Adults with ASD were approached through research databases of the Behavioural Genetics Clinic (BGC) at the Maudsley Hospital in South London, King's College London and City University as well as through research advertisements. The NT control group was recruited mainly through advertisements and also research databases at King's College London and City University. Gender ratio in the NT group was matched based on the male-female ratio in the ASD group.

Inclusion criteria for both ASD and NT groups were: age 18 years or older, intellectual level higher than 70 (measured by the Wechsler Abbreviated Scales of Intelligence-2nd edition (WASI-2; Wechsler, 2011) or the Wechsler Adult Intelligence Scale-3rd/4th edition (WAIS-III/IV; Wechsler, 1997; 2008) and fluent English. Additional inclusion criteria were applied for each group: having a formal ASD diagnosis (including Autistic disorder, Asperger disorder or atypical autism) by a clinician for the ASD group, and having no known psychiatric conditions for the NT control group.

Both ASD and NT groups were divided into young and old age groups. The same age cut-off criteria (i.e., 50 and over years) as in Study 1 were applied when

determining old age group. Table 4-1 presents final group sizes and age profile of ASD and NT groups.

Table 4-1 Young and old adults in ASD and NT groups: Mean (SD)

	Young			Old		
	N	Age (in years)		N	Age (in years)	
		Range	Mean (SD)		Range	Mean (SD)
ASD	29	19-48	29.48 (8.51)	29	50-71	61.32 (6.18)
NT	20	20-44	29.40 (7.54)	19	52-71	57.83 (6.33)

Two-way ANOVA results showed that study groups were matched on age. Reflecting the grouping strategy, there was a significant main effect of age group, $F(1, 93) = 400.48, p < .001$, but the effect of study group and the interaction of study group by age group were both non-significant, $F(1, 93) = 1.28, p = .26$ and $F(1, 93) = 1.41, p = .24$, respectively.

Groups were examined in terms of gender ratio, intellectual ability, total years of education and level of income. Demographics of the four groups can be seen in Table 4-2.

Table 4-2 Demographics of age groups in the ASD and NT groups: Mean (SD)

	ASD		NT		F^1	p -value	effect size: η^2
	Young N = 29	Old N = 29	Young N = 20	Old N = 19			
Gender ratio (M:F)	22:7	22:7	11:9	11:8	-	-	-
VIQ	107.34 (16.58)	108.07 (16.72)	111.60 (11.18)	107.89 (10.77)	0.45 ^{group} 0.24 ^{age} 0.53 ^{agexgroup}	.50 ^{group} .63 ^{age} .47 ^{agexgroup}	0.01 ^{group} .003 ^{age} 0.01 ^{agexgroup}
PIQ	113.55 (13.92)	113.24 (20.26)	115.40 (10.72)	104.89 (15.48)	0.98 ^{group} 2.71 ^{age} 2.41 ^{agexgroup}	.33 ^{group} .10 ^{age} .12 ^{agexgroup}	0.01 ^{group} 0.03 ^{age} 0.03 ^{agexgroup}
FSIQ	111.83 (14.99)	111.03 (17.05)	114.75 (11.01)	107.58 (13.80)	0.01 ^{group} 1.71 ^{age} 1.09 ^{agexgroup}	.93 ^{group} .20 ^{age} .30 ^{agexgroup}	.000 ^{group} 0.02 ^{age} 0.01 ^{agexgroup}
YoE	16.55 (3.11)	15.31 (3.83)	18.05 (2.21)	16.11 (4.4)	2.54 ^{group} 4.90^{age*} 0.24 ^{agexgroup}	.11 ^{group} .03 ^{age} .63 ^{agexgroup}	0.03 ^{group} 0.05 ^{age} 0.003 ^{agexgroup}
Level of Income	2.83 (1.71)	3.17 (1.56)	3.65 (1.42)	3.37 (1.50)	2.45 ^{group} 0.01 ^{age} 0.93 ^{agexgroup}	.12 ^{dx} .92 ^{age} .34 ^{agexgroup}	0.03 ^{group} .000 ^{age} 0.01 ^{agexgroup}

YoE: Total years of education

¹ All $df_M s = 1$ and $df_R s = 93$

^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group

* $p < .05$

A log-linear analysis was conducted to investigate possible effects of study and age groups on gender ratio. The three-way log-linear analysis produced a final model that retained none of the effects including the interaction effect. The likelihood ratio of this model was $\chi^2(3) = 3.77$, $p = 0.29$. This indicated that age groups and study groups were not significantly different in terms of male : female ratio.

Two-way ANOVA analysis was performed to examine whether age groups and study groups were matched on intellectual level (Verbal IQ: VIQ, Performance IQ: PIQ and Full-Scale IQ: FSIQ), total years of education and income level. The main effect of

study group was not significant for all measures. There was also a non-significant main effect of age group, except for total years of education, indicating that young adults ($M=17.16$, $SD=2.85$) had slightly more years of education than old adults ($M=15.63$, $SD=4.04$). No significant interaction of age group by study group was detected on any of the measures (Table 4.2).

Since different recruitment methods might result in sampling artefacts, the sources of participants in the old and young ASD groups were examined. 62% of adults with ASD in each age group were recruited through the Behavioural Genetics Clinic, at the Maudsley Hospital in London (18 young ASD and 17 older ASD), whereas 38% were recruited via adverts or research volunteer databases (11 young and 12 old). Thus the proportions of adults from different recruitment sources was equivalent across the two ASD age groups. Age at first ASD diagnosis was known for 22 adults (76%) in each ASD age group; other participants did not know the age of their first diagnosis. Since the majority of participants were recruited via the diagnostic clinic, most were recently diagnosed; mean age of diagnosis was 24.00 years ($SD=8.72$, age-range: 6-42 years) in the young ASD group and 54.77 years ($SD=7.08$, age-range: 40-70 years) in the old ASD group.

4.3.4 Measures

Descriptive and quantitative methods that facilitated the exploration of age-related differences in ASD symptoms, mental health difficulties and quality of life (QoL) were used, through a series of standardized tests and questionnaires during in-person research sessions carried out by the author. The tasks and questionnaires listed below were chosen in view of their psychometric properties and practical use and, also, their use

with the target population (elderly and/or adults, and those with ASD) in previous research studies (see Chapter 2).

4.3.4.1 Wechsler Abbreviated Scales of Intelligence - Second Edition (WASI-II; Wechsler, 2011):

The WASI-II is a standardized assessment of intelligence, a revised version of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). The WASI-II is linked to the Wechsler Adult Intelligence Scale - 4th edition (WAIS-IV; Wechsler, 2008) providing an estimation of comparable intelligence scores. It has 4 subtests: Vocabulary, Similarities, Block Design, and Matrix Reasoning. Scores allow an estimate of general intellectual ability (full-scale intelligence; FSIQ); scores from the first two subtests allow an estimate of verbal intelligence (VIQ), while the latter two measure performance intelligence (PIQ). Raw scores are calculated by summing the item scores, then converted to T scores and composite scores. A composite score of 69 and below is considered “extremely low”, 70-79 is “borderline”, 80-89 is “low average”, 90-109 is “average”, 110-119 is “high average”, 120-129 is “superior”, and 130 and above is “very superior”. In the current study, a cut-off score of 70 was set for recruitment, in order to meet the minimum mental requirements of the other tasks in the study. The WASI-II has been widely used for obtaining rapid estimates of IQ for research purposes, when administration of the full battery is not feasible. Psychometric properties of the WASI-II have been reported to be good, with .90 to .92 average internal consistency reliability coefficients, and test-retest reliability ranging from .83 to .96, inter-scorer reliability of .94 to .99, convergent validity of .47 to .94, and construct validity on a two-factor model (Verbal Comprehension and Perceptual Reasoning) (Wechsler, 2011). Its relationships with other instruments (e.g. WASI; Wechsler, 1999,

WAIS-IV; Wechsler, 2008, and KBIT; Kaufman & Kaufman, 1990) provide additional evidence of the scale's validity (Wechsler, 2011).

4.3.4.2 Client Service Receipt Inventory (CSRI; Beecham & Knapp, 1992):

This questionnaire collects self-reported retrospective information mainly about use of health and social care services. There are 5 categories in the “generic mental health UK” version of the questionnaire: socio-demographic information, usual living situation, employment and income, service receipt, and medication profile. The CSRI is largely structured with a few narrative answers required.

4.3.4.3 ASD Traits

4.3.4.3.1 Social Responsiveness Scale (SRS-2; Constantino & Gruber, 2012):

The SRS-2 is a 65-item scale assessing the severity of social impairments related to ASD. The scale has self- and informant-report versions and generates scores for “social awareness”, “social cognition”, “social communication”, “social motivation”, and “restricted interests and repetitive behaviour” in addition to a total score of severity of ASD-related social deficits. It also has two DSM-5 compatible subscales: “Social Communication and Interaction (SCI)” and “Restricted Interests and Repetitive Behaviour (RRB)”. Each item is rated on a 4-point Likert scale ranging from “not true (1)” to “almost always true (4)”. Raw scores are converted to T-scores with a minimum score of 36 for total score, 35 for SCI, 32 for social awareness, 37 for social cognition, communication and motivation, and 40 for RRB subscales. Maximum T score is 90 for all scores. The SRS-2 has demonstrated good psychometric characteristics with strong internal consistency (correlations ranged .94 - .96), and inter-rater reliability (coefficients ranged from .61 to .92) (Bruni, 2014; Constantino & Gruber, 2012).

4.3.4.4 Assessments for Self-Reported Mental Health

4.3.4.4.1 The Patient Health Questionnaire (PHQ; Spitzer, Kroenke, Williams, & PHQ Primary Care Group, 1999):

The PHQ is a shortened self-administered version of the Primary Care Evaluation of Mental Disorders Screening Questionnaire for Depressive Symptoms (PRIME-MD; Spitzer et al., 1994). The questionnaire assesses a range of mental disorders: somatoform disorders, depression, anxiety, panic disorder, harmful use of alcohol, and eating disorders. It has 11 items with various sub-items. Items are assessed based either on a 3-4 point Likert scale (e.g. “not bothered” to “bothered a lot”) or yes/no answers. Scoring for each disorder group is based on counting answers at specific points on the Likert scale (e.g. answers at point 3 and over) or if some answers are “yes”. The scores are compared to identified cut-off criteria for each disorder group and interpreted as indicating or not indicating possible difficulty/disorder. Psychometric properties of the PHQ are good, with a good validity $K=0.65$; overall accuracy is 85% (sensitivity 75%, specificity 90%), compared to clinical diagnoses by independent mental health professionals (Spitzer et al., 1999).

4.3.4.4.2 The Obsessive-Compulsive Inventory-Revised (OCI-R; Foa et al., 2002):

The Obsessive-Compulsive Inventory-Revised (OCI-R; Foa et al., 2002) is the short version of the Obsessive-Compulsive Inventory (OCI; Foa, Kozak, Salkovskis Coles, & Amir, 1998), a self-rated measure by which symptoms of obsessive compulsive disorder (OCD) are investigated. The revised OCI consists of 18 items and 6 domains (i.e., washing, obsessing, hoarding, ordering, checking, and neutralizing). Answers are rated based on a 5-point Likert scale, from “not at all (0)” to “extremely (4)”. Scores are calculated by summing item scores. Psychometric properties of the

instrument (e.g. internal consistency, 0.81-0.93; test-retest reliability, and validity) are reported to be good (Foa et al., 2002). With a cut-off score of possible clinical diagnosis set as 21, 65.6% sensitivity and 63.9% specificity has been reported (Foa et al., 2002). In a recent study, a cut-off score of 29 has been suggested for adults with ASD with a sensitivity of 69% and specificity of 70% (Cadman et al., 2015). Therefore, in the current work different cut-off scores were used in the ASD (cut-off 29) and NT groups (cut-off 21).

4.3.4.4.3 Attention-Deficit / Hyperactivity Disorder (ADHD) - Self-Report Scale Symptom Checklist (ASRS-v1.1; Kessler et al., 2005):

ASRS-v1.1 is a 6-question self-report screening questionnaire for ADHD. It is a subset of the WHO's 18-question Adult ADHD Self-Report Scale-Version1.1 (Adult ASRS-V1.1) Symptom Checklist. It assesses the frequency of core difficulties experienced by people with ADHD. Items are rated on a 5-point Likert scale from “never” to “very often”. Scores are calculated by counting items rated over a specific point (e.g. if they occur more than “sometimes”). The cut off score is 4, indicating that 4 or higher number of answers at specific points on the scale may point out ADHD. The ASRS v1.1 Screener has been reported to have good sensitivity and specificity and a positive predictive value between 57% and 93%. Internal consistency of the screener has been reported in the range 0.63–0.72 and test-retest reliability in the range 0.58–0.77 (Kessler et al., 2005, 2007).

4.3.4.4.4 Beck Anxiety Inventory (BAI; Beck & Steer, 1990):

This is a 21-item questionnaire measuring anxiety based on subjective, somatic, or panic-related symptoms of anxiety. Participants rate items on a 4-point Likert scale ranging from “not at all (0)” to “severely, I could barely stand it (3)”. Scores range from

0 to 63; a total score of 0-9 is interpreted as “normal or no anxiety”, 10-18 as “mild to moderate anxiety”, 19-29 as “moderate to severe anxiety”, and 30-63 as “severe anxiety” (Beck & Steer, 1990). Scores can also be interpreted based on a 3-factor structure, with “subjective”, “somatic”, and “panic” subscales (Beck, Steer, & Beck, 1993). Psychometric properties of the BAI have been reported to be good (e.g. high internal consistency with Cronbach: 0.90-0.94; validity: 0.47-0.81; and test-retest reliability: 0.67-0.93) (Beck & Steer, 1990; Fydrich, Dowdall, & Chambless, 1992). A cut-off score of 20 has been reported to have a sensitivity of 0.67 and a specificity of 0.93 to identify panic disorder (Stein et al., 1999). A less strict cutoff (i.e., 8) with a sensitivity of 0.89 and specificity of 0.97 has also been suggested in a more recent study to identify people with panic disorder (with or without agoraphobia) (Leyfer, Ruberg, & Woodruff-Borden, 2006). To the author’s knowledge, no published cutoff scores were available for ASD. A cut off score of 20 was used in the current study to identify people who were at least moderately anxious.

4.3.4.4.5 Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996):

BDI-II consists of 21 self-report items assessing the severity of depressive symptoms, such as loss of energy, worthlessness, and agitation. Items are rated on a 4-point scale ranging from “0 (e.g. I don’t feel I am being punished)” to “3 (e.g. I feel I am being punished)” and total scores range from 0 to 63. A total score of 0 - 13 is interpreted as a "minimal depression"; 14 - 19 as "mild depression"; 20 - 28 as "moderate depression", and; 29 - 63 as "severe depression". Scores can also be interpreted on subscale level: “cognitive-affective” and “somatic” subscales. The BDI-II has been reported to have good psychometric properties (high internal consistency: Cronbach of 0.90-0.94; test-retest reliability: $r = 0.93$ and validity: a correlation of 0.71)

(Beck et al., 1996). A cut-off score of 16 was recommended with a sensitivity of 88.2% and a specificity of 92.1% (Huffman et al., 2010). This cut-off was used for both ASD and NT groups in the present study, since no specific cut-off has been established for ASD. However, it should be noted that some authors have suggested NT cut-offs may over-identify depression in ASD (Gotham, Unruh, & Lord, 2014).

4.3.4.5 Quality of Life

4.3.4.5.1 The World Health Organization Quality of Life Assessment (WHOQOL-BREF; WHOQOL Group, 1998):

The WHOQOL-BREF is a 26-item self-assessment scale for quality of life. It is a shortened version of the WHOQOL-100 (WHOQOL Group, 1994). The scale consists of 4 domains of QoL: physical (e.g. mobility, energy and fatigue), psychological (e.g. negative/positive feelings, self-esteem), social (e.g. personal relationships and social support), and environment (e.g. financial resources, transport and home environment). In addition, it has two items questioning an individual's overall perception of quality life and general health. Answers are rated on a 5-point Likert scale, ranging from 1 (e.g. "very dissatisfied") to 5 (e.g. "very satisfied"). Higher scores indicate better QoL. Domain scores are calculated by averaging the item scores in each domain. Scores then can be converted to transformed scores that are comparable with the WHOQOL-100. Domain scores can also be transformed to a 0-100 scale. The WHOQOL-BREF has demonstrated good psychometric properties with >0.8 internal consistency (except for social relationships: Cronbach was 0.68) and overall significant discriminant and construct validity (Castro, Oliveira, Miguel, & Araujo, 2007; Skevington, Lotfy, & O'Connell, 2004; WHOQOL Group, 1998).

4.3.5 Procedure

Testing took place for all participants within a quiet room within the MRC Social, Genetic and Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience, King's College London and/or the Autism Research Lab in the Psychology Department at City University London. Participants were sometimes tested in two testing sessions on different days as necessary (e.g. they could not complete all tests in one testing slot). All participants were thanked and reimbursed for their time and travel costs.

4.3.6 Statistical Analysis

Parametric tests were employed for statistical analysis where applicable. Homogeneity of variance was measured using Levine's test. Normality of data distribution was checked in several ways: the Nonparametric Kolmogorov-Smirnov test, the Nonparametric Shapiro-Wilk test, histograms, Q-Q plots, and examination of skewness and kurtosis scores. Bootstrap analysis was performed to test whether the results were robust against deviations from parametric assumptions (Chong & Choo, 2011), when at least three of the above indicators suggested deviation from the normal distribution. The independent bootstrap test is nonparametric. 95% mean difference confidence intervals obtained from the bootstrap test were reported alongside such cases to support outcomes of the test statistic. All bootstrap tests were based on 1000 samples.

Two-way ANOVA was used to investigate the effect of study group (ASD vs. NT) and age group (young vs. old) on outcome measures. To reduce the number of statistical tests, subscales were only explored where total scores showed significant group, age or age by group effects. When there was a significant age by group interaction, results of multiple group comparisons using t-test along with effect sizes

(Cohen's d) were presented for exploratory purposes. Since these analyses were exploratory, a significance level of .05 was used rather than more conservative p values (e.g. $p < .0125$ level of significance applying Bonferroni correction) when multiple tests were run. For the correlation analysis either a Spearman's or Pearson's correlation coefficient was calculated depending on parametric status of the variables. Multiple regression analyses were conducted for only global QoL scores in study groups and with only variables that had significant correlation with the outcome variable included as possible predictors. Forward stepwise method was used in all regression analyses, with confirmatory checks using backward elimination method to identify all significant predictors. Categorical data were tested by using a Pearson Chi Square statistic.

4.4 Results

4.4.1 Diagnostic Group and Age Group Effects

4.4.1.1 Diagnostic Group and Age Group Effects on ASD Traits

Table 4-3 presents ASD trait scores (total score and scores at sub-scale level) of young and old adults in the ASD and NT groups.

Table 4-3 ASD trait scores (SRS-2) of young and old adults in ASD and NT groups: Mean (SD)

			ASD		NT		F^1	p -value	effect size: η^2
			Young N = 29	Old N = 29	Young N = 20	Old N = 19			
ASD traits	Total		73.24 (9.97)	70.17 (12.04)	47.40 (7.56)	45.84 (5.38)	161.51^{group***} 1.37 ^{age} 0.15 ^{agexgroup}	<.001 ^{group} .24 ^{sge} .70 ^{agexgroup}	.64 ^{group} .02 ^{age} .002 ^{agexgroup}
	Sub-scales	SCI	72.79 (10.14)	69.62 (11.94)	46.85 (6.92)	46 (5.98)	158.12^{group***} 1.04 ^{age} 0.35 ^{agexgroup}	<.001 ^{group} .31 ^{age} .56 ^{agexgroup}	.63 ^{group} .01 ^{age} .004 ^{agexgroup}
		RRB	72.79 (11.68)	70.38 (13.08)	50.35 (10.29)	46.32 (4.67)	106.48^{group***} 2.05 ^{age} 0.13 ^{agexgroup}	<.001 ^{group} .16 ^{age} .72 ^{agexgroup}	.53 ^{group} .02 ^{age} .001 ^{agexgroup}

SCI: Social Communication and Interaction

RRB: Restricted Interests and Repetitive Behaviour

¹ All $df_M s = 1$ and $df_{RS} = 93$

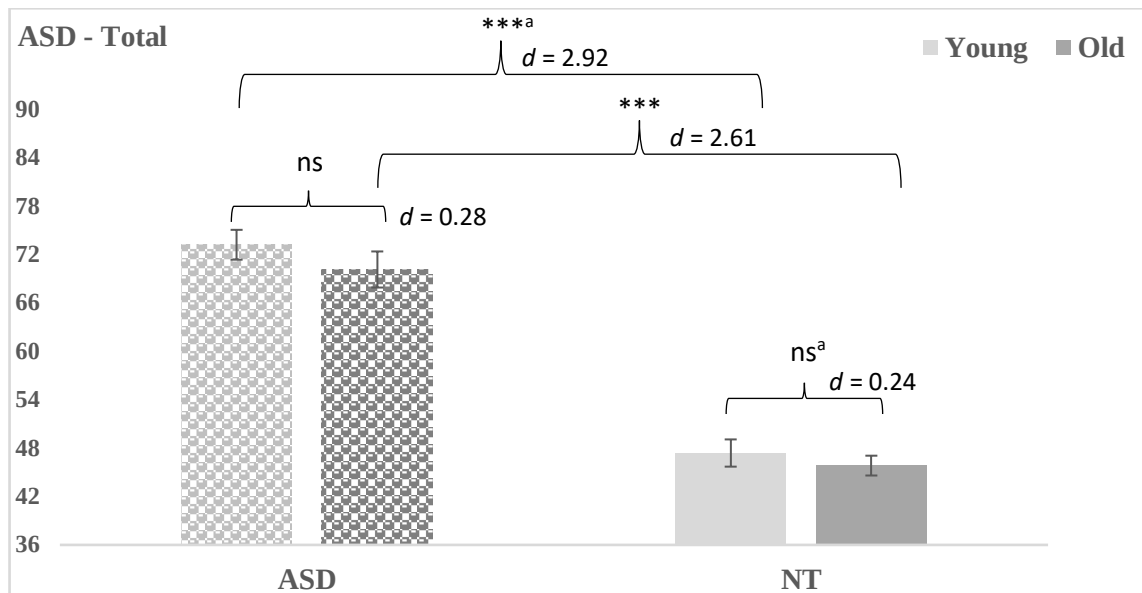
^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group

*** $p < .001$

Two-way ANOVA showed a significant main effect of study group on total ASD trait score. The main effect of age group and the interaction effect of age group by study group were non-significant (Table 4-3). This showed that adults with ASD (M=71.71, SD=11.06) had more ASD traits than NT adults (M=46.64, SD=6.55) in general. Figure 4-1 shows performance for the ASD and NT young and old groups with effect sizes shown for exploratory purposes, which were in parallel with factorial ANOVA results.

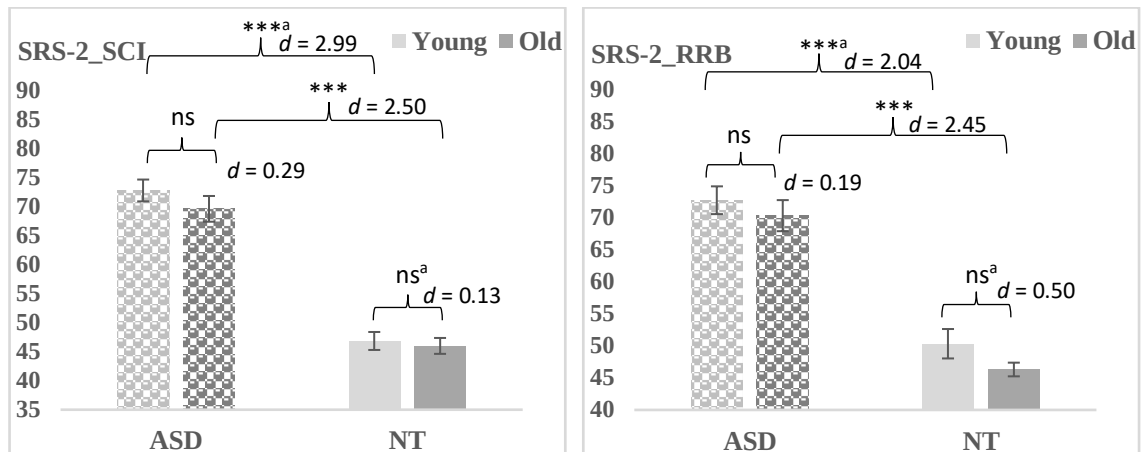


^a Bootstrap derived
^{ns} p > .05, ***p < .001.

Figure 4-1 Total ASD trait scores (SRS-2) of young and old adults in ASD and NT groups, with effect sizes marked for information

Diagnostic and age group effects were further investigated in each subscale score of SRS-2. There was a significant main effect of study group on Restricted Interests and Repetitive Behaviours sub-score and on Social Communication and Interaction score. Effects of age group and interaction between age group and study group were non-significant on both subscales (Table 4-3). Results indicated that adults with ASD had both poorer social communication (M=71.21, SD=11.09) and interaction and more restricted interests and repetitive behaviours (M=71.59, SD=12.35) compared to NT adults (M=46.44, SD=6.41 and M=48.38, SD=8.21, respectively) regardless of age.

Figure 4-2 shows performance for the ASD and NT young and old groups with effect sizes shown for exploratory purposes, which were in parallel with factorial ANOVA results. Although being not significant, there was a medium effect on the RRB subscale score in the NT group showing that young NT adults had slightly higher restricted interests and repetitive behaviours compared to old NT adults.



^a Bootstrap derived
^{ns} $p > .05$, **** $p < .001$.

Figure 4-2 ASD trait scores (SRS-2) of young and old adults in ASD and NT groups on the Social Communication and Interaction (SCI) and Restricted Interests and Repetitive Behaviours (RRB) subscales, with effect sizes marked for information

Further statistical comparison of SCI sub-scores showed a significant main effect of study group on each sub-score: $F(1, 93) = 66.10$, $p < .001$, $\eta^2 = .42$ for social awareness, $F(1, 93) = 118.18$, $p < .001$, $\eta^2 = .56$ for social cognition, $F(1, 93) = 183.75$, $p < .001$, $\eta^2 = .66$ for social communication and $F(1, 93) = 94.91$, $p < .001$, $\eta^2 = .51$ for social motivation. These results indicated that adults with ASD had poorer social awareness ($M=63.88$, $SD=11.31$), social cognition ($M=67.78$, $SD=11.95$), social communication ($M=71.47$, $SD=10.99$) and social motivation ($M=70.60$, $SD=10.88$) compared to NT adults ($M=46.59$, $SD=8.29$; $M=45.36$, $SD=5.82$; $M=45.28$, $SD=6.32$ and $M=50.77$, $SD=8.11$, respectively).

4.4.1.2 Diagnostic Group and Age Group Effects on Quality of Life (QoL)

Since there is no total score for WHOQOL, separate two-way ANOVA analyses were conducted to test the influence of study (ASD vs NT) and age (Young vs Old) groups on each subscale: global quality of life (QoL) score and QoL scores in physical health, psychological health, social relationships and environment. Table 4-4 presents the mean QoL domain scores.

Table 4-4 Means of the QoL domains (WHOQOL) of young and old adults in ASD and NT groups: Mean (SD)

	ASD		NT		F^1	p -value	effect size: η^2
	Young N = 29	Old N = 29	Young N = 20	Old N = 19			
Global	48.71 (22.50)	59.05 (29.30)	76.25 (17.63)	77.63 (15.35)	23.85^{group***} 1.54 ^{age} 0.90 ^{agexgroup}	<.001 ^{group} .22 ^{age} .35 ^{agexgroup}	.20 ^{group} .02 ^{age} .01 ^{agexgroup}
Physical	59.85 (19.79)	64.78 (22.52)	85.54 (14.26)	78.38 (20.01)	23.09^{group***} 0.07 ^{age} 2.18 ^{agexgroup}	<.001 ^{group} .79 ^{age} .14 ^{agexgroup}	.20 ^{group} .001 ^{age} .02 ^{agexgroup}
Psychological	46.55 (15.55)	54.31 (21.55)	73.33 (13.88)	75.22 (13.06)	46.50^{group***} 1.90 ^{age} 0.71 ^{agexgroup}	<.001 ^{group} .17 ^{age} .40 ^{agexgroup}	.33 ^{group} .02 ^{age} .01 ^{agexgroup}
Social Relationships	39.37 (20.28)	50.57 (23.67)	77.08 (14.78)	67.98 (19.50)	43.12^{group***} 0.06 ^{age} 5.85^{agexgroup*}	<.001 ^{group} .80 ^{age} .02 ^{agexgroup}	.32 ^{group} .001 ^{age} .06 ^{agexgroup}
Environment	61.21 (15.11)	63.36 (22.31)	75.00 (14.76)	79.61 (9.96)	18.62^{group***} 0.94 ^{age} 0.12 ^{agexgroup}	<.001 ^{group} .33 ^{age} .73 ^{agexgroup}	.17 ^{group} .01 ^{age} .001 ^{agexgroup}

¹ All $df_M s = 1$ and $df_R s = 93$.

^{group} Main effect of study group

^{age} Main effect of age group

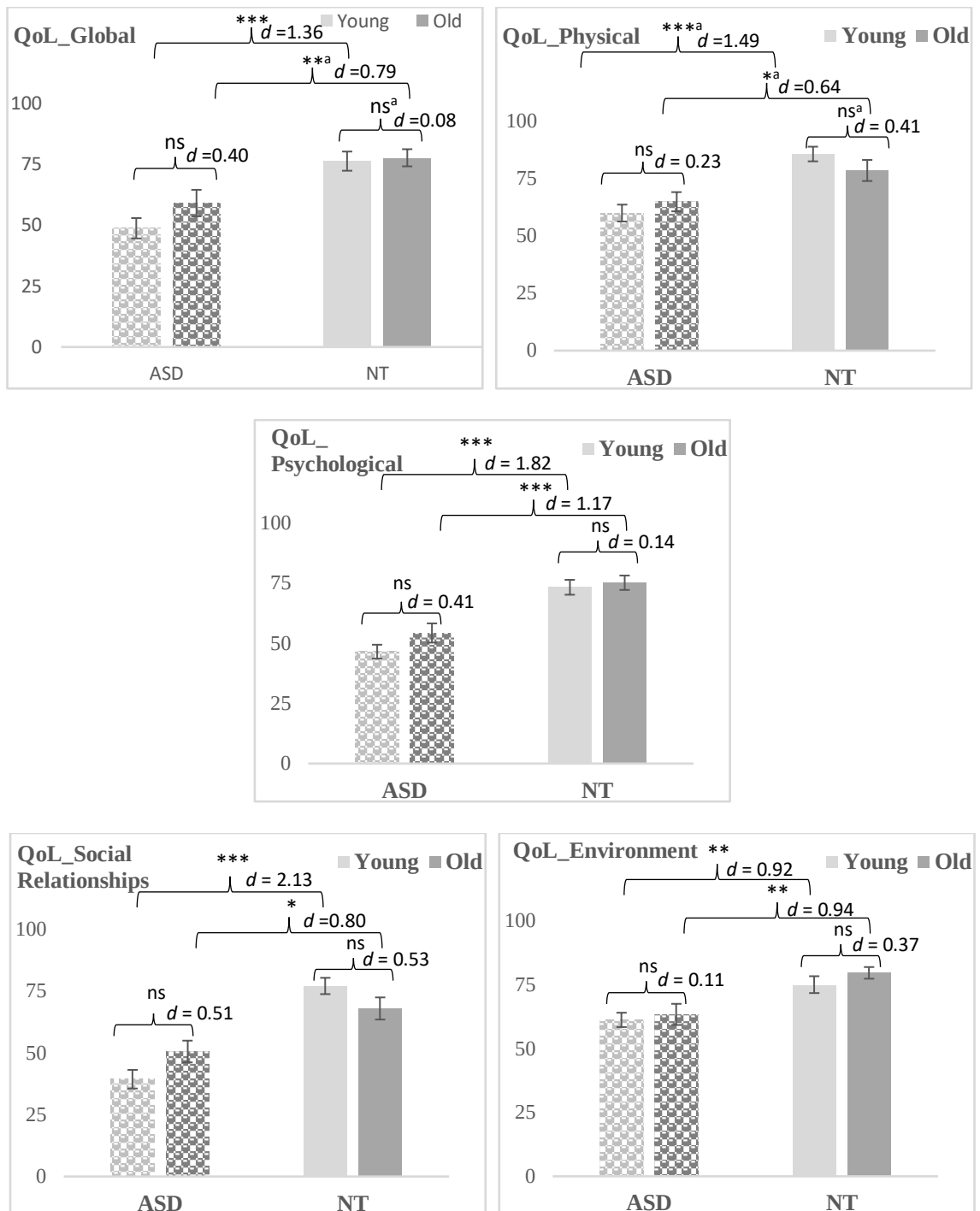
^{agexgroup} Interaction effect of age group by study group

* $p < .05$, *** $p < .001$

All five subscales of the WHOQOL showed the same pattern of significant effects: study group showed a main effect, with QoL worse in the ASD than NT group, but age and age by group effects were not significant (except for the QoL in social relationships). The interaction effect of age group by study group on QoL in social relationships domain score was significant. This indicated that age group effect differed in the ASD and NT groups. Specifically, in the NT group young adults ($M=77.08$, $SD=14.78$) had better QoL regarding social relationships than old adults ($M=67.98$, $SD=19.50$), whereas it was the opposite for the ASD group (young $M=39.37$, $SD=20.28$ and old $M=50.57$, $SD=23.67$).^a Bootstrap derived

^{ns} $p > .05$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 4-3 shows performance for the ASD and NT young and old groups with effect sizes shown for exploratory purposes, which were in parallel with factorial ANOVA results. Although the differences between young and old adults did not reach significance for both NT and ASD groups in terms of QoL in social relationships, medium effect sizes were observed in both groups.



^a Bootstrap derived
^{ns} $p > .05$, * $p < .05$, ** $p < .01$, *** $p < .001$.

Figure 4-3 Global quality of life (WHOQOL) score of young and old adults in ASD and NT groups, with effect sizes marked for information

4.4.2 Self-Reported Mental Health in Study Groups

Self-reported mental health was examined in both ASD and NT groups. Individuals reporting symptoms past suggested clinical cut-off for at least one other (i.e., non-ASD) mental health difficulty were assigned to the group with other mental health difficulties. Group members were further investigated on each specific mental health difficulty. When there was more than one measure available assessing the same mental health difficulty (e.g. anxiety and depression), those who met the cut-off score of at least one measure were allocated to the ‘with other mental health difficulty’ group.

Figure 4-4 shows the percentages and numbers of individuals with additional self-reported mental health difficulties within age groups in the ASD and NT groups. Since some individuals had more than one other mental health difficulty, total percentages exceed 100 in some groups.

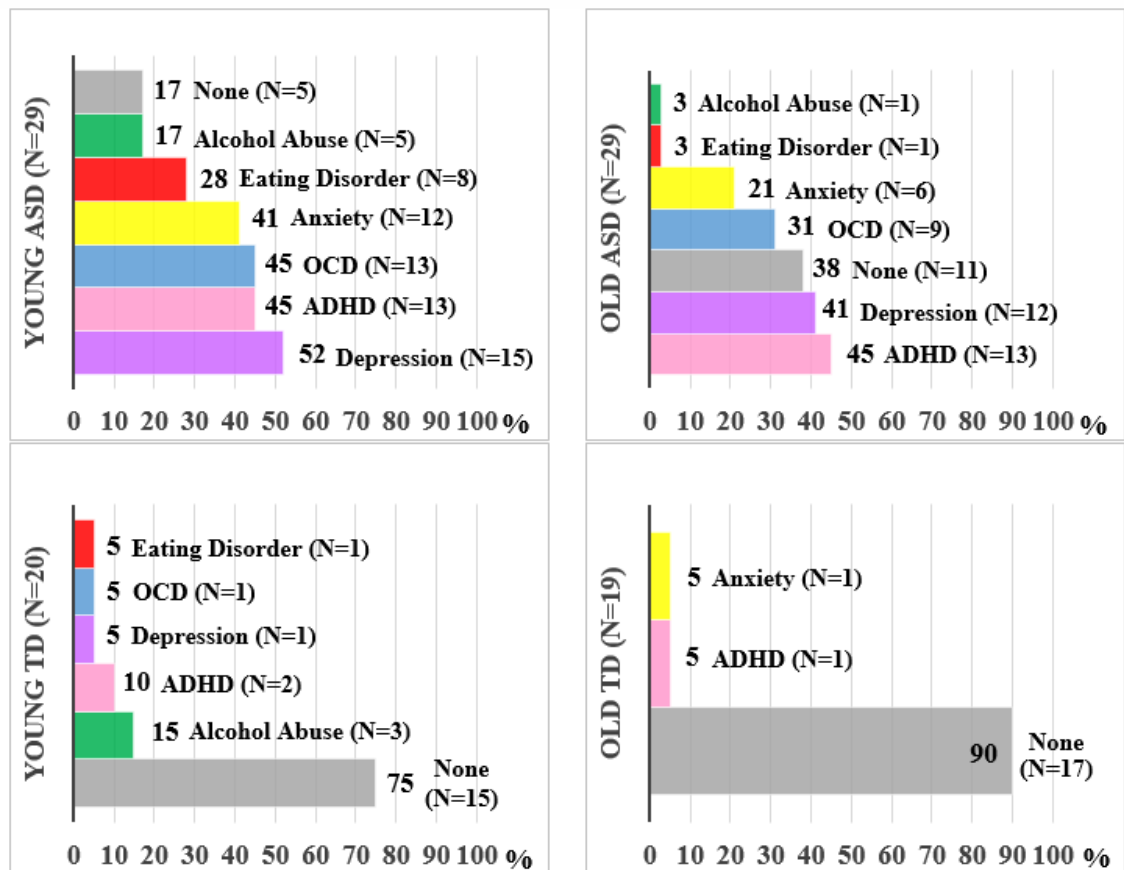


Figure 4-4 Percentages and numbers of young and old adults with mental health difficulties (as self-reported on the ASRS, BAI, BDI, OCI-R and PHQ) in ASD and NT groups

Since inclusion criteria for the NT group but not ASD group included having no known psychiatric condition, study groups were not compared. Within the ASD group, chi-square analysis results showed that young and old ASD groups did not differ in terms of having additional mental health difficulties, $\chi^2(1) = 3.11, p = .14$.

4.4.3 Associates of QoL: Age, Intellectual Level, Severity of ASD Traits, OCD, Anxiety and Depression in Diagnostic Groups

To reduce the chance of type 1 error due to multiple comparisons, associates and predictors of global QoL only was examined in the following analyses, given the high

intercorrelation with other subscales of the WHOQOL in both ASD (Table 4-5) and NT (Table 4-6) groups.

Table 4-5 Associations between QoL domain scores (WHOQOL) in the ASD group

		QoL				
		Global	Physical	Psychological	Social Relationships	Environment
QoL	Global	1	.65***	.82***	.51***	.69***(a)
	Physical	-	1	.45***	.16 (p=.23)	.60***(a)
	Psychological	-	-	1	.59***	.65***(a)
	Social Relationships	-	-	-	1	.50***(a)
	Environment	-	-	-	-	1

^(a) Spearman's rho

***p < .001

Table 4-6 Associations between QoL domain scores (WHOQOL) in the NT group

		QoL				
		Global	Physical	Psychological	Social Relationships	Environment
QoL	Global	1	.66***(a)	.74***(a)	.45***(a)	.47***(a)
	Physical	-	1	.64***(a)	.33*(a)	.40*(a)
	Psychological	-	-	1	.59***	.54***
	Social Relationships	-	-	-	1	.39*
	Environment	-	-	-	-	1

^(a) Spearman's rho

*p < .05, **p < .01, ***p < .001

Intellectual level was not significantly related to global QoL score in the ASD and NT group (Table 4-7).

Table 4-7 Associations between global QoL score (WHOQOL) and age (in years) or intellectual level (WASI-II) in ASD and NT groups

		Age (in years)	Intellectual Level		
			FSIQ	VIQ	PIQ
ASD	QoL_Global	.18 (<i>p</i> = .18)	.01 (<i>p</i> = .92)	-.02 (<i>p</i> = .87)	.06 (<i>p</i> = .67)
NT	QoL_Global	.03 (<i>p</i> = .87)	.07 ^(a) (<i>p</i> = .66)	-.13 ^(a) (<i>p</i> = .45)	.24 ^(a) (<i>p</i> = .14)

^(a) Spearman's rho

Associations between self-reported global QoL score and both ASD traits and self-reported mental health difficulties were tested in the ASD and NT groups (Table 4-8). Severity of self-reported mental health difficulties were significantly and negatively correlated with global QoL score in both study groups.

Table 4-8 Associations between global QoL scores (WHOQOL) and severity scores of ASD traits (SRS-2), OCD (OCI-R), anxiety (BAI) and depression (BDI-II) in ASD and NT groups

		Severity scores			
		ASD traits	OCD	Anxiety	Depression
ASD	QoL_Global	-.36*	-.33*	-.50*** ^(a)	-.72*** ^(a)
NT	QoL_Global	-.41*	-.44*	-.43*	-.46**

^(a) Spearman's rho,

p* < .05, *p* < .01, ****p* < .001

A multiple regression analysis was conducted to find significant predictor/s of global QoL domain score in study groups. Severity scores that were significantly correlated with the domain score were included as possible predictors.

For the ASD group a multiple linear regression analysis was run to predict global QoL score based on severity scores of ASD traits, OCD, anxiety and depression. A significant regression equation was found ($F(1, 56) = 47.76, p < .001$) with an $R^2 = .46$

(Table 4-9). The only significant predictor of global QoL score was severity of depression ($\beta = -.68, p < .001, 95\% \text{ CI } [-1.97, -1.08]$).

Table 4-9 Multiple regression results to predict global quality of life (QoL_Global; WHOQOL) based on severity scores of ASD traits (SRS-2), OCD (OCI-R), anxiety (BAI) and depression (BDI-II) in the ASD group

Step 1	B	SE B	β
(Constant)	77.52	4.28	
Depression	-1.53	0.22	-.68***

Dependent Variable: QoL_Global

Note: $R^2 = .46, ***p < .001$.

Similarly, for the NT group a multiple linear regression analysis was run to predict global QoL score based on severity scores of ASD traits, OCD, anxiety and depression. A significant regression equation was found ($F(1, 37) = 8.90, p < .01$) with an $R^2 = .19$ (Table 4.13). The only significant predictor of global QoL score was severity of OCD ($\beta = -.44, p < .01, 95\% \text{ CI } [-2.08, -0.40]$).

Table 4-10 Multiple regression results to predict global quality of life (QoL_Global; WHOQOL) based on severity scores of ASD traits (SRS-2), OCD (OCI-R), anxiety (BAI) and depression (BDI-II) in the NT group

Step 1	B	SE B	β
(Constant)	85.05	3.62	
OCD	-1.24	0.42	-.44**

Dependent Variable: QoL_Global

Note: $R^2 = .19, **p < .01$

4.5 Results Summary Table

Variable		Age Group Effect	Study Group Effect	Age Group x Study Group Effect	Other Significant Correlates
ASD-traits (SRS-2)		Ns.	ASD > NT (large effect)	Ns.	• QoL (-)
Psychiatric Conditions (PHQ; OCI-R; BAI; BDI-II; ASRS-v1.1)	Any Psychiatric Condition	Ns. ¹	N/A	N/A	N/A
	Anxiety	N/A	N/A	N/A	• QoL (-)
	Depression	N/A	N/A	N/A	• QoL (-)
	OCD	N/A	N/A	N/A	• QoL (-)
	ADHD	N/A	N/A	N/A	N/A
QoL (WHOQOL)	Global	Ns.	ASD < NT (medium effect)	Ns.	• ASD-traits (-) • OCD, Anxiety and Depression (all (-)) • Other QoL (+)

y: Young and o: Old

(+) positive association; (-) negative association

¹ Tested only in the ASD group

Unless identified effect size is small or less

4.6 Discussion

This study examined ASD-traits, mental health and wellbeing in young and old adults compared to their NT counterparts. As expected, results showed that ASD traits were more common in the ASD group compared to NT group. No significant age-group effects were found on ASD traits in either group, and age was not correlated with severity of ASD-traits in the ASD or NT groups. The present results did not support previous studies that found age-related abatement in ASD symptoms in young adults (e.g., Esbensen et al., 2009; Gray et al., 2012; Howlin et al., 2013; Seltzer et al., 2003; Shattuck et al., 2007; Woodman et al., 2015), but were in parallel with research showing no association with age (e.g., Bastiaansen et al., 2011 and Bishop & Seltzer, 2012). It should be noted that a medium effect size was found for the non-significant age difference in RRBIs in the NT group, suggesting lower RRBIs in older versus younger NT adults might have reached significance with a larger sample size.

Self-reported mental health difficulties were common in the ASD group, with almost half of both age groups scoring above the suggested clinical cut-off scores for depression and ADHD, and around a third reporting OCD and anxiety. Smaller numbers of people in both the young and old ASD adult groups scored above the cut-off for eating disorder and alcohol abuse. Young and old adults with ASD did not differ in terms of the proportion of individuals with an additional mental health difficulty according to self-report. There are mixed findings in the literature, with some studies reporting fewer psychiatric symptoms in older ASD adults compared to young adults (e.g., Lever & Geurts, 2016b; Totsika et al., 2010), and other studies finding the opposite (e.g., Davis et al., 2011).

Adults with ASD had poorer QoL than NT adults. Age had no significant effect on any domain of QoL, in line with some previous research with old (e.g., van Heijst & Geurts, 2015; Totsika et al., 2010) and young ASD adults (e.g., Renty & Roeyers, 2006, but see Howlin et al., 2013 and Orsmond et al., 2004). However, there was a significant age by group interaction on the social relationship related-QoL. This indicated that old adults with ASD had better QoL in social relationships than younger ASD adults; whereas it was the opposite in the NT group. This suggests that ageing may affect different domains of QoL in different ways. This might be because older NT adults feel lonely compared to their younger days, but adults with ASD feel under less social pressure in older age. More in depth qualitative work would be needed to find out why age has different apparent relationships with social QoL in NT and ASD adults.

Examination of the predictors of QoL was restricted to global QoL, in order to minimize the chance of type 1 error due to multiple comparisons, and since the five QoL subscales were significantly inter-correlated in both ASD and NT adults. Intellectual ability was not related to QoL in the ASD or NT group. In both study groups severity of ASD traits, OCD, anxiety and depression was associated with poor QoL. Regression analysis showed that severity of depression was the strongest correlate of global QoL in the ASD group, whereas in the NT group the strongest correlate of global QoL was severity of OCD.

4.6.1 Limitations

The present work has some limitations that should be considered. The cross-sectional design used may be subject to cohort effects. The author attempted to minimize any bias in group selection, by recruiting young and old participants from similar sources. However, the ideal future design would be longitudinal, although given

the constraints of a PhD and urgent need for research on ageing in ASD, cross-sectional work is still of value in understanding age-related effects.

In this study the old and young adult groups were based on a cut-off age of 50. Future longitudinal studies are needed to find out more about functioning of adults in their 70's and 80's with ASD.

In this study assessments were dependent on self-report tools. Ideally, multiple informants would provide valuable data in future studies. While self-report may be considered more valid for quality of life assessment, questionnaire measures of mental health would ideally be combined with clinician ratings from direct interview. In addition, although established cut-off scores were taken from the literature to estimate rates of mental health difficulties, only some of these have been reported to be suitable for ASD population (e.g., for the OCI-R; Foa et al., 2002 by Cadman et al., 2015), while other measures lack ASD-specific cut-off scores. In order to recruit a representative sample of NT adults, our recruitment information and adverts asked for adults without psychiatric diagnoses, although we did not specifically screen for these or exclude any participants. In the ASD group, however, we did not exclude those with additional psychiatric difficulties in our advertisement materials, since anxiety and depression are so common that an unrepresentative sample might have resulted. This approach, however, did limit our ability to compare rates of mental health problems in the ASD and NT samples.

Since analyses were mainly exploratory, conservative *p* values were not used although the sample size was relatively small for the number of tests were run. We attempted to reduce the risk of Type 1 error by, for example, examining subscores only where total scores showed significant effects. However, overall our relatively small

sample sizes may have limited power to detect significant results, as reflected in effect sizes. Replication of the present results is needed, and until then the findings should be interpreted with caution.

The findings should be interpreted taking into account the psychometric properties of the measures; although the best available measures were chosen, psychometric properties were in some cases unknown or limited.

4.7 Conclusion

This study is a part of a larger study also investigating cognitive skills in young and old adults with ASD (see Chapter 6). In the current part of the study, it was demonstrated that self-rated ASD traits are equivalent in young and old adults, as are additional mental health difficulties. ASD-related traits and additional mental health difficulties were associated with poorer QoL in both young and old adults with ASD. Age-related effects were not found in general, except for QoL in social relationships, showing a better outcome in older ages in ASD only. However longitudinal studies are needed to enlighten developmental trajectories in ASD-related difficulties, mental health and QoL in the elderly population with ASD.

Chapter 5 A Novel ToM Task: the ToM Cartoon Stories Task

5.1 Introduction

In this chapter, a novel ToM task (the ToM Cartoon Stories task: ToM-CSt) that was designed for the purpose of Study 2 and 3 will be introduced. First, a brief review of ToM assessment tools used with adults having ASD is provided, followed by a description of the design of the ToM-CSt and pilot results.

5.2 Assessment of ToM in adults with ASD

ToM ability in ASD was first assessed within a group of children using a ‘false belief task’ (Wimmer & Perner, 1983) the ‘Sally-Anne’ task (Baron-Cohen et al., 1985). False belief tasks aim to measure ToM by assessing the ability to infer a character’s mistaken mental representation of a state of affairs (location or identity of contents) in a story. False belief of the character in the story is due to the fact that a part of the story is unbeknownst to the character but the participants themselves actually observe and/or know what happen (Wimmer & Perner, 1983). In the ‘Sally-Anne’ task (see Figure 5-1), a character (Anne) changes place of an object when another character (Sally) is not present. Participants were asked where Sally would look for the object upon her return. Giving a correct answer to this question requires an ability to distinguish own knowledge from the character’s false knowledge. Results of the study showed that unlike NT children and children with Down’s syndrome, 80% of children with ASD failed in the task, although they have matched mental age with NT group and chronological age with Down’s group (Baron-Cohen et al., 1985).

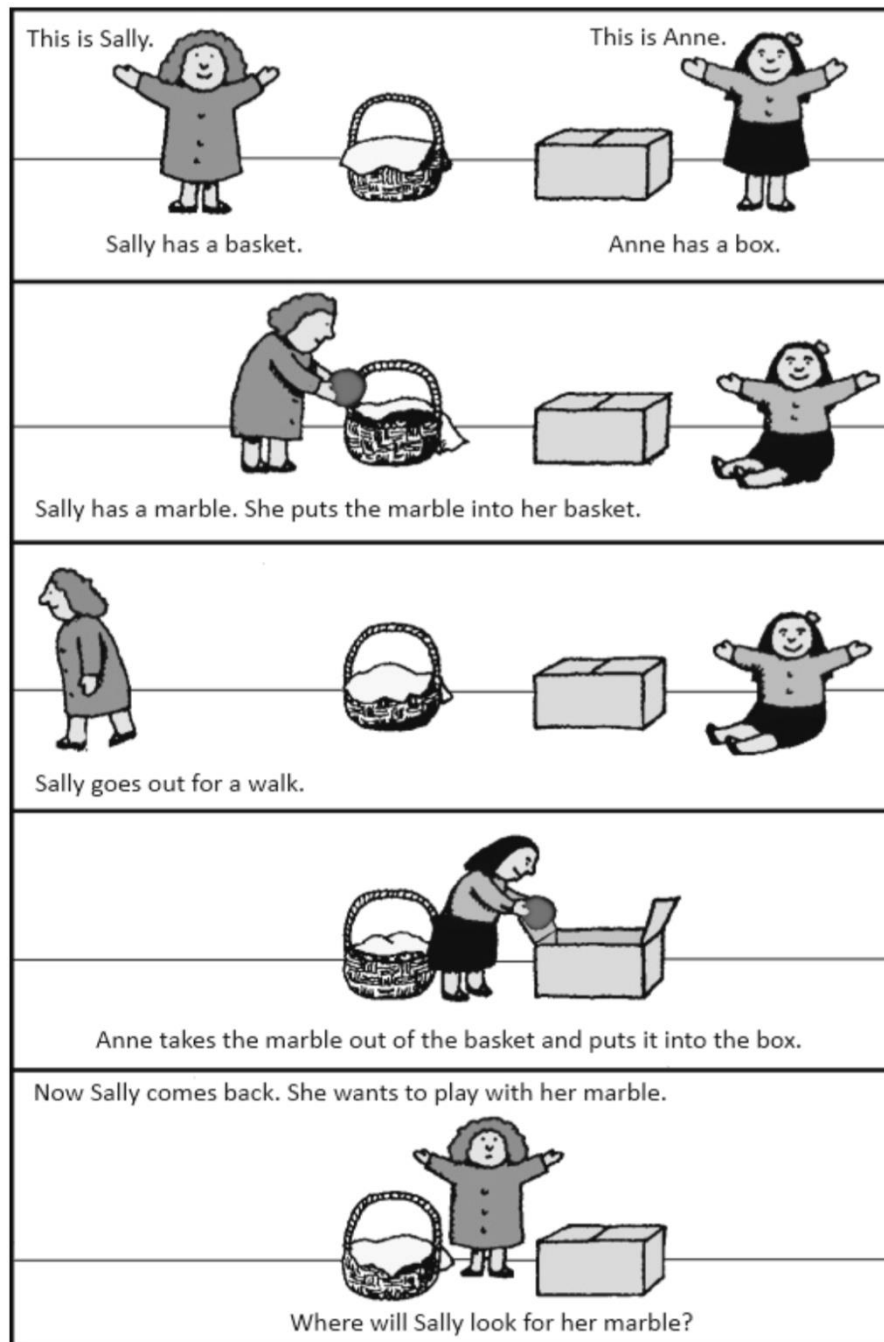


Figure 5-1 The Sally-Anne Task to test false-belief attribution. (Source: from Frith, 1989 as cited in Happé, 2015)

Attributing a false-belief is considered a good test of ToM because answers cannot be based on solely on own belief or reality. However, it should also be considered that the task has been criticised for being used to assess mental state

understanding. Bloom and German (2000) suggested that performance on the task interferes with other skills (e.g., understanding task question and memory). They also reported that the ability of mental state attribution can be present even though individuals (especially neurotypical young children) fail at false belief understanding.

Understanding one character's mental state about a physical state of affairs, as in Sally-Anne Task, encompasses 'first order' ToM ability. It should be noted that older individuals often pass first-order false-belief tasks (Bowler, 1992). More complex ToM tasks assess the ability to represent higher order (e.g. second-order, third-order etc.) mental states. These higher order mental state attributions are required when understanding more complex cognitive states for example irony, double-bluff, faux pas and sometimes metaphor (Perner & Wimmer, 1985). False belief paradigms have been used extensively with children with ASD; however, in order to examine ToM in older ages and age-related effects in complex mentalizing skills, more advanced ToM tasks are needed. In the next part, ToM measures used in the adult ASD literature will be introduced.

5.2.1 Advanced ToM tasks used with adults with ASD

Advanced ToM tasks used with older individuals with ASD have been devised in different modalities: verbal, visual-static and visual-dynamic.

The Strange Stories task (Happé, 1994) is an advanced verbal ToM test developed to assess subtle ToM difficulties. The task consists of 24 short stories where a speaker's nonliteral utterance can be explained by a range of complex mental states such as misunderstanding, irony, double bluff, white lie and pretence. A shorter version, comprising eight ToM and matched control stories (Fletcher et al., 1995), has been widely used in the autism literature (e.g., Dziobek et al., 2006; Spek, Scholte, & van

Berckelaer-Onnes, 2010; White, Oswald, Ollendick, & Scahill, 2009). The Faux Pas test is another advanced verbal ToM test, with 10 stories involving unintended but socially inappropriate utterances that has a greater emotional loading, since the inappropriate comment has an unforeseen negative emotional consequence (e.g., embarrassment) in each case. (Baron-Cohen, Stone, Jones, & Plaisted, 1999; Stone et al., 1998). These types of verbal ToM tasks typically include control stories that do not require mental state attribution in order to control more general cognitive abilities. However, studies using verbal ToM tasks to test age-related effects reported contradictory results: equal (e.g., MacPherson et al., 2002; Saltzman et al., 2000), superior (Happé et al., 1998) or reduced (e.g., Charlton et al., 2009; Maylor et al., 2002) performance in old adults compared to young group. These contradictory findings perhaps suggest that vocabulary skills might mask age-related differences in ToM performances (Slessor et al., 2007).

ToM tasks using visual stimuli (e.g., images and videos) aim at reducing demands on verbal skills and general cognitive ability (e.g. working memory) compared to verbal tasks, thereby enabling more accurate assessment of ToM (Moran, 2013). Some verbal story tasks have been developed to be accompanied with images, which enables administration under conditions of low memory load (e.g. Stone et al., 1998).

5.2.1.1 Static Visual ToM Tasks

Static visual ToM tasks use images or cartoon strips have also been used to assess mental state attribution in adults. In these tasks, mental states of characters are presented in the form of images and/or drawings (e.g. cartoons). **The Cartoon Task** (Gallagher et al., 2000) is a ToM task in which participants are presented with cartoons. There are three different types of cartoon stimuli in the task with 28 cartoons in each: theory of mind, non-theory of mind and jumbled pictures (see Figure 5-2). Theory of mind

cartoons require attribution of either false belief or ignorance. Non-theory of mind cartoons do not require understanding mental states. Jumbled pictures include randomly placed objects taken from children's colouring books and cartoons. These three conditions were used to isolate brain regions involved in ToM using fMRI (Gallagher et al, 2000).

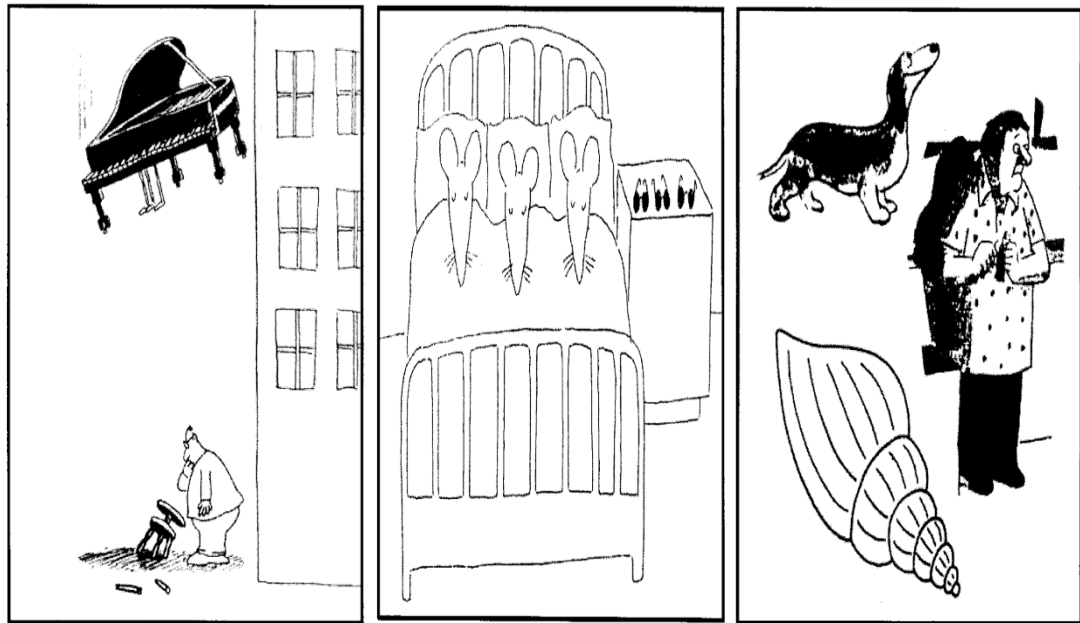


Figure 5-2 Examples of cartoon types in the Cartoon Task: ToM, non-ToM and Jumbled pictures, respectively.

Single Cartoons Task (Happé, Brownell, & Winner, 1999) is another cartoon ToM task in which 12 single-frame cartoons were used. The cartoons are of two different kinds: theory of mind and non-mental cartoons. Theory of mind cartoons require mental state attribution, whereas non-mental cartoons do not (see Figure 5-3). These stimuli were used to assess ToM in individuals with right-hemisphere damage due to stroke, many of whom were elderly.

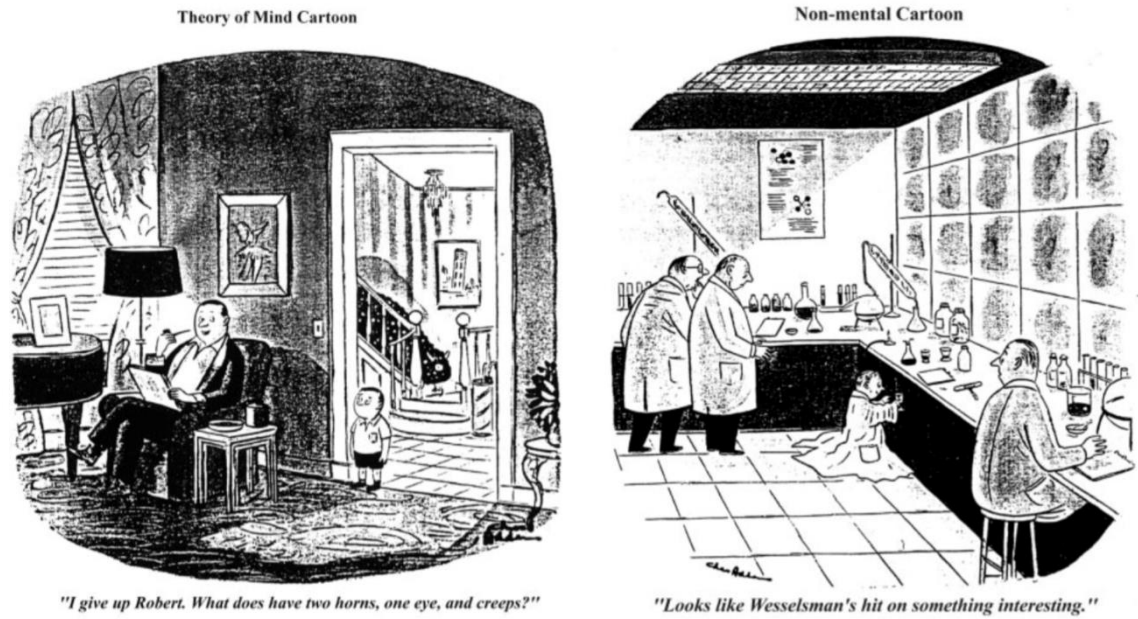


Figure 5-3 Examples of cartoons in the Single Cartoon Task

One way of achieving more naturalistic ToM assessment is by using images of real people as stimuli. Baron Cohen and colleagues (1997, 2001) devised the “**Reading the Mind from the Eyes**” Test (the revised version of the test was also used in the current study), which is a proposed to test with a reduced verbal demand nonverbal in adults, and to reveal deficits in those on the autism spectrum (Baron-Cohen et al., 2001; Baron-Cohen, Wheelwright, Stott, Bolton, & Goodyer, 1997). In this test, real photos of the eye region of different individuals are presented to participants and they are asked to choose which one of the four option words best describes the feelings or thoughts of person in the photo (see Figure 5-4 for an example).



Figure 5-4 Examples of the photographs from the RMET

Although the test has been reported as an effective measure of metalizing difficulties in adults, the stimuli used in the test may compromise the test validity (Johnston, Miles, & McKinlay, 2008). In a critical review of the test, Johnston and colleagues (2008) suggested that the test does not necessarily assess accurate identification of mental states, since real mental states of the people in the photos are unknown, and performance is evaluated based on a consensus answer. Further, they pointed out that the foil options in the test, rather than the photos themselves, are likely to be leading participants to choose the correct answer. Also, due to substantial proportion of emotional statements in the task and being predicted by alexithymia rather than ASD diagnosis, the RMET was suggested as more likely testing emotion processing rather than ToM (Bird & Cook, 2013; Oakley, Brewer, Bird, & Catmur, 2016).

Although these tasks are advanced with regard to ecological validity of ToM assessment, they remain limited when the nature of social interactions in real world situations are considered. Understanding mental states often requires several cues at the same time, e.g. contextual information, prosody, and body language (Rutherford, Baron-Cohen, & Wheelwright et al., 2002).

5.2.1.2 Dynamic ToM Tests

There are also dynamic ToM tasks using audio, visual or audio-visual dynamic stimuli to assess mental state attribution. An audio ToM task using real social stimuli is the **Reading the Mind in the Voice test** (Rutherford et al., 2002) in which participants are asked to attribute mental states from vocalizations. The test consists of 40 segments of dialogs (i.e. are a sentence or a phrase) lasting approximately 2 seconds each that were chosen from dramatic audio books. At the end of each segment participants are asked to choose one of two options best describing the mental state of the person in the audiotape. The test also includes control task using the same audio stimuli in which participants are asked to judge the age of the person speaking in the audiotape.

A dynamic visual ToM task, **the Frith-Happé Triangles** (Abell, Happé, & Frith, 2000), has been used with children (e.g. Abell et al., 2000) and adults (e.g. Castelli et al., 2002) with ASD. The task involves short video clips in which two animated triangles interacting with each other. Two types of score are generated in this task: accuracy and psychological state talk. Accuracy is evaluated based on correct understanding the interaction between the triangles; such as, “The red triangle is trying to persuade the blue triangle to go out”. Psychological state talk, on the other hand, is about how the interaction is described, and it is evaluated based on using psychological state words (e.g. think, understand, and persuade). The task is very short and easy to administer; but the use of animated stimuli was criticised as undermining the power of catching ToM difficulties more akin to those experienced in real world social exchanges (Dziobek, 2012). However, it should be noted that in contrast the other tasks using unnaturalistic stimuli, the stimuli in the Frith-Happé Triangles task are deliberately not naturalistic,

rather relying on just one type of cue, biological motion to convey mental states of the triangles. It was designed this way to limit compensation using learnt strategies.

ToM tasks with visual and dynamic stimuli attempt to reduce load on verbal skills and working memory, but their dependence on a single modality of social cues limits their validity with regard to ToM assessment (Roeyers & Demurie, 2010). Audiovisual dynamic tasks using real life scenarios are more likely to be relevant to real world social interactions and thus be more ecologically valid ToM measures. A number of ToM tasks using audio-visual dynamic stimuli are available in the adult ASD literature. The main tasks reported in the ASD literature are briefly summarized below.

The Awkward Moments Test (AMT; Heavey et al., 2000) includes eight short (45-120 seconds) film scripts; 7 were taken from different UK TV advertisements and 1 was from a UK TV series. After presenting each film, two forced-choice questions were asked to participants: a ToM question and a control question. The ToM question is “how does the character in the film feel” and a correct answer to it requires understanding complex mental states. The control question is either about visual features in the film or information available within the dialogue of the characters. They also included an open-ended question regarding characters’ intentions (the director’s intention was asked instead of the character’s in two films), which allows participants to generate their own answers. The measure has good convergent validity when compared with the Strange Stories Task (Happé, 1994; Happé et al., 1998), but the lack of control films, use of memory questions unmatched for difficulty with the ToM questions, and the highly dramatized stimuli may be considered as limitations.

The Reading the Mind in Films Task (RMF; Golan, Baron-Cohen, Hill, & Golan, 2006b) consists of 22 short (lasting 5-30 seconds) film scenes from feature films,

involving complex emotions and mental states of interacting characters. Participants are asked a forced choice question with 4 options (1 correct answer and 3 foils) at the end of each film about the protagonist's emotion or mental state. This task has also good convergent validity when compared with the Cambridge Mindreading Face–Voice Battery (CAM; Golan, Baron-Cohen, & Hill, 2006a), but it has neither control clips nor control questions. Also, the films have highly affective content, which limits somewhat the naturalistic quality of the task.

The Movie for the Assessment of Social Cognition (MASC; Dziobek et al., 2006) includes a 15 minute-long video about four characters meeting for a dinner party. The video is paused at 46 different points and participants are asked an open-ended question about characters' mental states (e.g. feelings, thoughts and intentions) at each pause. After seeing the whole video, four control questions are asked to test memory and general comprehension skills. The task has good convergent validity when compared with the Strange Stories Task (Happé, 1994; Happé et al., 1998) and re-test reliability, but a relatively long (45 minutes) time is needed for administration and performance on memory questions reached ceiling in the original study (Dziobek et al., 2006).

The Moral Dilemmas Film Task (MDFT; Barnes, Lombardo, Wheelwright, & Baron-Cohen, 2009) has 4 video clips (each lasting 30 seconds to 2 minutes) from an American TV show “House” involving two characters interacting. After seeing each clip, participants are asked to write down what happened in the clip. Performance was rated based on the length of these narratives, number of reference to mental states and to objects. The task uses open-ended questions which could be considered as a strength

since participants' answers are not orientated. However, it also has limitations such as using dramatized stimuli and not using control test items.

The Awareness of Social Inference Test (TASIT; McDonald, Flanagan, & Rollins, 2002) part 2 (i.e. Social Inference-Minimal) and 3 (i.e. Social Inference-Enriched) consist of 31 clips in total assessing understanding of complex emotions and ToM. Part 2 includes 15 short (15-60 seconds) video clips with ambiguous dialogues that could be either sincere or indirect (e.g., sarcastic). Part 3 includes 16 video clips suggesting indirect intentions of characters (either sarcasm or lies/deception). After each clip participants are asked 4 forced choice questions (yes or no) about characters' feelings, thoughts, intentions and the pragmatic meaning of the speech. The task has good convergent validity when compared with understanding 2nd-order ToM stories (taken from a number of studies e.g., Fletcher et al., 1995; Gallagher et al., 2000; Happé et al., 1999) (McDonald et al., 2006), but long administration time and the lack of control clips and questions somewhat limit its usefulness as a ToM assessment.

The Strange Situations Film Task (Murray, 2014) includes 15 short (lasting 6 minutes in total) video clips (12 ToM and 3 control clips) with a man and a woman interacting in various social situations. After each video clip participants are asked three open-ended questions: one about characters' intention ('why did Alice say that?'), one interaction question (e.g. "what would you say if you were in Max's situation?"), and a memory question asking about a factual element of the video clip. Performance was assessed based on accuracy of each question as well as use of psychological state talk in answering the intention question. The task has good convergent validity when compared with the Strange Stories (Happé, 1994) and is easy to administer, but performance on control questions reached ceiling in the original study.

Despite having good convergent validity, these tasks are not free from limitations in terms of design and administration. Employing highly dramatized/affective stimuli, lack of control items and/or questions, long administration time and possible orientating effects of forced choice questions on participants are among the main problems with these tasks.

A number of studies using these advanced ToM tasks included ASD adults who were aged 50 and over in their sample (Dziobek et al., 2006; Golan et al., 2006b; Mathersul, McDonald and Rushby, 2013; Murray, 2014), but the mean age of the groups remained well below 50 years and no specific age-related effects have been investigated. To our knowledge there is only one study assessing age-related effects on ToM in a group of ASD adults including those aged 50 and over years old. Using the Faux Pas test (Spek et al., 2010; Stone et al., 1998), Lever and Geurts (2015) reported a significant age and study group effect on faux pas performance in a group of adults with ASD (N=118, age-range: 20-79 and $M_{age}=47.6$ years) and healthy controls (N=118, age-range: 20-77 and $M_{age}=47.7$ years). This showed that adults with ASD compared to healthy controls and old adults compared to young adults had poorer understanding of faux pas stories. However, when a subgroup of adults who aged 50 and over years were examined, none of these effects were significant. This indicated that there might be a protective age-related effect on ToM ability in old adults with ASD.

5.3 Devising the ToM Cartoon Stories Task (ToM-CSt): A picture-sequencing ToM task

Since theory of mind (ToM) impairments are a potential endophenotype of ASD, it is important to be able to assess subtle ToM impairments throughout the lifespan. However, there is a need for measures valid to assess subtle ToM impairments in old

adults. Given possible memory and mobility problems of elderly people, tasks with reduced memory demands and that can be administered remotely would be useful. To this end, an advanced picture-sequencing test of ToM, the ToM Cartoon Stories Task (ToM-CSt), was designed.

Picture sequencing tasks are visual tasks in which participants are asked to put different pictures (each depicting a different scene of a story) in a specific order to complete the story. Verbal demands in these tasks are reduced since only images need be manipulated to complete the task. This type of task has been used with adults for assessment of reasoning abilities (e.g. WAIS-III; Wechsler, 1997), as well as ToM in various research populations including schizophrenia (Langdon, Coltheart, Ward, & Catts, 2002), borderline personality disorder (Ghiassi, Dimaggio & Brune, 2010), Huntington's disease (Saft et al., 2013) and bipolar disorder (van Rheenen & Rossell, 2013). A picture-sequencing task was also used in the early ToM research on ASD, but with a younger population: children and adolescents (Baron-Cohen, Leslie, & Frith, 1986). In Baron-Cohen's task, there were 15 picture stories in total, each having 4 different pictures telling the story. Stories included mechanical, behavioural or intentional content. Mental state attributions were required for successful performance on intentional stories. Although the task detected impaired ToM performance by children with ASD compared to NT children and children with Down's syndrome (Baron-Cohen et al., 1986), the difficulty level and content of the stories in the task do not seem age-appropriate for older individuals.

The ToM Cartoon Stories task (ToM-CSt) was designed by the current author specifically for adult populations including older adults. In this test, participants are presented with a set of cartoon stories including 10 ToM and 5 control stories. In each

story participants are required to put 5 cartoon pictures in a specific order to complete the story. Presentation order of the pictures in each story and the order of ToM vs. control stories in the set are both assigned randomly. The task has been designed to be used as a postal measure as well as in experimental in-person testing. In the postal version, participants need to put an appropriate number from 1-5 under the box of each picture to order them in each story. (Figure 5-5).

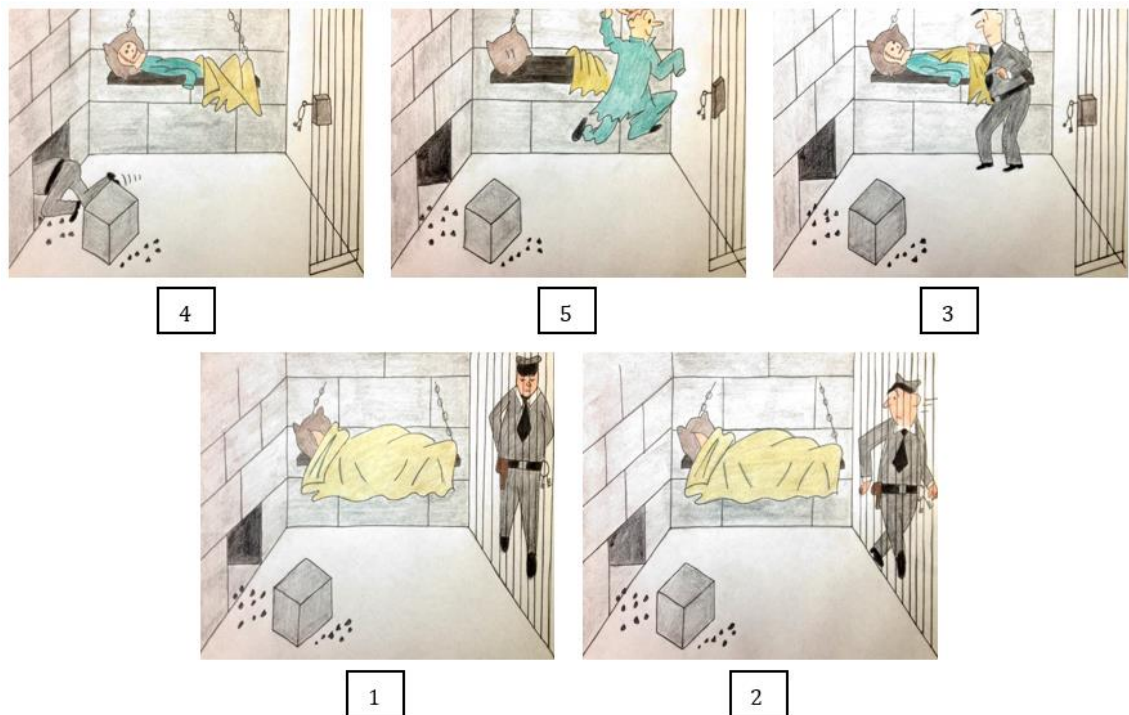


Figure 5-5 An example of ToM story in postal version of the ToM-CSt task. Numbers in the boxes show the correct order.

Participants are also asked to briefly explain what the main point is in each story, with space for open-ended answers provided below the cartoon pictures. In the in-person experimental version, cartoon pictures are placed in front of participants for each story and they are asked to put them in the correct order. Similar to the postal version, they were are to explain what the story is about after ordering the pictures.

In the process of designing the test, first stories that require mental attribution (ToM stories) were created. Then, control stories were generated with social content in them but without any need to attribute characters' mental states in order to order the pictures. During the creation of these stories different cartoons and false belief stories were examined for inspiration. 26 different stories were created with 16 ToM and 10 control stories. A cover page with demographic questions, such as age, gender, occupation, and family history of ASD, was also created for the pilot study.

Pictures were first drawn by the author onto an A5-size page and coloured in. Then each picture were scanned and saved as a JPEG file. After random assignment procedure, they were put into final format for two different versions of the task. For the postal measure version, an A4 page with a landscape layout was allocated to each story (please see Appendix E). The pictures telling each story were located as 3 in the upper row and 2 in the lower row with boxes provided below each picture for participants to put the order number (Figure 1). The size of the pictures was set to 6.10 cm. height and 8.56 cm. width in order to adjust their resolution and also to fit them onto the page. A space was provided under each set of pictures with the question asking the main point of each story. A cover page gave instructions (please see Appendix E). In the in-person experimental version, cartoon pictures were printed on cards sized 9.6x14.2 cm. Letters from A to E were assigned for pictures in each story for recording purposes. A recording sheet was created for the experimenter to record the order of each picture chosen by the participant and the explanation of main point. The main point of each story was asked upon completion of ordering the five pictures of the story.

5.3.1 Pilot Study

The 26 (16 ToM and 10 control stories) stories were piloted with 21 (14 female and 7 male) typically developed (NT) people aged 20-71 (M=37.3) years. Data were collected on accuracy of ordering the pictures, understanding the main point in each story and rating the difficulty of each story based on a Likert scale of 1 (very easy) to 5 (very difficult). Table 5-1 shows pilot data with selected stories highlighted.

Table 5-1 Pilot data showing number of participants giving correct verbal answers, achieving correct picture ordering and mean level of subjective difficulty for ToM and control stories with selected stories highlighted in gray

Cartoon Stories	Number of participants giving correct verbal answers (N = 16)	Number of participants achieving correct picture ordering (N = 21)	Mean level of subjective difficulty (N = 16)
ToM			
Story_1	5	16	2.25
Story_2	9	12	2
Story_3	10	18	1.94
Story_4	4	6	3.38
Story_5	8	10	2.63
Story_6	14	20	1.81
Story_7	9	7	2.13
Story_8	13	17	2.13
Story_9	12	17	1.88
Story_10	11	13	2.19
Story_11	10	16	2.19
Story_12	10	18	1.85
Story_13	8	17	2.67
Story_14	11	17	2.4
Story_15	5	14	2.8
Story_16	4	14	2.94

Table continued on the next page

Cartoon Stories	Number of participants giving correct verbal answers (N = 16)	Number of participants achieving correct picture ordering (N = 21)	Mean level of subjective difficulty (N = 16)
Control			
Story_1	13	14	1.69
Story_2	13	15	2.19
Story_3	15	19	1.31
Story_4	15	19	1.25
Story_5	15	18	1.50
Story_6	10	13	2.13
Story_7	11	10	1.56
Story_8	12	14	1.8
Story_9	14	18	2.2
Story_10	12	18	1.56

Based on participants' performance and feedback some stories were excluded as they were too difficult, some revised and made more appropriate in terms of content, difficulty, and clarity. The best stories were then selected to make a final set of 15 cartoon stories, including 10 ToM and 5 control stories (please see Appendix E). Control cartoons were selected to try to match ToM stories for difficulty. The final set was used in the studies reported in chapters (Chapter 6 and Chapter 7).

5.4 Conclusion

In this chapter, a brief review of ToM tasks used with adults with ASD have been presented. There are a number of ToM tools used with adults having ASD. These tasks used different types and modalities of stimuli (verbal, visual, auditory and static or dynamic) and have their strengths and limitations. In the present chapter also a novel ToM task was introduced with details of its design and pilot data. This task was used in studies presented in the next chapters (6 and 7).

Chapter 6 Social Cognition and Local-Global Processing in Young and Old Adults with Autism Spectrum Disorder (ASD)

6.1 Introduction

The main cognitive theories of autism suggest that children with ASD have cognitive deficits in social cognition and executive functions as well as having superior local processing ability (Bonnell et al., 2003; Frith, 1989; Frith & Happé, 1994; Happé, 1997; Plaisted et al., 1998). A similar cognitive profile has been shown in adults with ASD, in terms of difficulty attributing mental states (e.g. Baron-Cohen et al., 2001; Beaumont & Newcombe, 2006; Happé, 1994; Heavey et al., 2000; Rutherford et al., 2002) and local processing bias (e.g. Jolliffe & Baron-Cohen, 1997, 1999, 2000; Rumsey & Hamburger, 1988; Pring et al., 1995, but e.g. Beaumont & Newcombe, 2006), but how ageing affects these skills remains largely unknown. Only a few studies have investigated age-related effects on these cognitive abilities (Geurts & Vissers, 2012; Lever & Geurts, 2015) and reported different age-related effects on some cognitive domains compared to NT groups (e.g. fluency was less affected in the ASD group; see Chapter 2 for further details.). Although not yet broadly investigated in the ASD population, the effect of ageing on these cognitive skills has been examined in the neurotypical elderly. As reviewed in Chapter 2, studies in general report an age-related decline in Theory of Mind (ToM) ability (e.g. Charlton et al., 2009; Maylor et al., 2002), although some reported no age effect (Castelli et al., 2010; Li et al., 2013). Local-global processing has also been investigated in typical ageing (see Chapter 2). While some studies have found intact global processing with advancing age in NT adults (e.g. Bruyer & Scailquin, 2000; Bruyer et al., 2003; Georgiou-Karistianis et al.,

2006; Roux & Ceccaldi, 2001), others showed a reduced global processing bias and even superior local processing skills in older adults (Lux et al., 2008; Oken et al., 1999).

Inter-relations among cognitive deficits and their link to ASD symptoms have also been documented in younger individuals (i.e., children and adolescents), although findings are mixed (see Brunsdon & Happé, 2014 for a recent review). For ToM, negative associations with ASD symptoms, especially social and communication difficulties, have been reported (Bennett et al., 2013; Lerner et al., 2011; Nagar Shimoni et al., 2012), although non-significant associations have also been found (Bennett et al., 2013; Loth et al., 2010). Positive relationships between local processing and both restricted and repetitive behaviours and interests (RRBI) (Chen et al., 2009; Losh, Childress, Lam, & Piven, 2008 but see Drake et al., 2010; South et al., 2007) and social-communicative difficulties (Noens & van Berckelaer-Omnes, 2005, 2008; Russell-Smith et al., 2012) have been reported (but see Burnette et al., 2005; Morgan et al., 2003; Teunisse et al., 2001). However, we yet do not know whether these links continue into older ages.

Alexithymia, and related deficits in empathy skills, are aspects of social cognition that have been investigated more recently in children and adults with ASD. Alexithymia is a condition, which co-occurs with ASD in perhaps 50% of cases (Berthoz & Hill, 2005; Bird et al., 2010; Hill, Berthoz, & Frith, 2004), identified with difficulties in understanding one's own emotions (Nemiah, Freyberger, & Sifneos, 1976). Lombardo and colleagues (2007) found that adults with ASD ($N=30$, $M_{age}=29.13$ years, $SD=7.40$) had more difficulties with understanding their own emotions (on the Toronto Alexithymia Scale: TAS; Bagby, Parker & Taylor, 1994) compared to healthy controls ($N=30$, $M_{age}=29.93$ years, $SD=7.83$) (Lombardo, Barnes, Wheelwright, & Baron-

Cohen, 2007). They also found that adults with ASD had worse cognitive empathy skills, less empathic concern for others and elevated personal distress (on the Interpersonal Reactivity Index: IRI; Davis, 1983) than healthy control adults ($N=30$, $M_{age}=29.93$ years, $SD=7.83$). Similarly, Rogers and colleagues (2007) found that while adults with Asperger's Syndrome ($N=21$, $M_{age}=42.9$ years, $SD=10.6$) had poorer cognitive empathy skills than healthy controls ($N=21$, $M_{age}=41.9$ years, $SD=13.8$), there was no difference between the two groups in terms of feeling empathic concern for others (on the Interpersonal Reactivity Index: IRI; Davis, 1983) (Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007). Adults with Asperger's Syndrome also reported higher personal distress in tense inter-personal settings. Using the same measure, similar results were reported by Lever and Geurts (2016a) in a group of adults with ASD ($N=237$, $M_{age}=46.0$ years, $SD=13.8$) compared to healthy controls ($N=198$, $M_{age}=45.6$ years, $SD=16.4$). Bird and colleagues have linked the long-standing but mixed literature on empathy in ASD (e.g., Baron-Cohen & Wheelwright, 2004; Travis, Sigman, & Ruskin, 2001; Yirmiya, Sigman, Kasari, & Mundy, 1992; Wing, 1981) to alexithymia, showing that comorbid alexithymia, rather than ASD per se, predicts emotion recognition and empathy difficulties (e.g., Bird & Cook, 2013).

It is important to examine whether established cognitive deficits persist into older adulthood and how links to ASD symptoms may change in old age. This has both practical and theoretical significance. Knowing about cognitive strengths and difficulties should allow better planning for ASD individuals' wellbeing (e.g. quality of life, mental health) in later life. In addition, theories such as the fractionated triad account of autism, which proposes that different facets of ASD are independent at the

behavioural, cognitive and genetic level (Happé & Ronald, 2008), have not been tested in older age groups.

6.2 Aim

The study reported in this chapter aimed to investigate age-related effects on ToM, local-global processing skills, alexithymia symptoms and empathy skill in young and old adults with ASD compared to NT counterparts. The study was also intended to examine associations between these facets of ASD-related difficulties and QoL and severity of psychiatric conditions across study groups as a function of age.

Primary research questions and objectives were as follows:

1. To examine age-related effects on social cognition in adults with ASD compared to NT controls
2. To examine age-related effects on local-global processing abilities in adults with ASD compared to NT controls
3. To explore predictors of QoL (social cognition and local-global processing) as a function of age

In addition to the main research objectives above, a subsidiary research question concerned the inter-correlations among ASD-related cognitive skills, and their relationships to ASD traits, in old adulthood.

Although analyses were mainly exploratory, tentative hypotheses for the research objectives detailed above were as follows:

Hypotheses for aim 1 and 2:

1. Reduced ToM and global processing ability with older age.

Hypotheses for aim 3 and the subsidiary question:

No prediction could be derived from the literature and the analyses were exploratory in nature.

6.3 Method

6.3.1 Ethics

This study was a part of the study presented in Chapter 4 under the same Ethical Approval that was granted by the Psychiatry, Nursing and Midwifery Research Ethics Subcommittee (PNM RESC) at King's College London (PNM/13/14-26). Information sheets were provided to all participants and written consent was taken before the study took place (copies of study information sheet, consent form and the letter of ethics approval can be found in Appendix F).

6.3.2 Design

Group comparisons between adults with ASD and neurotypical (NT) control adults who do not have known psychiatric conditions were made on a range of measures assessing symptoms of ASD and other psychiatric conditions (e.g. depression and anxiety), quality of life (QoL), and cognitive skills. Sample size was set at minimum 20 per group, i.e. 80 participants in total, giving estimated 80% power to detect a medium effect size (Cohen, 1992; Field, 2009).

6.3.3 Participants

Table 6-1 presents the study sample, which is the same group reported in Chapter 4. Please see Chapter 4 for further details.

Table 6-1 Young and old adults in ASD and NT groups: Mean (SD)

	Young			Old		
	N	Age (in years)		N	Age (in years)	
		Range	Mean (SD)		Range	Mean (SD)
ASD	29	19-48	29.48 (8.51)	29	50-71	61.32 (6.18)
NT	20	20-44	29.40 (7.54)	19	52-71	57.83 (6.33)

6.3.4 Measures

There was an overlap between measures used in Chapter 4 and some of the measures used in the present chapter. Below only measures not reported in Chapter 4 are described in detail. For details of the rest of the measures (listed below) please see Chapter 4.

- Anxiety: Beck Anxiety Inventory (BAI; Beck & Steer, 1990);
- Depression: Beck Depression Inventory-II (BDI-II; Beck et al., 1996);
- ASD traits: Social Responsiveness Scale (SRS-2; Constantino & Gruber, 2012);
- IQ: Wechsler Abbreviated Scales of Intelligence - Second Edition (WASI-II; Wechsler, 2011);
- OCD: The Obsessive-Compulsive Inventory-Revised (OCI-R; Foa et al., 2002),
- QoL: The World Health Organization Quality of Life Assessment (WHOQOL-BREF; WHOQOL Group, 1998).

6.3.4.1 Social Cognition

6.3.4.1.1 The Reading the Mind in the Eyes Test (RMET) - Revised (Baron-Cohen et al., 2001):

The task includes 36 black-and-white photographs of eye region of different human faces and 4 words for each from which participants choose one to describe what the person is thinking or feeling in the photograph. Figure 6-1 shows examples of photographs taken from the test. The size of the photographs was set to 15 x 6 cm in the

present study. Total scores range from 0 to 36 given the fact that each correct guess gets 1 point. Participants are also given a glossary of the words in the task to make sure that they know the meaning of each word. Total scores range from 0 to 36, with each correct answer getting 1 point. Psychometric properties of the test have generally been reported to be good in several languages with a few mixed findings (e.g. regarding internal consistency ranging from 0.58-0.70) (Dehning et al., 2012; Girli, 2014; Vellante et al., 2013; Yildirim et al., 2011; Pfaltz et al., 2013; Prevost et al., 2014). The task has been widely used in social cognition research with adults, both in clinic and neurotypical groups (see Chapter 2 for a detailed review of the literature).



Figure 6-1 Examples of the photographs from the RMET

6.3.4.1.2 The ToM Cartoon Stories Task (ToM-CSt)

For the purpose of the present research, a novel picture-sequencing task was designed by the author in order to assess Theory of Mind (ToM) ability. More detailed description of the task development and design can be found in Chapter 5. The task includes pictures describing 10 ToM and 5 control cartoon stories. Figure 6-2 shows an example ToM story from the task in the correct order. The 5 pictures comprising each story are given in a jumbled order and the participant is required to put them in the correct order. Upon completion of sequencing the cartoon pictures, participants are asked to explain the main point in the story. The ToM Cartoon Stories Task was

designed to be suitable for in-person testing as well as for postal/on-line data collection. In the present study, in-person administration of the task was used. The size of each picture was set to 14 x 9.5cm. Performance was evaluated based on accuracy of sequencing stories, identification of the main point in them and use of psychological state talk in the explanation of the main points. Further details about scoring system of the task can be found in Appendix G and task psychometrics were reported in the results section.

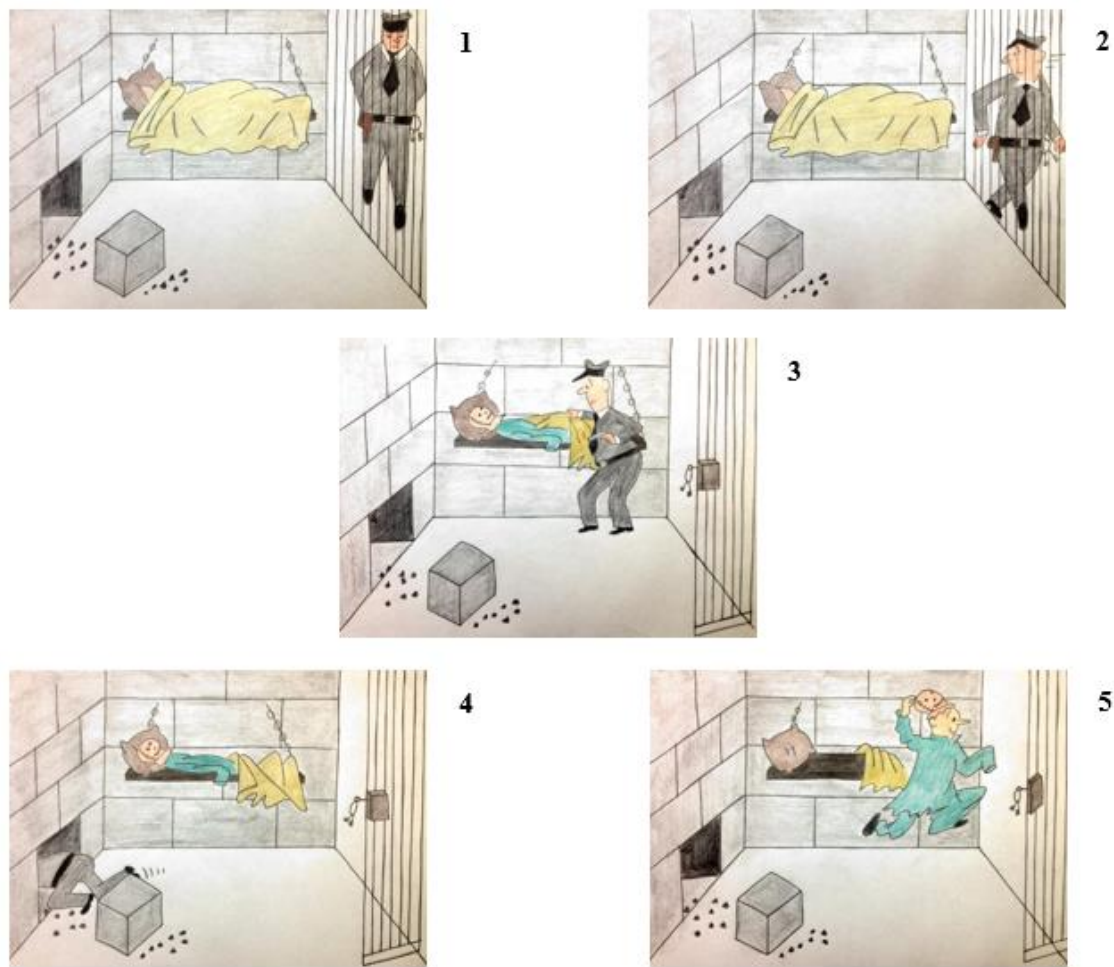


Figure 6-2 A ToM story (in the correct order) from the ToM Cartoon Stories task

6.3.4.1.3 The Frith-Happé Triangles Test (Abell et al., 2000):

In this test participants are presented with short (c. 45 seconds) videos (1 practice and 4 experimental clips) of two triangles: a small blue and a large red triangle. The triangles are interacting throughout the clips within a white space, plus a blue enclosure in three of the experimental clips. Interaction between the triangles depicts 4 different mentalizing stories in each experimental clip: surprising, coaxing, mocking, and seducing. Figure 6-3 shows a scene taken from one of the experimental clips. Participants are asked to explain what is going on in the video clip after watching each one. Performance on each item is scored based on appropriateness of the answers and

psychological state talk of participants, ranging from 0 to 2 for each, leading to a total score of 0-8. The task has been used with a wide range of ages in the ASD literature and validated as a ToM task (Abell et al., 2000; Castelli et al., 2002; Klein, Zwickel, Prinz, & Frith, 2009; Moriguchi et al., 2006).

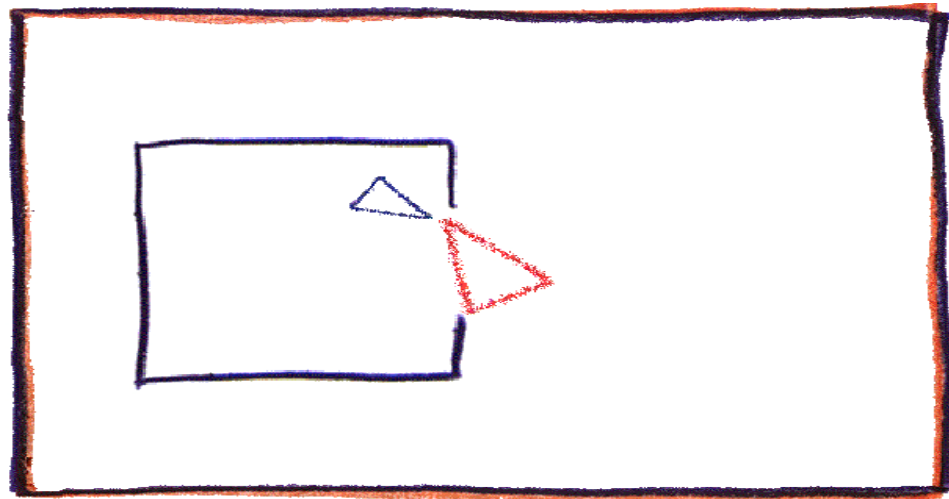


Figure 6-3 A scene taken from the Triangles Test

An inter-rater reliability analysis using the Kappa statistic was conducted to determine consistency among raters. Task scores for 20% of participants in each study group (i.e. young ASD, old ASD, young NT, old NT) were double-rated by two independent raters who were blind to group. Given good agreement between the independent raters, the first rater's ratings were used for the subsequent analyses (Table 6-2).

Table 6-2 Inter-rater reliability results of F-HT scores of young and old adults in ASD and NT groups: Weighted Kappa

	ASD		NT	
	Young N = 7	Old N = 7	Young N = 5	Old N = 5
Accuracy	.94	.92	.93	.95
PST ¹	1.00	1.00	.88	.89

¹ Psychological State Talk

6.3.4.1.4 The Strange Situations Film Task (Murray, 2014):

This task consists of 15 short (c. 20 seconds) video clips: 3 practice, 12 mental state, and 3 control clips. In these clips there are two characters in various daily situations, communicating or interacting. Figure 6-4 shows a scene taken from one of the video clips in the task. Three questions are asked at the end of each clip: an intention question (e.g. “Why did character X say that?”), an interaction question (e.g. “If you were in character Y’s situation what would you say next?”), and a memory question about a factual element of the clip (e.g. “How long was character X going away for?”). Accuracy and psychological-state talk scores (i.e. ranging from 0 to 2 and 0 to 3, respectively) are allocated for the intention question (total accuracy scores range from 0 to 24 for the experimental clips and 0 to 6 for control clips, and total psychological state talk scores range from 0 to 36 for the experimental clips and 0 to 9 for control clips), while scores are rated based on accuracy only for the interaction (total score ranges from 0 – 24 for the experimental clips and 0 – 6 for the control clips) and the memory questions (each is scored as either 0 or 1; total score ranges from 0-12 for experimental clips and 0-3 for control clips). Scoring criteria are shown in more detail in Appendix H. The task was devised and reported as a part of Kim Murray’s PhD thesis (2014), who reported that the task to be discriminated between ASD and NT adults, and was significantly associated with well-established ToM tasks (i.e. with the Strange Stories Task (Happé, 1994) in the ASD group and with the Frith-Happé Triangles Task (Abell et al., 2000) in the NT group).



Figure 6-4 A scene taken from the Strange Situations task

An inter-rater reliability analysis using the Kappa statistic was conducted to determine consistency among raters. Task scores for 20% of participants in each study group (i.e. young ASD, old ASD, young NT, old NT) were double-rated by two independent raters who were blind to group. Given good agreement between the independent raters, the first rater's ratings were used for the subsequent analyses (Table 6-3).

Table 6-3 Inter-rater reliability results of SSFt scores of young and old adults in ASD and NT groups: Weighted Kappa

		ASD		NT	
		Young N = 7	Old N = 7	Young N = 5	Old N = 5
Experimental Clips	Intention	.92	.90	.83	1.00
	PST ¹	1.00	1.00	.96	1.00
	Interaction	.93	.86	.90	.98
	Memory	1.00	1.00	1.00	1.00
Control Clips	Intention	1.00	.84	1.00	1.00
	PST ¹	1.00	1.00	.90	1.00
	Interaction	.92	.92	.65	.63
	Memory	.64	1.00	1.00	1.00

¹ Psychological State Talk

6.3.4.1.5 Coat Story Task (Bowler, 1992):

This is a ToM test consisting of a story and 11 questions: 7 prompt questions, a test, a justification, a reality and a memory question. Questions are asked in the course of reading the story to the participant. Performance on this test is rated based on the accuracy (the score ranges 0 – 1) of the response and the psychological-state talk (the score ranges 0 – 2). Subjects are credited with a correct response for accuracy score only if they give correct answers to the test, the reality and the memory questions. Then, their psychological-state talk is evaluated based on their answer to justification question, which fall into one of the three categories: zero-order (i.e. no mental state attribution, such as “This is what he said.”), first-order (i.e. only one character’s mental state attribution in a statement, such as “He knows that they are out of stock.”), and second-order mental state attribution (i.e. attributing one character’s mental state in which other character’s mental state is embedded, such as “She does not know that he knows that they are out of stock”). To our knowledge no psychometric properties have been reported for this task.

6.3.4.2 Alexithymia

6.3.4.2.1 The 20–Item Toronto Alexithymia Scale (TAS-20) (Bagby et al., 1994):

The TAS-20 is a self-report measure consisting of 20 items tapping emotional understanding. The scale has three factors: difficulty in identifying feelings (7 items), difficulty in describing feelings (5 items), externally oriented thinking (8 items). All items are rated on a 5-point Likert scale from “strongly disagree (1)” to “strongly agree (5)”. Total scores range from 0 to 100, with higher scores indicating greater alexithymia, i.e. poorer ability to understand emotions. A minimum total score of 61 is suggested to identify individuals with alexithymia. The scale has demonstrated good

internal consistency, construct validity and test-retest reliability (Bagby et al., 1994; Taylor, Bagby, & Parker, 2003; Taylor et al., 1988).

6.3.4.3 Empathy

6.3.4.3.1 The Interpersonal Reactivity Index (IRI) (Davis, 1983):

The IRI is a 28-item self-report questionnaire measuring a range of empathy-related skills or traits, including both cognitive and emotional components of empathy. Participants respond to each item using a 5-point Likert scale (from “does not describe me well (0)” to “describes me very well (4)”). The measure has 4 subscales (with 7 items in each) assessing 4 factors related to empathy: perspective taking, fantasy, empathic concern, and personal distress. Subscale scores range from 0 to 28, with higher score indicating better empathy skills/traits. The IRI has been reported to have good internal consistency, test–retest reliability, and convergent validity (Davis, 1983).

6.3.4.4 Local and Global Processing

6.3.4.4.1 Embedded Figures Test (EFT; Witkin, 1971):

The EFT is a perceptual test assessing cognitive style (e.g. local processing bias) and analytic ability. It involves locating a previously seen simple geometric figure within a larger complex geometric figure which has been designed to embed or obscure the simple figure. Figure 6-5 shows an example of complex and embedded figures. The EFT has two alternative versions (Form A and Form B), which do not differ in difficulty and/or number of items. Form B was chosen for the current study, and complex figures were presented on laminated cards, and each simple form was given to the participant on a transparent sheet. Performance of EFT is evaluated based on the time (in seconds) required for solution of each item (failed items are coded as 180 seconds, which is the maximum time allowed for solution of each item). The overall

score for the test is the mean solution time of all items. The EFT has good psychometric properties, with test-retest reliability and validity ranging from .89 - .95 (Witkin, 1971).

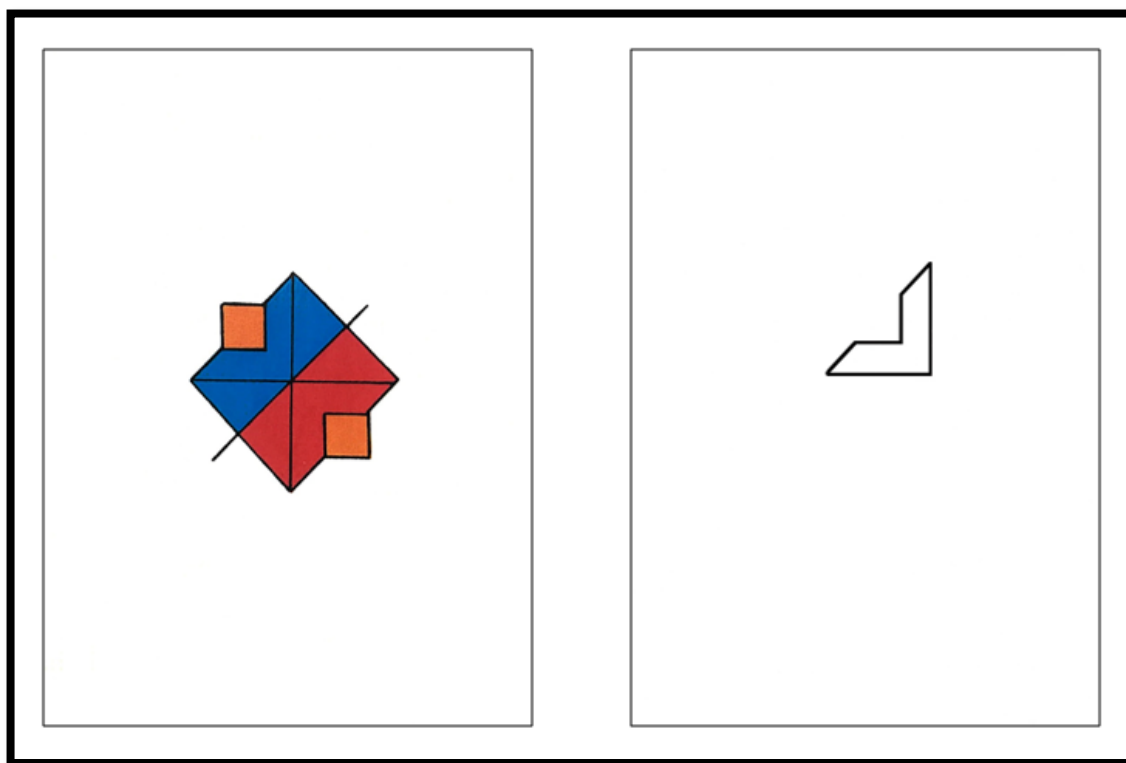


Figure 6-5 A complex and an embedded figure from the EFT test

6.3.4.4.2 Phoneme Segmentation Task (Booth, 2006):

The Phoneme Segmentation Task is an auditory local processing task that consists of 45 non-words with or without a target phoneme /p/ within them, in addition to 3 practice non-words. The target phoneme is placed as the initial sound, medial or final sound, or absent, with 15 non-words in each condition. Stimuli were presented using SuperLab Pro software run on a laptop computer. High quality headphones were provided in order for participants to hear stimuli appropriately. The response input was the laptop-keyboard with ‘N’ button for answer “No” and ‘Y’ button for answer “Yes”. Figure 6-6 shows example non-words in each condition. Participants are required to determine whether there is the target phoneme in each word. Performance is rated based

on number of successful identifications up of the presence of the target phoneme (i.e. /p/) and response time, measured from the offset of each item. The task was devised as a part Dr Rhonda Booth's PhD thesis (2006).

Target absent	Target initial	Target medial or final
Besh	Payod	Elopive
Mexonib	Plufernart	Zeonasp
Gusf	Poung	Lipt

Figure 6-6 Non-words from the Phoneme Segmenting Task

6.3.4.4.3 Fragmented Pictures Task (Booth, 2006; Snodgrass, Smith, Feenan, & Corwin, 1987):

The Fragmented Pictures Task is a visual global processing task that includes 10 pictures of objects (+1 practice item, all taken from the Fragmented Picture Completion task; Snodgrass et al., 1987), that were presented starting with the most fragmented version, progressing frame by frame (allowing 5 seconds between two frames) to the whole image. Using SuperLab Pro software controlled by a laptop computer, 8 frames for each picture were presented: 1st frame is the most fragmented and 8th frame is the whole picture. Images appeared within a 3.25 by 3.25-inch square and at the centre of a 13-inch computer screen. Figure 6-7 shows an item from the task. Participants are required to guess what the picture is at the earliest frame possible. Performance is evaluated based on frame number in which an accurate guess was made. The task was devised as a part of Dr Rhonda Booth's PhD thesis (2006).

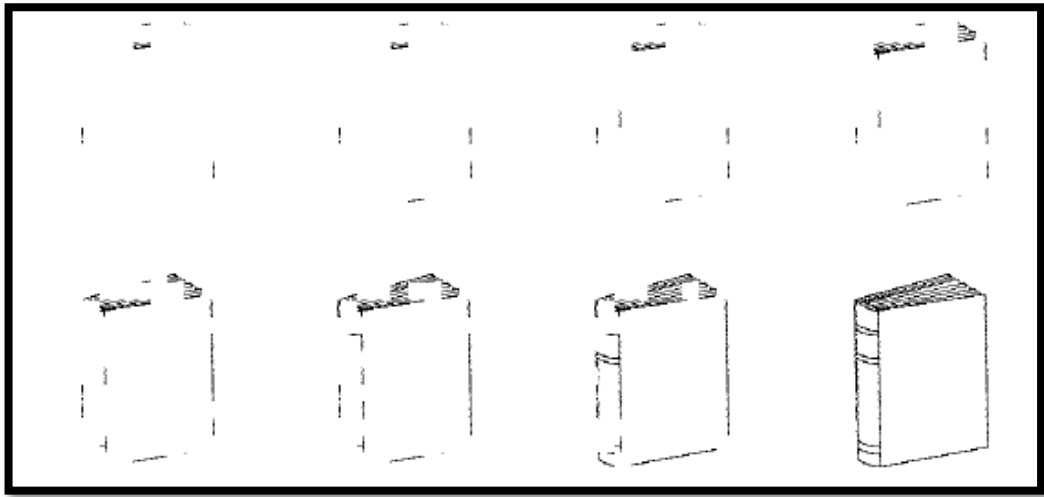


Figure 6-7 A picture of book with its fragmented frames from the Fragmented Pictures Task

6.3.5 Procedure

Please see Chapter 4 for details.

6.3.6 Statistical Analysis

Parametric tests were employed for statistical analysis where applicable. Homogeneity of variance was measured using Levine's test. Normality of data distribution was checked in several ways: the Nonparametric Kolmogrov-Smirnov test, the Nonparametric Saphiro-Wilk test, histograms, Q-Q plots, and examination of skewness and kurtosis scores. Bootstrap analysis was performed to test whether the results were robust against deviations from parametric assumptions (Chong & Choo, 2011), when at least three of the above indicators suggested deviation from the normal distribution. The independent bootstrap test is nonparametric. Thus 95% mean difference confidence intervals obtained from the bootstrap test were also reported alongside to support outcomes of the test statistic. All bootstrap tests were based on 1000 samples.

First, psychometric properties of the novel ToM task, the ToM Cartoon Stories Task (ToM-CSt), were examined. Then, two-way ANOVA was used to investigate influence of study group (ASD vs. NT) and age group (young vs. old) on social cognition and local-global processing ability. Also, mixed-design ANOVA was used to test auditory local processing performance on the Phoneme Segmentation Task. To reduce the number of statistical tests, a composite score was created for ToM performance using Principal Component Analysis (PCA) and subscales were only explored where total scores showed significant group, age or age by group effects. ANOVA results were followed by separate group comparison analyses by using dependent/independent t-test, with effect sizes (Cohen's *d*) were presented for exploratory purposes. Since these analyses were exploratory, a significance level of .05 was used rather than more conservative *p* values (e.g. at .0125 level of significance with the Bonferroni correction) when multiple tests were run. For the correlation analysis either a Spearman's or Pearson's correlation coefficient was calculated depending on parametric status of the variables'. Multiple regression analyses were conducted for only global QoL scores in study groups and with only variables that had significant correlation with the outcome variable included as possible predictors. Forward stepwise method was used in all regression analyses, with confirmatory checks using backward elimination method to identify all significant predictors. Categorical data were tested by using a loglinear analysis, Pearson Chi Square statistic and multinomial regression analysis, as necessary.

6.4 Results

6.4.1 ToM Cartoon Stories Task (ToM-CSt): Psychometrics

6.4.1.1 Item Analysis

Internal consistency was tested for each scale-score of the ToM-CSt (Table 6-4). Satisfactory reliability was achieved for experimental scales (.71 - .78). However, reliability of control scales was low except for reliability of psychological state talk scale, which was adequate (Cronbach's $\alpha = .59$). The low Cronbach's α values in the control cartoon stories indicated the different components of reasoning needed to get full-score in these scales. Therefore, one would not expect adequate alpha values on these subscales as shown on the experimental cartoon stories which appear to be tapping an underlying construct.

Table 6-4 Internal consistency for experimental and control cartoon stories in the ToM-CSt

	Experimental Cartoon Stories			Control Cartoon Stories		
	Accu	Pst	Seq	Accu	Pst	Seq
Cronbach's Alpha (α)	.78	.71	.76	.37	.59	.41

6.4.1.2 Inter-rater Reliability

An inter-rater reliability analysis using the weighted Kappa statistic was conducted to determine consistency among raters. ToM-CSt scores for 20% of participants in each study group (i.e. young ASD, old ASD, young NT, old NT) were double-rated by two independent raters who were blind to groups. Given the substantial to perfect agreement between the independent raters, the first rater's ratings were used for the analyses (Table 6-5).

Table 6-5 Inter-rater reliability results of ToM-CSt scores of young and old adults in ASD and NT groups: Weighted Kappa

			ASD		NT	
			Young N = 7	Old N = 7	Young N = 5	Old N = 5
ToM-CSt	Experimental Stories	Seq	1.00	1.00	1.00	1.00
		Accu	.89	1.00	1.00	.91
		Pst	.86	.86	.95	.87
	Control Stories	Seq	1.00	1.00	1.00	1.00
		Accu	.92	.88	.65	1.00
		Pst	1.00	.97	1.00	.92

6.4.1.3 Associations among Sub-scores of the ToM-CSt

The relationship between subscale scores of the novel task was examined in both study group. Results showed that the accuracy score was significantly and positively correlated with both sequence and psychological state talk score in the ASD group. However, psychological state talk and sequence scores were not significantly correlated. All scale scores of the ToM-CSt were significantly and positively correlated with each other in the NT group (Table 6-6).

Table 6-6 Associations between ToM-CSt scale scores in ASD and NT groups

			ToM-CSt		
			Sequence	Accuracy	PST ¹
ASD	ToM-CSt	Sequence	-	.63***	.24 ^{ns} (<i>p</i> =.07)
		Accuracy	-	-	.51***
		PST ¹	-	-	-
NT	ToM-CSt	Sequence	-	.78***	.59***
		Accuracy	-	-	.60***
		PST ¹	-	-	-

¹ Psychological State Talk

All correlation coefficients are Spearman's Rho

^{ns} *p* > .05, *** *p* < .001

6.4.1.4 Convergent Validity

Correlations between performance on the ToM-CSt experimental stories and other established social cognition tasks were investigated by study group in order to test convergent validity of the novel task.

In the ASD group, accuracy score was significantly and positively correlated with all other ToM task scores. Psychological state talk score of the novel task was also significantly and positively related to almost all other ToM task scores (except for the RMET score for which no significant correlation was detected). There was a significant positive correlation between sequence scale score and scores on the accuracy scale of the Triangles test, RMET and the intention scale of the Strange Situations Film Task (Table 6-7).

Table 6-7 Associations between ToM-CSt and traditional ToM task scores in the ASD group

		F-HT		RMET	SSFt		
		Accuracy	PST ¹		Intention	PST ¹	Interaction
ToM-CSt	Sequence	.30^{*(a)}	.26 ^{ns(a)} (<i>p</i> =.05)	.40^{**}(a)	.28^{*(a)}	.18 ^{ns(a)} (<i>p</i> =.17)	.16 ^{ns(a)} (<i>p</i> =.25)
	Accuracy	.37^{**}	.37^{**}	.32^{*(a)}	.51^{***}	.27[*]	.32[*]
	PST ¹	.26^{*(a)}	.56^{***}(a)	.09 ^{ns(a)} (<i>p</i> =.52)	.41^{**}(a)	.35^{**}(a)	.42^{***}(a)

F-HT: Frith-Happé Triangles Test

RMET: Reading the Mind in the Eyes Test

SSFt: Strange Situations Film Task

¹ Psychological State Talk

^(a) Spearman's Rho

^{ns}*p* > .05, ^{*}*p* < .05. ^{**}*p* < .01, ^{***}*p* < .001

Partial correlations between ToM scores controlling for FS-IQ showed that some of these significant coefficients did not survive. However, associations between F-HT accuracy and both ToM-CSt-accuracy and sequence scores were still significant. Similarly, significant correlation coefficients between ToM-CSt-accuracy and both F-HT psychological state talk and SSFt-intention scores survived. RMET and ToM-CSt-sequence as well as psychological state talk scores of the ToM-CSt and F-HT were also significantly associated after controlling for FS-IQ.

Similar results were found in the NT group, especially for the accuracy and psychological state talk scale of the ToM-CSt. This time RMET was also significantly and positively correlated with the latter. In this group, sequence scale performance was also significantly and positively related to all other ToM task scores (Table 6-8).

Table 6-8 Associations between ToM-CSt and traditional ToM task scores in the NT group

		F-HT		RMET	SSFt		
		Accuracy	PST ¹		Intention	PST ¹	Interaction
ToM-CSt	Sequence	.52*** ^(a)	.32* ^(a)	.57*** ^(a)	.61*** ^(a)	.49** ^(a)	.57*** ^(a)
	Accuracy	.45** ^(a)	.34* ^(a)	.50** ^(a)	.48** ^(a)	.43** ^(a)	.53*** ^(a)
	PST ¹	.38*	.36* ^(a)	.37* ^(a)	.44**	.39*	.44** ^(a)

F-HT: Frith-Happé Triangles Test

RMET: Reading the Mind in the Eyes Test

SSFt: Strange Situations Film Task

¹ Psychological State Talk

^(a) Spearman's Rho

* $p < .05$, ** $p < .01$, *** $p < .001$

After controlling for FS-IQ, correlation coefficients were no longer significant in the NT group: between ToM-CSt-sequence and F-HT psychological state talk score, and between ToM-CSt-psychological state talk and F-HT accuracy.

Analysis was then performed to examine associations between ToM-CSt task performance and both alexithymia and empathy scores. None of the scale scores of the ToM-CSt was significantly correlated with alexithymia in the ASD group. Only psychological state talk score was significantly correlated both with perspective taking and empathic concern scores of the empathy measure (Table 6-9).

Table 6-9 Associations of the ToM-CSt with alexithymia (TAS-20) and empathy (IRI) in the ASD group

		Alexithymia				Empathy			
		Total	IF	DF	EOT	PT	F	EC	PD
ToM-CSt	Sequence	.05 ^{ns(a)} (<i>p</i> =.73)	.03 ^{ns(a)} (<i>p</i> =.80)	.06 ^{ns(a)} (<i>p</i> =.66)	.04 ^{ns(a)} (<i>p</i> =.76)	.07 ^{ns(a)} (<i>p</i> =.62)	.16 ^{ns(a)} (<i>p</i> =.22)	.06 ^{ns(a)} (<i>p</i> =.67)	-.17 ^{ns(a)} (<i>p</i> =.21)
	Accuracy	-.07 ^{ns(a)} (<i>p</i> =.61)	-.05 ^{ns} (<i>p</i> =.70)	-.03 ^{ns} (<i>p</i> =.85)	-.11 ^{ns} (<i>p</i> =.43)	.04 ^{ns} (<i>p</i> =.79)	.11 ^{ns} (<i>p</i> =.41)	.03 ^{ns(a)} (<i>p</i> =.80)	-.12 ^{ns} (<i>p</i> =.36)
	PST ¹	-.19 ^{ns(a)} (<i>p</i> =.15)	-.13 ^{ns(a)} (<i>p</i> =.33)	-.17 ^{ns(a)} (<i>p</i> =.19)	-.18 ^{ns(a)} (<i>p</i> =.18)	.33 ^{*(a)}	.13 ^{ns(a)} (<i>p</i> =.35)	.29 ^{*(a)}	-.06 ^{ns(a)} (<i>p</i> =.68)

¹Psychological State Talk

^(a)Spearman's Rho

^{ns}*p* > .05, ^{*}*p* < .05

In the NT group, there was no significant association between ToM-CSt scores and either alexithymia or empathy scores (Table 6-10).

Table 6-10 Associations of the ToM-CSt with alexithymia (TAS-20) and empathy (IRI) in the NT group

		Alexithymia				Empathy			
		Total	IF	DF	EOT	PT	F	EC	PD
ToM-CSt	Sequence	.03 ^{ns(a)} (<i>p</i> =.86)	-.03 ^{ns(a)} (<i>p</i> =.84)	-.15 ^{ns(a)} (<i>p</i> =.36)	.25 ^{ns(a)} (<i>p</i> =.13)	-.06 ^{ns(a)} (<i>p</i> =.73)	.09 ^{ns(a)} (<i>p</i> =.60)	.01 ^{ns(a)} (<i>p</i> =.97)	.08 ^{ns(a)} (<i>p</i> =.62)
	Accuracy	.07 ^{ns(a)} (<i>p</i> =.69)	-.02 ^{ns(a)} (<i>p</i> =.92)	-.04 ^{ns(a)} (<i>p</i> =.80)	.17 ^{ns(a)} (<i>p</i> =.30)	-.07 ^{ns(a)} (<i>p</i> =.68)	-.02 ^{ns(a)} (<i>p</i> =.90)	-.09 ^{ns(a)} (<i>p</i> =.58)	.05 ^{ns(a)} (<i>p</i> =.78)
	PST ¹	.11 ^{ns} (<i>p</i> =.52)	.05 ^{ns(a)} (<i>p</i> =.79)	-.10 ^{ns(a)} (<i>p</i> =.53)	.30 ^{ns} (<i>p</i> =.07)	-.06 ^{ns} (<i>p</i> =.70)	-.09 ^{ns} (<i>p</i> =.57)	-.23 ^{ns(a)} (<i>p</i> =.15)	.04 ^{ns} (<i>p</i> =.81)

¹Psychological State Talk

^(a)Spearman's rho

^{ns}*p* > .05

6.4.2 Composite ToM Score

Since several ToM measures were used to assess ToM ability, a composite score of ToM was created separately in each study group by using Principal Component Analysis (PCA). In order to select variables to include in the PCA, first all ToM scores were examined in terms of their inter-correlation with each other in the ASD and NT groups. Table 6-11 and Table 6-12 shows inter-correlations among established ToM tasks in the ASD and NT groups, respectively (see also Table 6-7 and Table 6-8 reported above for inter-correlation between ToM-CSt and established ToM tasks in both groups). Inter-correlation between performances on established ToM tasks were

generally good in the ASD group. Almost all scores significantly and positively correlated with more than one other scale score, except for the RMET score. Performance on the RMET test was significantly associated only with the accuracy score of the Triangles test (Table 6-11).

Table 6-11 Associations between traditional ToM task scores in the ASD group

		F-HT		RMET	SSFt		
		Accuracy	PST ¹		Intention	PST ¹	Interaction
F-HT	Accuracy	-	.56***	.34**^(a)	.39**	.18 ^{ns} (<i>p</i> =.17)	.15 ^{ns} (<i>p</i> =.25)
	PST ¹	-	-	.20 ^{ns(a)} (<i>p</i> =.13)	.43***	.46***	.30*
RMET		-	-	-	.25 ^{ns(a)} (<i>p</i> =.06)	.07 ^{ns(a)} (<i>p</i> =.59)	.11 ^{ns(a)} (<i>p</i> =.41)
SSFt	Intention	-	-	-	-	.66***	.52***
	PST ¹	-	-	-	-	-	.43***
	Interaction	-	-	-	-	-	-

F-HT: Frith-Happé Triangles Test

RMET: Reading the Mind in the Eyes Test

SSFt: Strange Situations Film Task

¹ Psychological State Talk

^(a) Spearman's Rho

^{ns} *p* > .05, **p* < .05, ***p* < .01, ****p* < .001

Inter-correlation between different ToM tasks was also good in the NT group. Scale scores, including the RMET score, was significantly and positively associated with more than one other ToM task scale score (Table 6-12).

Table 6-12 Associations between traditional ToM task scores in the NT group

		F-HT		RMET	SSFt		
		Accuracy	PST ¹		Intention	PST ¹	Interaction
F-HT	Accuracy	-	.55*** ^(a)	.37* ^(a)	.63***	.58***	.45** ^(a)
	PST ¹	-	-	.13 ^{ns(a)} (<i>p</i> = .43)	.33* ^(a)	.47** ^(a)	.34* ^(a)
RMET		-	-	-	.50** ^(a)	.21 ^{ns(a)} (<i>p</i> = .20)	.43** ^(a)
SSFt	Intention	-	-	-	-	.75***	.57*** ^(a)
	PST ¹	-	-	-	-	-	.55*** ^(a)
	Interaction	-	-	-	-	-	-

F-HT: Frith-Happé Triangles Test

RMET: Reading the Mind in the Eyes Test

SSFt: Strange Situations Film Task

¹ Psychological State Talk

^(a) Spearman's Rho

^{ns} *p* > .05, **p* < .05, ***p* < .01, ****p* < .001

Variables which showed low inter-correlations with others and those which showed multicollinearity were excluded, leading to total 4 variables included in the PCA in both groups. The Kaiser-Meyer-Olkin measure verified that the sample sizes were adequate for the analyses in both groups (KMO = .68 for the ASD group and KMO = .77 for the NT group), and all KMO values for each variable in both groups were above the acceptable limit of .50 (Field, 2009). Bartlett's test of sphericity $\chi^2(6) = 46.36$, *p* < .001 (in the ASD group) and $\chi^2(6) = 52.86$, *p* < .001, showed that associations between variables were large enough for both PCA. Only one component had an eigenvalue over Kaiser's criterion of 1 and explained 53.94% of the variance in the ASD group and 65.71% of the variance in the NT group. Scree plots were in parallel with these results. Table 6-13 shows the factor loadings after extraction in each study group.

Table 6-13 Summary of principal component analysis results for a set of ToM scores in ASD and NT groups

	Factor Loadings for ToM Ability	
	ASD	NT
FH-T - Accuracy	.62	.80
SSFt - Intention	.85	.86
SSFt - Interaction	.68	.78
ToM-CSt - Accuracy	.76	.81

6.4.3 Study Group and Age Group Effects on Cognitive Skills

6.4.3.1 Study Group and Age Group Effects on Social Cognition

Social cognition, which was assessed on various measures including the novel ToM task (the ToM Cartoon Stories Task; ToM-CSt), was examined in young and old adults with and without ASD.

6.4.3.1.1 Study Group and Age Group Effects on ToM

A two-way ANOVA was performed to test effects of study group, age group and age group by study group on the composite ToM score (Table 6-14). For results on ToM measures separately please see Appendix I.

Table 6-14 Performance of young and old adults in ASD and NT groups based on the composite ToM score: Mean (SD)

	ASD		NT		F^1	p -value	effect size: η^2
	Young N=29	Old N=29	Young N=20	Old N=20			
ToM	0.10 (1.06)	-0.10 (0.94)	0.53 (0.45)	-0.55 (1.13)	0.01 ^{group} 10.72 ^{age**} 5.01 ^{agexgroup*}	.94 ^{group} .0015 ^{age} .03 ^{agexgroup}	<.001 ^{dgroup} .10 ^{age} .05 ^{agexgroup}

¹ All $df_{MS} = 1$ and $df_{RS} = 93$

^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group

* $p < .05$, ** $p < .01$

A significant age group effect and a non-significant study group effect were found on the composite ToM score (Table 6-14). The interaction effect of age group by study group was significant. This showed that young and old adults with ASD had similar

ToM performance (M=0.10, SD=1.06 vs. M=-0.10, SD=0.94, respectively), whereas young NT adults (M=0.53, SD=0.45) outperformed old NT adults (M=-0.55, SD=1.13).

6.4.3.1.2 Study Group and Age Group Effects on Alexithymia and Empathy

Alexithymia and empathy were assessed on self-reported questionnaires in young and old adults with and without ASD. Table 6-15 shows scores of each group on both tests.

Table 6-15 Alexithymia (TAS-20) and empathy (IRI) scores of young and old adults in ASD and NT groups: Mean (SD)

		ASD		NT		F^1	p -value	effect size: η^2
		Young N = 29	Old N = 29	Young N = 20	Old N = 19			
Alexithymia	Total (max = 100)	60.69 (12.12)	58.14 (14.21)	38.75 (9.53)	35.58 (8.69)	83.52^{group***} 1.38 ^{age} 0.02 ^{agegroup}	< .001 ^{group} .24 ^{age} .90 ^{agegroup}	.47 ^{group} .02 ^{age} < .001 ^{agegroup}
	Identifying Feelings (IF) (max = 35)	21.31 (6.89)	18.93 (7.62)	10.25 (4.01)	9.63 (3.62)	64.29^{group***} 1.39 ^{age} 0.48 ^{agegroup}	< .001 ^{group} .24 ^{age} .49 ^{agegroup}	.41 ^{group} .02 ^{age} .01 ^{agegroup}
	Describing Feelings (DF) (max = 25)	17.69 (4.62)	17.07 (5.11)	9.90 (3.93)	9.16 (3.73)	71.35^{group***} 0.54 ^{age} 0.004 ^{agegroup}	< .001 ^{group} .47 ^{age} .95 ^{agegroup}	.43 ^{group} .01 ^{age} < .001 ^{agegroup}
	Externally Orientated Thinking (EOT) (max = 40)	21.69 (5.22)	22.14 (4.58)	18.35 (4.12)	16.79 (4.10)	20.71^{group***} 0.34 ^{age} 1.11 ^{agegroup}	< .001 ^{group} .56 ^{age} .30 ^{agegroup}	.18 ^{group} .004 ^{age} .01 ^{agegroup}
Empathy	Perspective Taking (PT) (max = 28)	12.21 (4.40)	12.97 (5.49)	19.00 (4.82)	20.00 (5.38)	44.18^{group***} 0.72 ^{age} 0.01 ^{agegroup}	< .001 ^{group} .40 ^{age} .91 ^{agegroup}	.32 ^{group} .01 ^{age} < .001 ^{agegroup}
	Fantasising (F) (max = 28)	13.41 (7.21)	13.76 (5.75)	16.15 (6.78)	12.79 (5.78)	0.44 ^{group} 1.28 ^{age} 1.93 ^{agegroup}	.51 ^{group} .26 ^{age} .17 ^{agegroup}	.01 ^{group} .01 ^{age} .02 ^{agegroup}
	Empathic Concern (EC) (max = 28)	16.10 (6.64)	19.38 (4.54)	21.15 (4.28)	22.26 (4.07)	13.88^{group***} 4.25^{age*} 1.03 ^{agegroup}	< .001 ^{group} .042 ^{age} .31 ^{agegroup}	.13 ^{group} .04 ^{age} .01 ^{agegroup}
	Personal Distress (PD) (max = 28)	13.55 (4.69)	13.59 (6.32)	8.25 (6.21)	9.47 (4.68)	16.79^{group***} 0.30 ^{age} 0.27 ^{agegroup}	< .001 ^{group} .59 ^{age} .61 ^{agegroup}	.15 ^{group} .003 ^{age} .003 ^{agegroup}

¹ All $df_{MS} = 1$ and $df_{RS} = 93$

^{group} Main effect of study group

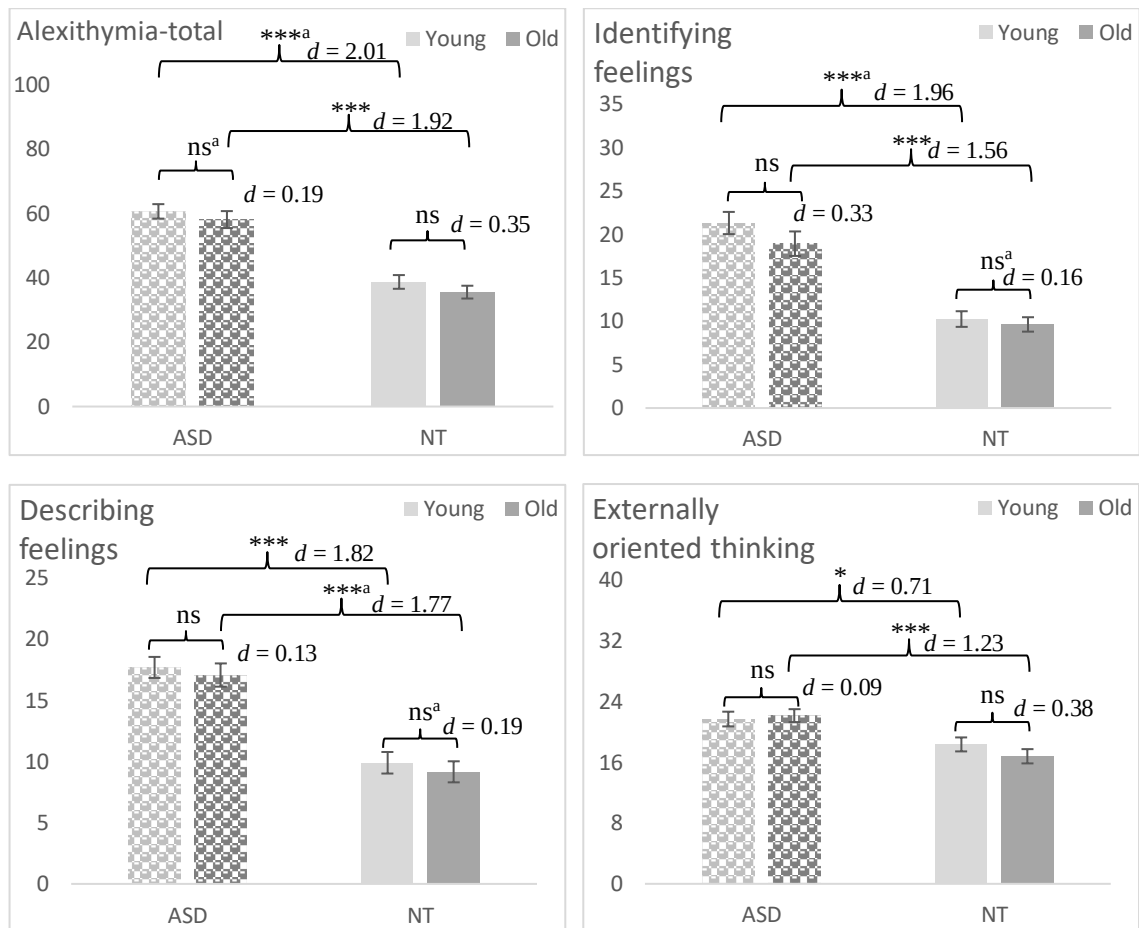
^{age} Main effect of age group

^{agegroup} Interaction effect of age group by study group

* $p < .05$, ** $p < .01$, *** $p < .001$

Two-way ANOVA was conducted to test age and study group effects on alexithymia and empathy scores. A significant main effect of study group on total **alexithymia** score was found. However, there was no significant age group effect or interaction effect of age group by study group on total TAS-20 score. This indicated that adults with ASD had more self-reported problems with understanding emotions than NT controls in general ($M=59.41$, $SD=13.15$ vs $M=37.21$, $SD=9.15$, respectively). Investigation of group and age effects on subscores of alexithymia also indicated similar results. There was a significant main effect of study group on all three subdomains. Age group effect and interaction effect of age group by study group were non-significant on each subscale. Results indicated that adults with ASD had more difficulties with identifying ($M=20.12$, $SD=7.30$) and describing ($M=17.38$, $SD=4.84$) feelings as well as with making decisions based on emotions ($M=21.91$, $SD=4.87$) compared to NT adults ($M=9.95$, $SD=3.79$; $M=9.54$, $SD=3.80$ and $M=17.59$, $SD=4.13$, respectively) (Table 6-15).

Figure 6-8 shows performance for the ASD and NT young and old groups with effect sizes shown for exploratory purposes, which were in parallel with factorial ANOVA results.



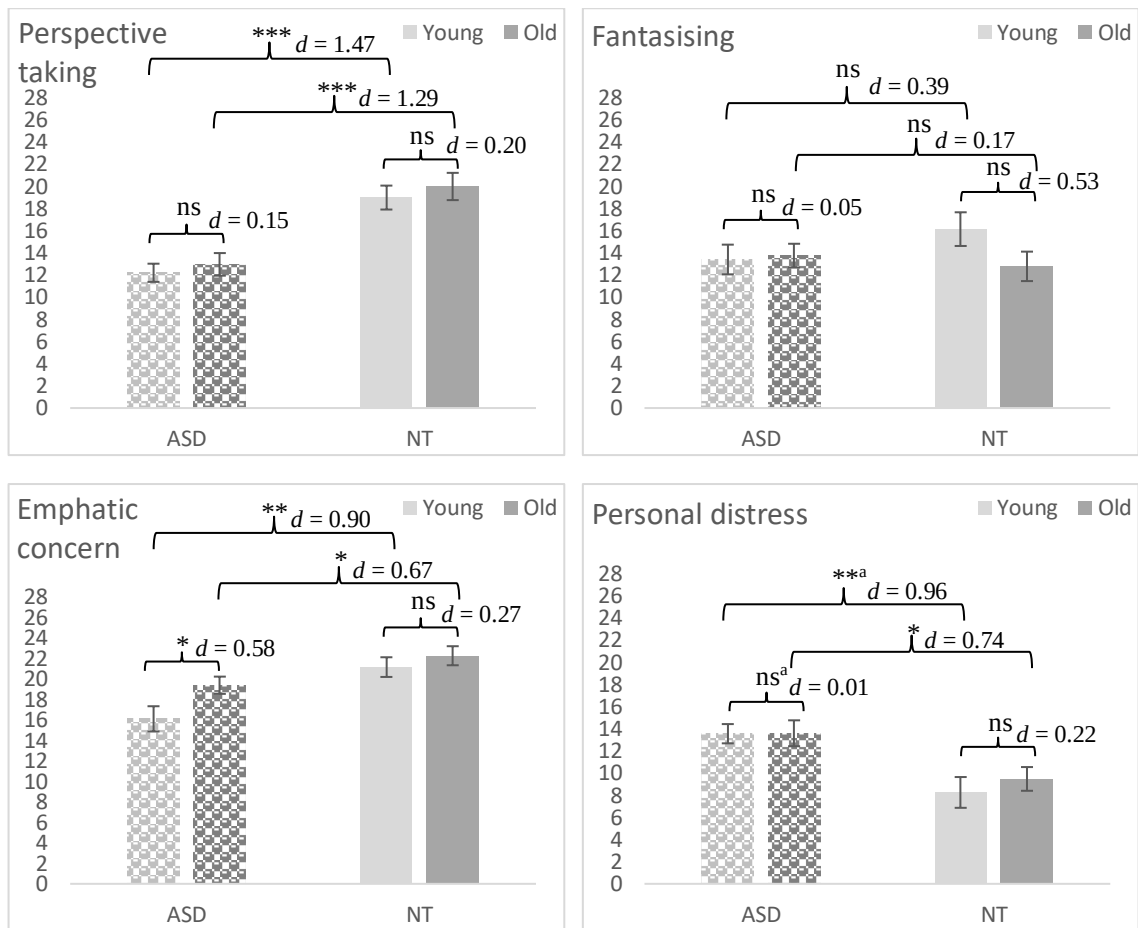
^a Bootstrap derived
^{ns} $p > .05$, * $p < .05$, *** $p < .001$

Figure 6-8 Mean alexithymia (TAS-20) scores of young and old adults in ASD and NT groups, with effect sizes marked for information

Separate two-way ANOVA analyses were conducted to examine **empathy skills** as self-reported on the IRI. A significant study group effect on perspective taking was found. Main effect of age group and the interaction effect of age group by study group were both non-significant. This showed that adults with ASD were poorer at taking other' perspectives (M=12.59, SD=4.94) compared to NT controls (M=19.49, SD=5.06). No significant main effect of study group or age group nor interaction effect between the two was found on fantasising subscale score. This showed that groups were similar in terms of fantasising. There was a significant main effect of study group and

age group on empathic concern, with a non-significant interaction effect between the two. This indicated that adults with ASD compared to NT adults ($M=17.74$, $SD=5.87$ vs $M=21.69$, $SD=4.16$, respectively) and young adults compared to old adults ($M=18.16$, $SD=6.26$ vs $M=20.52$, $SD=4.54$, respectively) in general reported less empathic concern for others. A significant main effect of study group on personal distress was found. However, there was no significant age group effect nor interaction effect of age group by study group on personal distress. This showed that adults with ASD felt more personal distress than NT controls ($M=13.57$, $SD=5.52$ vs $M=8.85$, $SD=5.48$, respectively) (Table 6-15).

Figure 6-9 shows performance for the ASD and NT young and old groups with effect sizes shown for exploratory purposes, which were in parallel with factorial ANOVA results.



^a Bootstrap derived

ns $p > .05$, * $p < .05$, ** $p < .01$, *** $p < .001$

Figure 6-9 Mean empathy scores (IRI) of young and old adults in ASD and NT group, with effect sizes marked for information

6.4.3.2 Summary of Age Group and Study Group Effects on Social Cognition

To sum up, age-related effects on ToM performance differed between ASD and NT groups. Young and old adults with ASD had similar ToM performance, whereas young NT adults outperformed old NT adults. Adults with ASD had more alexithymia and lower self-rated empathy skills compared to NT adults regardless of age.

6.4.3.3 Study Group and Age Group Effects on Local - Global Processing Ability

Local and global processing performance by young and old adults with and without ASD was tested on three different measures, and analysed with two-way

ANOVAs and mixed design ANOVA (for the Phoneme Segmentation Task) (Table 6-16).

Table 6-16 Performance of young and old adults in ASD and NT groups on the local-global processing tasks, the Embedded Figures Test (EFT), the Fragmented Pictures Task and the Phoneme Segmentation Task: Mean (SD)

		ASD		NT		F ²	p-value	effect size: η^2
		Young N = 29	Old N = 29	Young N = 20	Old N = 19			
EFT	Accuracy (max = 12)	11.69 (0.60)	11.24 (1.81)	11.85 (0.37)	10.95 (1.51)	0.07 ^{group} 6.82^{age*} 0.77 ^{agexgroup}	.80 ^{group} .011 ^{age} .38 ^{agexgroup}	.001 ^{group} .07 ^{age} .01 ^{agexgroup}
	RT ¹ per item	12.41 (7.08)	11.24 (6.74)	11.15 (5.82)	18.28 (12.75)	2.89 ^{group} 3.08 ^{age} 5.98^{agexgroup*}	.09 ^{group} .08 ^{age} .016 ^{agexgroup}	.03 ^{group} .03 ^{age} .06 ^{agexgroup}
Fragmented Pictures Task	Mean Frame number for correct identification (max = 8)	5.11 (0.76)	5.35 (0.49)	4.83 (0.58)	5.79 (0.55)	0.39 ^{group} 22.11^{age***} 7.99^{agexgroup**}	.53 ^{group} < .001 ^{age} .006 ^{agexgroup}	.004 ^{group} .19 ^{age} .08 ^{agexgroup}
Phoneme Segmentation Task	Accuracy	Target Absent (max = 15)	12.55 (1.96)	12.48 (1.64)	12.60 (1.64)	12.32 (1.38)	N/A	N/A
		Target Initial (max = 15)	13.31 (2.27)	14.03 (1.40)	13.05 (3.02)	14.53 (1.17)	N/A	N/A
		Target medial/final (max = 15)	12.45 (2.46)	11.41 (2.57)	13.30 (1.89)	13.53 (2.22)	N/A	N/A
	RT ¹	Target absent	1.21 (0.43)	1.29 (0.52)	1.00 (0.60)	1.24 (0.31)	N/A	N/A
		Target initial	0.72 (0.40)	0.73 (0.41)	0.54 (0.42)	0.66 (0.27)	N/A	N/A
		Target medial/final	1.22 (1.12)	1.11 (0.54)	0.84 (0.53)	0.99 (0.28)	N/A	N/A

¹ Response Time in seconds

² All $df_M s = 1$ and $df_R s = 93$

^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group

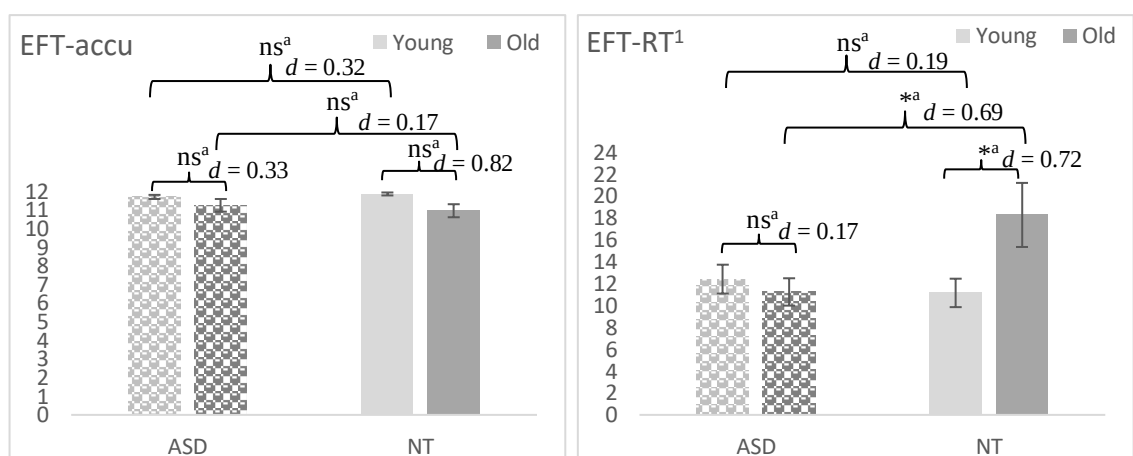
* $p < .05$, ** $p < .01$, *** $p < .001$

N/A: data were analysed using a different statistical method; please see below.

Embedded Figures Test: There was a significant main effect of age group on EFT accuracy score. Main effect of study group and interaction effect between age group and study group on EFT accuracy score were both non-significant. This showed

that young adults tend to detect embedded figures more accurately than old adults in general ($M=11.76$, $SD=0.52$ vs $M=11.13$, $SD=1.68$). Main effects of study group and age group on EFT response time were both non-significant. However, there was a significant interaction effect of age group by study group on EFT response time. Specifically, young adults ($M=11.15$, $SD=5.82$) outperformed old adults ($M=18.28$, $SD=12.75$) in the NT group; whereas performance by young ($M=12.41$, $SD=7.08$) and old ($M=11.24$, $SD=6.74$) adults with ASD was similar (Table 6-16).

Figure 6-10 shows performance for the ASD and NT young and old groups with effect sizes shown for exploratory purposes, which were in parallel with factorial ANOVA results.



¹ Response Time

^a Bootstrap derived

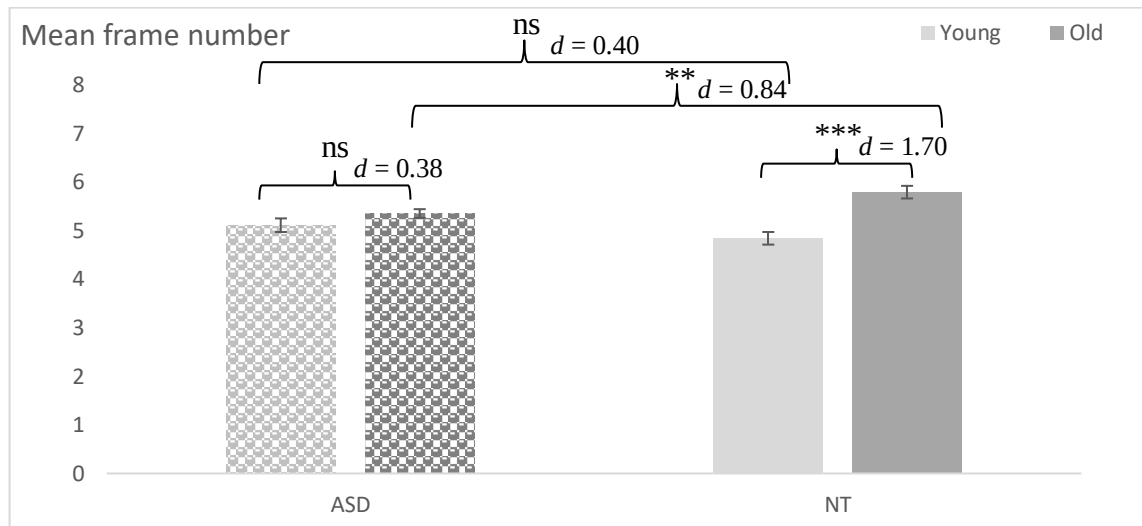
^{ns} $p > .05$, ^{*} $p < .05$

Figure 6-10 Mean EFT accuracy scores and response time (in seconds) of young and old adults in ASD and NT groups, with effect sizes marked for information

Fragmented Pictures Task: There was no significant group effect on the mean frame number at which fragmented pictures identified correctly was non-significant. However, age group effect and interaction effect of age group by study group were both significant. Specifically, young adults ($M=4.83$, $SD=0.58$) outperformed old adults

($M=5.79$, $SD=0.55$) in the NT group; whereas performances of young ($M=5.11$, $SD=0.76$) and old ($M=5.35$, $SD=0.49$) adults with ASD were similar (Table 6-16).

Figure 6-11 shows exploratory pairwise comparison results for fragmented pictures performance with effect sizes on the graph, which were in parallel with factorial ANOVA results.



$^{ns}p > .05$, $^{**}p < .01$, $^{***}p < .001$

Figure 6-11 Mean frame number of correct identification of fragmented pictures in study (ASD / NT) and age (Young / Old) groups, with effect sizes marked for information

Phoneme Segmentation Task: The effect of phoneme position was tested by using mixed design ANOVA for accuracy and reaction time scores (separately) with study and age groups as the between-subjects factors and phoneme position (initial vs. medial/final) as the within-subjects factor. There was a significant main effect of study group on the accuracy score ($F(1, 93) = 4.44$, $p < .05$, $\eta^2 = .05$), showing that performance of adults with ASD was poorer than NT adults in general ($M=12.80$, $SD=1.84$ vs $M=13.59$, $SD=1.82$, respectively). There was a main effect of phoneme position on accuracy score, showing that participants in both groups detected the phoneme more often when it was at the initial position rather than medial or final ($F(1,$

93) = 17.09, $p < .001$, $\eta^2 = 0.16$). Interaction effects of phoneme position by study group and phoneme position by age group on accuracy scores were both significant ($F(1, 93) = 7.13$, $p < .01$, $\eta^2 = 0.07$ and $F(1, 93) = 8.64$, $p < .01$, $\eta^2 = 0.09$, respectively), whereas the three-way interaction (i.e. phoneme position x age group x study group) was not ($F(1, 93) = 0.25$, $p = .62$, $\eta^2 = 0.003$). The significant interaction between phoneme position and study group indicated that while adults with ASD were poor in detecting phonemes when they were in the medial or final position rather than initial ($M=11.93$, $SD=2.55$ vs $M=13.67$, $SD=1.90$, respectively), adults in the control group did equally well in both positions ($M=13.41$, $SD=2.04$ vs $M=13.77$, $SD=2.40$, respectively). The significant interaction between phoneme position and age group indicated that old adults were worse at detecting phonemes in the medial or final position compared to the initial position ($M=12.25$, $SD=2.63$ vs $M=14.23$, $SD=1.32$, respectively), whereas young adults' performances in both positions were similar ($M=12.80$, $SD=2.26$ vs $M=13.20$, $SD=2.57$) (Figure 6-12).

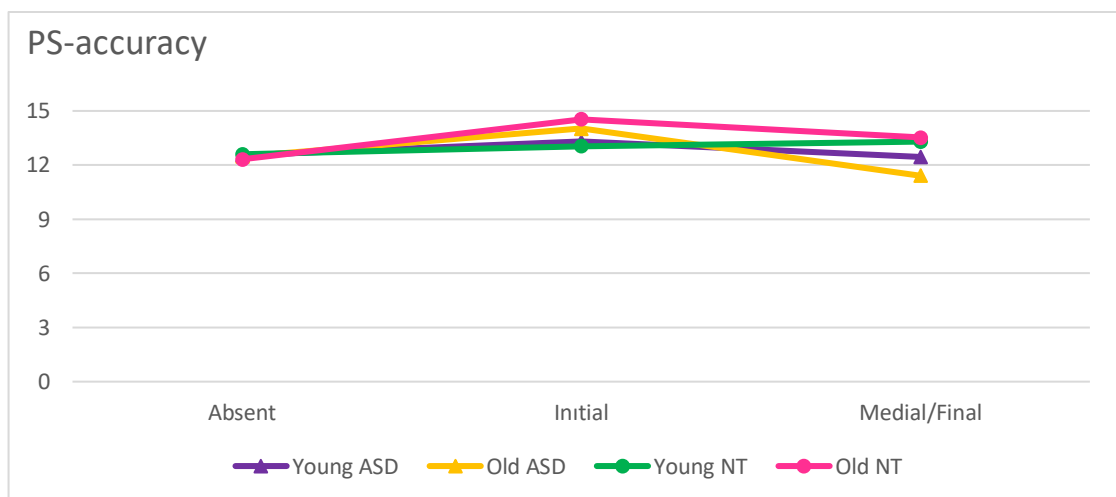
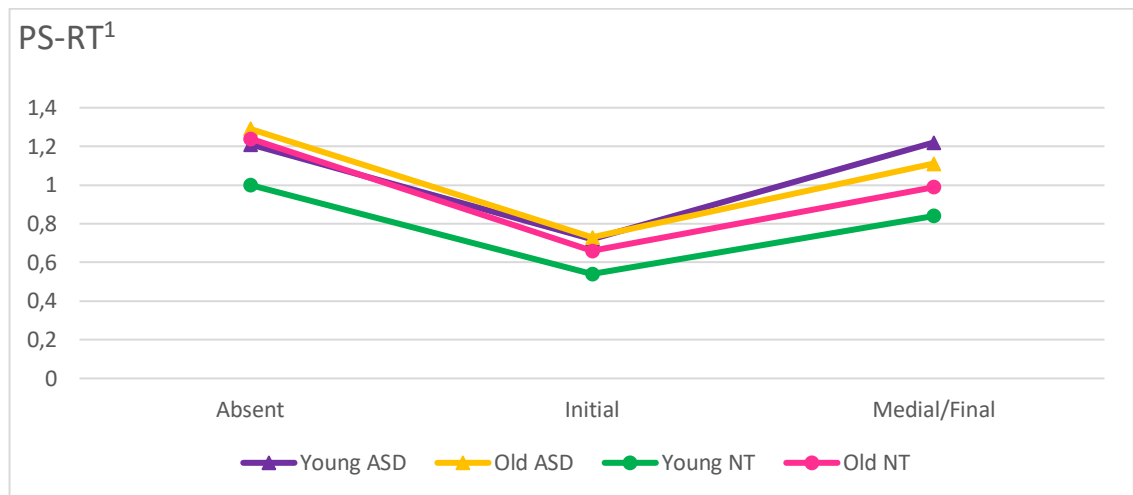


Figure 6-12 Mean number of correctly detected phonemes in the target-absent, -initial and -medial/final position in the Phoneme Segmentation Task in study (ASD / NT) and age (Young / Old) groups: Mean

The only significant effect on reaction time of detecting phonemes at initial vs. final/medial position, was the phoneme position, $F(1, 93) = 50.63, p < .001, \eta^2 = 0.35$. This indicated that all groups detected the target phoneme faster when it was at the initial position rather than medial / final position (Figure 6-13).



¹Reaction time in seconds

Figure 6-13 Mean reaction time (in seconds) for correctly detected phonemes in the target-absent, -initial and -medial/final position in the Phoneme Segmentation Task in study (ASD / NT) and age (Young / Old) groups: Mean

An index score of relative difficulty of disembedding target phonemes across target initial versus medial/final trials was calculated for each individual, based on the difference between mean reaction time of target-medial/final and target-initial trials divided by mean reaction time of target medial/final trial:

$$\frac{(\text{Mean reaction time of target medial or final}) - (\text{Mean reaction time of target initial})}{(\text{Mean reaction time of target medial or final})}$$

A two-

way ANOVA was conducted to test possible effects of age and study groups. None of the effects were significant: $F(1, 93) = 0.29, p = .59, \eta^2 = .003$ for main effect of the study group, $F(1, 93) = 0.44, p = .51, \eta^2 = .01$ for main effect of the age group and $F(1, 93) = 0.56, p = .46, \eta^2 = .01$ for an interaction effect of age group by study group.

This indicated that groups did not differ in terms of relative effect of phoneme position, which was in line with the mixed-design ANOVA findings above.

6.4.3.4 Summary of Age Group and Study Group Effects on Local-Global Processing Ability

To summarise results, age-related effects on both visual-local processing and visual-global processing performance differed between ASD and NT groups. Performance of young and old adults with ASD on these skills were similar, while young NT adults outperformed old NT adults. However, for auditory local-processing performance there was a general advantage for young adults in both study groups and adults with ASD had poorer performance than NT adults in general.

6.4.4 Associations between QoL and Cognitive Skills in Study Groups

To reduce the chance of type 1 error due to multiple comparisons, associates and predictors of global QoL only was examined in the following analyses, given the high inter-correlation with other subscales of the WHOQOL in both study groups (please see Chapter 4).

6.4.4.1 Associations between QoL and Social Cognition

Global QoL was not significantly associated with ToM or empathy skills in either study group. Alexithymia was significantly and negatively correlated with global QoL in the ASD group only, showing that more alexithymia was associated with poor QoL. A negative association between QoL and alexithymia was also observed in the NT group although this was not significant. However, Fisher's r -to- z transformation results showed that correlation coefficients of study groups were not significantly different, $z = -0.46$, $p = .33$ (Table 6-17).

Table 6-17 Associations between QoL (WHOQOL) and social cognition (composite ToM, TAS-20 and IRI) scores in ASD and NT groups

		ToM	Alexithymia	Empathy			
				PT	F	EC	PD
ASD	Qol_Global	-.17 ^{ns} (<i>p</i> =.20)	-.32 ^{*(a)}	.02 ^{ns} (<i>p</i> =.88)	.03 ^{ns} (<i>p</i> =.83)	.04 ^{ns(a)} (<i>p</i> =.78)	.06 ^{ns} (<i>p</i> =.64)
NT	Qol_Global	.07 ^{ns(a)} (<i>p</i> =.68)	-.23 ^{ns(a)} (<i>p</i> =.17)	.31 ^{ns(a)} (<i>p</i> =.06)	-.11 ^{ns(a)} (<i>p</i> =.50)	.12 ^{ns(a)} (<i>p</i> =.46)	-.16 ^{ns(a)} (<i>p</i> =.34)

^(a)Spearman's rho

^{ns}*p* > .05, **p* < .05

Associations between global QoL score and alexithymia subscores were further examined in both study groups. Difficulties with identifying feelings were significantly and negatively correlated with global QoL score in both study groups. There was a significant relationship between difficulties with describing feelings and QoL in the ASD group only, but Fisher's *r* to *z* transformation results showed that correlation coefficients between study groups did not differ significantly (*z*=0.81, *p*=.21). Externally oriented thinking score was not related to QoL in either group (Table 6-18).

Table 6-18 Associations between QoL (WHOQOL) and alexithymia subscores (TAS-20) in ASD and NT groups

		Alexithymia		
		IF	DF	EOT
ASD	Qol_Global	-.32*	-.36**	.03 ^{ns} (<i>p</i> =.85)
NT	Qol_Global	-.41 ^{*(a)}	-.20 ^{ns(a)} (<i>p</i> =.23)	.09 ^{ns(a)} (<i>p</i> =.57)

^(a)Spearman's rho

^{ns}*p* > .05, **p* < .05

6.4.4.2 Associations between QoL and Local-Global Processing Ability

Local-global performance was not associated with global QoL score in the ASD group. However, in the NT group, global processing performance on the Fragmented Pictures Task and global QoL score were significantly and negatively associated. Fisher's *r*-to-*z* transformation results showed that the correlation coefficients of study groups were significantly different, *z* = -2.50, *p* = .006. Thus NT adults with poorer QoL

scores had poorer global processing skills. However, after controlled for IQ, the significant correlation between QoL and visual global processing skill in the NT group did not survive.

Table 6-19 Associations between QoL (WHOQOL) and local-global performance processing (EFT; Fragmented Pictures Task; Phoneme Segmentation Task) in ASD and NT groups

		EFT		Fragmented Pictures Task - Mean Frame Number	Phoneme Segmentation Task – Relative Effect of Phoneme Position (RT ¹)
		Accuracy	RT ¹ (per item)		
ASD	QoL_Global	-.01 ^{ns(a)} (<i>p</i> =.92)	-.08 ^{ns(a)} (<i>p</i> =.58)	.19 ^{ns} (<i>p</i> =.16)	.06 ^{ns} (<i>p</i> =.67)
NT	QoL_Global	.11 ^{ns(a)} (<i>p</i> =.51)	-.23 ^{ns(a)} (<i>p</i> =.15)	-.33 ^{*(a)}	-.08 ^{ns(a)} (<i>p</i> =.63)

¹Response / Reaction Time

^(a)Spearman's rho

^{ns}*p* > .05, ^{*}*p* < .05

In Chapter 4, strong correlates of QoL scores were investigated based on age, intellectual ability and severity of psychiatric conditions using multiple regression analysis. Since in this chapter a number of additional significant correlates were found, multiple regression analysis for global QoL was re-run including these variables as possible predictors; however, additional associates did not make any difference.

6.4.5 Summary of Associations between QoL and Cognitive Skills in Study Groups

To sum up, in the ASD group there were significant associations between social cognition (especially alexithymia) and QoL. These associations were less apparent in the NT group. Although a number of significant cognitive associates of global QoL were found for both study groups, they did not make any changes on the best predictors of QoL: severity of depression for the ASD group and severity of OCD for the NT group.

6.4.6 Associations between ASD Traits and Cognitive Skills in Study Groups

6.4.6.1 Associations between ASD Traits and Social Cognition

6.4.6.1.1 Associations between ASD Traits and ToM

Total ASD trait score was not significantly related to ToM ability in either study group. However, at subscale level, social and communication difficulties were significantly and negatively correlated with ToM ability in the NT group (Table 6-20). Thus adults in the NT group who had more social and communication problems also had poorer ToM skills. When correlation coefficients of the two study groups were compared using Fisher's z to r transformation, it was found that they were not significantly different from each other, $z=-0.99$, $p=.16$. However, after controlled for IQ, the significant correlation between ToM and SCI score in the NT group did not survive.

Table 6-20 Associations between ASD traits (SRS-2) and composite ToM score in ASD and NT groups

		SRS-2		
		Total	SCI	RRB
ASD	ToM	-.14 ^{ns} ($p=.28$)	-.13 ^{ns} ($p=.35$)	-.21 ^{ns} ($p=.11$)
NT	ToM	-.31 ^{ns(a)} ($p=.06$)	-.33 ^{*(a)}	-.19 ^{ns(a)} ($p=.25$)

^(a)Spearman's rho

^{ns} $p > .05$, ^{*} $p < .05$

6.4.6.1.2 Associations between ASD Traits and both Alexithymia and Empathy

Associations of ASD trait scores with both alexithymia and empathy were examined across study groups. In both study groups, total ASD trait score were significantly and positively associated with total alexithymia score. Specifically, ASD trait scores were significantly and positively related to difficulties in both identifying and describing emotions as well as in making decisions based on feelings. The latter was not significant in the NT group; however, Fisher's r to z transformation results

showed that correlation coefficients of study groups did not differ significantly, $z=-0.77$, $p=.22$. None of the empathy scores were significantly related to the ASD trait scores in the ASD group, whereas there was a significant and negative correlation between ASD traits and perspective taking in the NT group. Fisher's r to z transformation results showed that correlation coefficients for this association were not significantly different between study groups, $z=-1.16$, $p=.12$. (Table 6-21).

Table 6-21 Associations between ASD traits (SRS-2) and alexithymia (TAS-20) or empathy (IRI) scores in ASD and NT groups

			Alexithymia				Empathy			
			Total	IF	DF	EOT	PT	F	EC	PD
ASD	ASD traits	Total	.76***	.61***	.69***	.45***	-.22 ^{ns} ($p=.10$)	-.02 ^{ns} ($p=.89$)	-.19 ^{ns(a)} ($p=.15$)	.22 ^{ns} ($p=.09$)
NT	ASD traits	Total	.57***	.62***	.46**	.31 ^{ns} ($p=.06$)	-.44**	-.27 ^{ns} ($p=.10$)	-.26 ^{ns} ($p=.11$)	.21 ^{ns} ($p=.19$)

^(a)Spearman's ρ

^{ns} $p > .05$, ** $p < .01$, *** $p < .001$

Associations with ASD traits were further examined at subscale level. Both SCI and RRB subscale scores were significantly and positively associated with alexithymia scores in both study groups. Associations were also significant for alexithymia subscores in both groups, except for non-significant associations between RRB and both difficulties with describing feelings and externally oriented thinking in the NT group. However, it should be noted that groups' correlation coefficients were significantly different for only describing feelings ($z=-1.71$, $p=.04$), but not for externally oriented thinking score ($z=-1.55$, $p=.06$) (Table 6-22).

Table 6-22 Associations between ASD traits subscales (SRS-2) and alexithymia (TAS-20) or empathy (IRI) scores in ASD and NT groups

			Alexithymia				Empathy
			Total	IF	DF	EOT	PT
ASD	ASD traits	SCI	.75***	.60***	.70***	.45***	-.21 ^{ns} (<i>p</i> =.11)
		RRB	.66***	.61***	.56***	.33*	-.17 ^{ns} (<i>p</i> =.20)
NT	ASD traits	SCI	.58***	.64***	.50**	.33*	-.42**
		RRB	.32*	.47**	.26 ^{ns} (<i>p</i> =.11)	.01 ^{ns} (<i>p</i> =.95)	-.24 ^{ns} (<i>p</i> =.13)

^(a)Spearman's rho

^{ns}*p* > .05, **p* < .05, ***p* < .01, ****p* < .001

There was a significant and negative relationship between SCI score and perspective taking in the NT group. This relationship was not significant in the ASD group, but correlation coefficients were not significantly different when compared using Fisher' r to z transformation, $z=-1.09$, $p=.14$ (Table 6-22).

6.4.6.2 Associations between ASD Traits and Local-Global Processing Ability

No significant associations were found between ASD trait scores and local-global processing performance in the ASD group, whereas ASD traits were significantly and negatively associated with visual local processing task performance in the NT group (Table 6-16). NT adults who had fewer ASD traits had better visual local processing skills. This correlation was still significant when controlled for IQ. Fisher's r to z transformation results showed that correlation coefficients of study groups were significantly different, $z=-2.42$, $p=.008$.

Table 6-23 Associations between severity of ASD traits (SRS-2) and local-global processing (EFT; Fragmented Pictures Task; Phoneme Segmentation Task) in ASD and NT groups

			EFT		Fragmented Pictures Task - Mean Frame Number	Phoneme Segmentation Task – Relative Effect of Phoneme Position (RT ¹)
			Accuracy	RT ¹ (per item)		
ASD	ASD traits	Total	.07 ^{ns(a)} (<i>p</i> =.58)	.03 ^{ns(a)} (<i>p</i> =.82)	-.04 ^{ns} (<i>p</i> =.75)	-.05 ^{ns} (<i>p</i> =.70)
NT	ASD traits	Total	-.42 ^{**} (a)	-.03 ^{ns(a)} (<i>p</i> =.84)	.11 ^{ns(a)} (<i>p</i> =.52)	.02 ^{ns(a)} (<i>p</i> =.92)

¹Response / Reaction Time

^(a)Spearman's rho

^{ns}*p* > .05, ^{**}*p* < .01

The significant association between ASD traits and visual local processing was further examined at subscale level of ASD traits. Both subscales were significantly and negatively associated with visual local processing task performance, indicating that NT adults who had fewer ASD traits had better visual local processing skills.

Table 6-24 Associations between ASD trait subscales (SRS-2) and visual local processing (EFT) in the NT group

		EFT_Accuracy
ASD traits	SCI	-.42 ^{**}
	RRB	-.34 [*]

¹Response / Reaction Time

All correlation coefficients are Spearman's rho

^{ns}*p* > .05, ^{*}*p* < .05, ^{**}*p* < .01

6.4.6.3 Summary of Associations between ASD Traits and Cognitive Skills in Study Groups

To summarise, results showed that associations between ASD traits and social cognition (especially alexithymia) were present in both study groups. However, ASD traits and visual local processing were correlated in the NT group only. Alexithymia was related to having more ASD traits in both study groups. Poor visual local processing performance was associated with higher ASD traits in the NT group, but not in the ASD group.

6.4.7 Associations among Cognitive Skills in Study Groups

6.4.7.1 Associations among Different Aspects of Social Cognition

6.4.7.1.1 Associations between ToM and both Alexithymia and Empathy

In both study groups, ToM skill and total alexithymia score was not significantly associated. Empathy scores and ToM ability were not significantly associated in both groups, except for a significant and negative relationship between ToM and empathic concern score. This showed that adults who had poorer ToM performance were more likely to report feeling less concern for others. Fisher's r-to-z transformation results showed that correlation coefficients of study groups were significantly different for empathic concern, $z = -1.72$, $p = .04$ (Table 6-25).

Table 6-25 Associations between composite ToM score and alexithymia (TAS-20) or empathy (IRI) in ASD and NT groups

		Alexithymia	Empathy			
			PT	F	EC	PD
ASD	ToM	-.24 ^{ns(a)} ($p = .07$)	.18 ^{ns} ($p = .19$)	.17 ^{ns} ($p = .21$)	.29 ^{*(a)}	-.22 ^{ns} ($p = .11$)
NT	ToM	.04 ^{ns(a)} ($p = .80$)	-.08 ^{ns(a)} ($p = .65$)	.23 ^{ns(a)} ($p = .17$)	-.07 ^{ns(a)} ($p = .69$)	-.04 ^{ns(a)} ($p = .83$)

^(a)Spearman's rho

^{ns} $p > .05$, $^*p < .05$

6.4.7.1.2 Associations between Alexithymia and Empathy Scores

Association between alexithymia and empathy was examined in each study group. In the ASD group, total alexithymia score was not significantly associated with any of the empathy scores. There was a significant and negative correlation between total alexithymia score and both perspective taking and personal distress in the NT group. Fisher's r-to-z transformation results showed that correlation coefficients of study groups were not significantly different for perspective taking ($z = -0.80$, $p = .21$) and ($z = 1.55$, $p = .06$).

Table 6-26 Associations between alexithymia (TAS-20) and empathy (IRI) scores in ASD and NT groups

			Empathy			
			PT	F	EC	PD
ASD	Alexithymia	Total	-.17 ^{ns(a)} (<i>p</i> =.22)	-.16 ^{ns(a)} (<i>p</i> =.24)	-.26 ^{ns(a)} (<i>p</i> =.05)	.20 ^{ns(a)} (<i>p</i> =.13)
NT	Alexithymia	Total	-.33*	-.18 ^{ns} (<i>p</i> =.27)	-.23 ^{ns(a)} (<i>p</i> =.17)	.49**

^(a)Spearman's rho

^{ns}*p* > .05, **p* < .05, ***p* < .01

Since the differences were not significant, alexithymia sub-scores were examined in both study groups in relationship with perspective taking and personal distress. Externally oriented thinking was significantly associated with perspective taking but not with personal distress in the ASD group. This indicated that adults with ASD who were able to make decisions based on emotions were better at taking perspectives of other people. In the NT group, a non-significant association between externally oriented thinking and perspective taking was found (but Fisher's r-to-z transformation results showed that correlation coefficients of study groups were not significantly different, $z = 0.05$, $p = .48$). Difficulties with identifying feelings were significantly correlated with both perspective taking and personal distress, showing that NT adults who had problems with identifying emotions felt more discomfort in tense social settings. Fisher's r-to-z transformation results showed that correlation coefficients of study groups were significantly different for perspective taking ($z = -1.67$, $p = .04$) but not for personal distress ($z = 1.04$, $p = .15$). Personal distress was also significantly related to difficulties with describing feelings of NT adults. Results showed that NT adults who had difficulties with identifying feelings had more problems with taking other people's perspectives and experienced more stress and worry in tense social settings. Adults who had problems with describing emotions were also feeling more personal distress in the NT group. Fisher's r-to-z transformation results showed that correlation coefficients of

study groups were significantly different for personal distress ($z= 2.11, p=.02$) (Table 6-27).

Table 6-27 Associations between alexithymia subscores (TAS-20) and empathy (IRI) scores in ASD and NT groups

		Empathy	
		PT	PD
ASD	IF	-.03 ^{ns} ($p=.81$)	.21 ^{ns} ($p=.12$)
	DF	-.12 ^{ns} ($p=.38$)	.02 ^{ns} ($p=.87$)
	EOT	-.28*	.10 ^{ns} ($p=.45$)
NT	IF	-.37 ^{*(a)}	.41 ^{*(a)}
	DF	-.23 ^{ns(a)} ($p=.15$)	.44 ^{** (a)}
	EOT	-.27 ^{ns} ($p=.10$)	.30 ^{ns} ($p=.07$)

^(a)Spearman's rho

^{ns} $p > .05$, * $p < .05$, ** $p < .01$

6.4.7.2 Associations between Social Cognition and Local-Global Processing Ability

6.4.7.2.1 Associations between ToM and Local-Global Processing Ability

There was a significant and negative association between ToM and both reaction time of visual local processing performance and visual global processing performance in both study groups, indicating that adults who had better ToM performance disembedded figures faster and also had better visual global processing. ToM performance of NT adults was also significantly and positively associated with accuracy score on the visual local processing task. It should be noted that the difference between correlation coefficients of study groups were just at the level of significance for this association, $z=1.63, p=.05$ (Table 6-28).

Table 6-28 Associations between composite ToM score and local-global processing performance (EFT; Fragmented Pictures Task; Phoneme Segmentation Task) in ASD and NT groups

		EFT		Fragmented Pictures Task - Mean Frame Number	Phoneme Segmentation Task – Relative Effect of Phoneme Position (RT ¹)
		Accuracy	RT ¹ (per item)		
ASD	ToM	.25 ^{ns(a)} (p=.06)	-.50 ^{***(a)}	-.56 ^{***}	.14 ^{ns} (p=.30)
NT	ToM	.54 ^{***(a)}	-.35 ^{*(a)}	-.45 ^{**(a)}	.09 ^{ns(a)} (p=.59)

¹Response / Reaction Time

^(a)Spearman's rho

^{ns}p > .05, *p < .05, **p < .01, ***p < .001

Partial correlations between ToM performance and local-global processing scores controlling for IQ showed that all associations survived except for the association between reaction time of EFT and ToM in the NT group.

6.4.7.2.2 Associations between Local-Global Processing Ability and both Alexithymia and Empathy

Associations between local-global processing performance and both alexithymia and empathy were generally not significant in both study groups (Table 6-29 and Table 6-30), except for a significant and negative relationship between mean frame number on the Fragmented Pictures Task and both fantasizing skill and empathic concern in the ASD group. This indicated that adults with ASD who had better global processing had poor fantasizing skills and felt less empathic concern for others (Table 6-29). However, it should be noted that Fisher's r-to-z transformation results showed that correlation coefficients between study groups were not significantly different for either fantasizing skill ($z = 0.66$, $p = .25$) or empathic concern ($z = 1.20$, $p = .12$).

Table 6-29 Associations between local-global processing performance (EFT; Fragmented Pictures Task; Phoneme Segmentation Task) and alexithymia (TAS-20) or empathy (IRI) scores in the ASD group

		EFT		Fragmented Pictures Task - Mean Frame Number	Phoneme Segmentation Task – Relative Effect of Phoneme Position (RT ¹)
		Accuracy	RT ¹ (per item)		
Alexithymia	Total	.05 ^{ns(a)} (<i>p</i> =.72)	-.05 ^{ns(a)} (<i>p</i> =.69)	.05 ^{ns(a)} (<i>p</i> =.71)	.06 ^{ns(a)} (<i>p</i> =.66)
Empathy	PT	.11 ^{ns(a)} (<i>p</i> =.43)	-.16 ^{ns(a)} (<i>p</i> =.24)	-.12 ^{ns} (<i>p</i> =.39)	.05 ^{ns} (<i>p</i> =.72)
	F	-.07 ^{ns(a)} (<i>p</i> =.58)	-.12 ^{ns(a)} (<i>p</i> =.36)	-.35**	-.13 ^{ns} (<i>p</i> =.35)
	EC	.09 ^{ns(a)} (<i>p</i> =.50)	-.15 ^{ns(a)} (<i>p</i> =.27)	-.28*(a)	-.10 ^{ns(a)} (<i>p</i> =.46)
	PD	-.01 ^{ns(a)} (<i>p</i> =.95)	.05 ^{ns(a)} (<i>p</i> =.72)	-.05 ^{ns} (<i>p</i> =.70)	.11 ^{ns} (<i>p</i> =.42)

¹Reaction Time

^(a)Spearman's rho

^{ns}*p* > .05, **p* < .05, ***p* < .01

Table 6-30 Associations between local-global processing performance (EFT; Fragmented Pictures Task; Phoneme Segmentation Task) and alexithymia (TAS-20) or empathy (IRI) scores in the NT group

		EFT		Fragmented Pictures Task - Mean Frame Number	Phoneme Segmentation Task – Relative Effect of Phoneme Position (RT ¹)
		Accuracy	RT ¹ (per item)		
Alexithymia	Total	.05 ^{ns(a)} (<i>p</i> =.76)	-.11 ^{ns(a)} (<i>p</i> =.51)	-.09 ^{ns} (<i>p</i> =.57)	-.08 ^{ns} (<i>p</i> =.64)
Empathy	PT	-.03 ^{ns(a)} (<i>p</i> =.84)	.25 ^{ns(a)} (<i>p</i> =.13)	.05 ^{ns} (<i>p</i> =.78)	-.21 ^{ns} (<i>p</i> =.20)
	F	.003 ^{ns(a)} (<i>p</i> =.99)	-.07 ^{ns(a)} (<i>p</i> =.65)	-.22 ^{ns} (<i>p</i> =.19)	-.12 ^{ns} (<i>p</i> =.48)
	EC	-.08 ^{ns(a)} (<i>p</i> =.62)	.13 ^{ns(a)} (<i>p</i> =.44)	-.03 ^{ns(a)} (<i>p</i> =.86)	-.03 ^{ns(a)} (<i>p</i> =.86)
	PD	-.05 ^{ns(a)} (<i>p</i> =.78)	-.23 ^{ns(a)} (<i>p</i> =.15)	.12 ^{ns} (<i>p</i> =.46)	.12 ^{ns} (<i>p</i> =.46)

¹Reaction Time

^(a)Spearman's rho,

^{ns}*p* > .05

6.4.7.3 Summary of Associations among Cognitive Skills in Study Groups

To sum up, significant associations among different cognitive skills (e.g., between ToM and visual local-global processing ability) were found in both study groups. However, non-significant associations (between alexithymia and local-global processing ability, were also present in both study groups. Inter-relationships between

some cognitive skills (e.g., between empathy and ToM) were significant in the ASD group only.

6.5 Discussion

This chapter reported age-related effects on cognitive skills, namely social cognition and local-global processing ability, in older adults with ASD compared to healthy controls. Inter-correlations among cognitive skills and associations between cognitive skills and both ASD traits and QoL were also examined in both study groups.

Results suggest that there may be a ‘protective’ age-related effect on theory of mind and visual local and global processing performance in the ASD group, whereas an age-related decline was found in the NT group. This finding is in keeping with the ‘safeguard hypothesis’ (Geurts & Vissers, 2012) and supports previous studies showing attenuated (although the interaction did not reach significance) ageing effects on ToM in old adults with ASD (Lever & Geurts, 2015). Age-related worsening on ToM tasks in the NT group was in line with findings from healthy ageing studies reporting age-related decline in ToM in older adults (e.g., Charlton et al., 2009; Maylor et al., 2002; Pardini and Nichelli, 2009; but see also Castelli et al., 2010; Happé et al., 1998; Li et al., 2012).

It is exciting to think that ToM may be preserved in older versus younger adults with ASD, such that older adults with ASD are no longer severely impaired in ToM task performance compared to NT peers. However, we should acknowledge the possibility that these results may reflect in part a selection effect. Studies of ageing in NT and other groups face a challenge to avoid ‘survivor’ effects; those elderly people most likely to volunteer for research at an advanced age are necessarily those who have relatively good functioning. Without using epidemiological sampling it is hard to avoid such

selection biases. However, in the present study we tried to avoid selection effects by recruiting young and old adults from similar sources. We succeeded in recruiting young and old ASD (and NT) samples matched for general intelligence, however, selection effects on other dimensions (e.g. interest in taking part, prosociality) cannot be entirely ruled out. On the other hand, selection and survivor effects might be expected to apply to both NT and ASD groups, so our finding of age related decline in the former but not the latter is still surprising.

Why might older ASD adults show preserved ToM performance compared to their NT peers? One possibility would be a genuine difference in brain maturation. However, an alternative explanation might involve compensation. Perhaps older adults with ASD have had longer than younger adults to devise compensatory routes to ToM task success. Or maybe a lifetime of trying to puzzle out social situations without intuitive ToM, which autobiographical reports describe as like doing mental arithmetic, effectively serves as ‘brain training’, thought to stave off cognitive decline in the elderly. These questions should be explored in future studies, using neuroimaging, implicit ToM tasks, or intervention techniques.

ASD advantage in weak central coherence was not found. The apparent age-related protective effect on both local and global processing skills in the ASD group in contrast to age-related decline on both skills in the NT group was difficult to interpret. Findings from healthy ageing studies are rather mixed. Studies have reported an intact global precedence in old adults (Bruyer & Scailquin, 2000; Bruyer, Scailquin, & Samson, 2003; Georgiou-Karistianis et al., 2006; Roux & Ceccaldi, 2001), but also reduced global processing performance sometimes accompanied with increased local processing bias (Lux et al., 2008; Oken et al., 1999). In the present work, an age-related

decline in visual global processing ability in the NT group partly supports the latter finding. However, in the same group age-related decline on visual local processing performance contradicts with the literature. A reason for this unexpected result might be due to the confounding effects on visual local processing task performance; such as processing speed. Confounding effects should also be considered when interpreting the age-related protective effect on both local and global processing tasks in the current work.

In Chapter 4, the correlates and predictors of QoL were examined. QoL was significantly poorer in the ASD group compared to NT group, but age was not a predictor of QoL in either group. Instead, the best predictors of QoL were severity of depression in the ASD group and severity of OCD in the NT group. In the present chapter, a number of significant associations were found between QoL and cognitive skills in both groups. However, adding these to the regression analysis showed that, although competence in ASD-related cognitive skills was linked to QoL, mental health problems were the strongest predictors of quality of life.

Adults with ASD had more self-rated alexithymia and lower empathy skills than the NT group regardless of age. However, adults with ASD reported feeling more personal distress in tense social settings compared to NT adults, which was also found previously in young adults with ASD (Rogers et al., 2007). Although feeling more personal distress in social setting is regarded as an indicator of greater empathy, this association could be due to the high level of anxiety that adults with ASD experience in social situations. This finding should be explored in future experimental studies, going beyond simple self-report, perhaps using physiological markers (e.g. skin conductance). Young adults had lower empathic concern scores than old adults in both NT and ASD

groups in the present study. It is interesting to see that the older adults with ASD, just like their peers, show more concern for others than younger adults.

Inter-correlations between different aspects of ASD-related cognitive skills have been examined in earlier studies of children with ASD, in part to test the fractionated triad account, although findings are mixed (see Brunsdon & Happé, 2014 for a detailed review). To our knowledge inter-relations among different aspects of ASD-related skills have not been investigated in adults with ASD, so these results, although exploratory, represent the first preliminary findings for the literature.

Knowing whether cognitive impairments in ASD adults are fractionable has important implications for genetic studies, clinical practice and developing interventions. The theory not only explains the heterogeneity of this condition among individuals, but also brings personalised intervention and support to the fore. For example, meeting needs of these individuals and provision of support should differ based on multi-dimensional assessment of distinct difficulties. Fractionation was evident in our data when inter-correlations among cognitive skills were tested. Performance on local-global processing tasks were associated with ToM and empathy but not with alexithymia, and associations between empathy and alexithymia mostly applied in the NT group only. A strong version of the fractionated triad account predicts unique and specific associations between different cognitive characteristics and different ASD symptoms. Significant associations between cognitive skills could not always be found in the ASD group. For example, ToM and cognitive empathy (perspective taking) skills were significantly and negatively associated with social and communication difficulties in the NT group only, although correlation coefficients did not differ significantly between study groups. Visual local processing ability was

significantly and negatively correlated with ASD traits in the NT group only. These results do not fully support the fractionated triad account.

In the present study a novel ToM designed for the purpose of this work was used. The task had reduced memory demands and based on visual images rather than verbal vignettes. Using tasks with low memory demands is very useful in ageing studies to control effects of ageing on memory skills that are likely to interfere with task performance. Stories depicted by images are suitable for the targeted age-group (i.e. young and old adults) and the measure was suitable to use in-person testing sessions as well as postal surveys. Adequate-to-substantial psychometric properties of the task were found, although further validity and reliability studies are needed.

6.5.1 Limitations

The present work has some limitations that should be considered for interpretation of the findings. As for the previous studies, low power due to relatively small sample size is a limitation and the cross-sectional design used in this study may be subject to cohort effects. It was attempted to reduce the risk of Type 1 error by, for example, creating composite score for ToM performance and testing possible predictors for only global QoL score. Also, as indicated in Chapter 4, the author attempted to minimize any bias in group selection, by recruiting young and old participants from similar sources. However, future longitudinal studies are needed including higher number of older adults aged over 70 years.

6.6 Conclusion

This study was a part of a larger study also investigating ASD traits, QoL and self-reported mental health difficulties in young and old adults with ASD (see Chapter 4). In the current part of the study, it was demonstrated that there may be a protective

age-related effect on ToM and local-global processing skills in the ASD group. Adults with ASD reported more alexithymia symptoms and less empathy skills compared to NT group in general. However, adults with ASD also reported feeling more personal distress in tense social settings than NT adults. Inter-correlations among cognitive skills, as well as between cognitive skills and both ASD traits and QoL in study groups were discussed.

Chapter 7 Wellbeing in Grandparents of Children with Autism Spectrum Disorder (ASD); an Exploration of Quality Of Life In Relation to Autistic Traits and Social Cognition in Older Adults

7.1 Introduction

Autism is increasingly seen as lying at the extreme of a normal distribution of traits, with many studies using dimensional measures of autistic-like social and communication difficulties in nonclinical samples (e.g. Baron-Cohen et al., 2001; Constantino et al., 2006; Hoekstra et al., 2008; Robinson et al., 2011). Since early work by Folstein and Rutter (1977a, 1977b), both twin and family studies have reported evidence for substantial heritability of ASD and autistic traits (Ronald and Hoekstra, 2011). The ‘Broader Autism Phenotype’ (BAP) has been defined as autism-related characteristics that are more common in relatives of individuals with autism spectrum disorder (ASD) than in the general population, and which reflect the genetic underpinnings of the condition (Bolton et al., 1994; Folstein & Rutter, 1977a, 1977b; Wolf, Narayan, & Moyes, 1988).

The first descriptions of BAP came from Kanner’s (1943) and Asperger’s (1944; translation by Frith 1991) case reports, indicating that ASD-like traits could be observed in parents of individuals with ASD. The first detailed review of BAP was reported in the late 1990’s (Bailey et al., 1998), and since that time there has been an increase in interest in these sub-clinical ASD traits and taking a dimensional approach to ASD in the general population.

Scarcely any studies have examined BAP in elderly people, despite the demographic trend for longer life and an ageing population. The present study, complementing the other work reported in this thesis, takes a dimensional approach to

explore BAP, social cognition and quality of life in grandparents of individuals with ASD. Given the substantial heritability of ASD and related traits, biological grandparents of individuals with ASD are expected to be a group enriched for the ‘broad autism phenotype’, including both behavioural traits and cognitive characteristics. To frame this work, a brief review of previous research on BAP is presented below.

7.1.1 Research on the ‘Broad Autism Phenotype’

BAP can be examined at different levels, such as behavioural, cognitive, and biological levels. The behavioural level refers to the observable impairments/characteristics, which are used for clinical diagnosis in individuals with ASD. Cognitive level includes cognitive skills and difficulties (e.g. social cognition, executive functions, and central coherence) that are likely to differ between people with ASD and the neurotypical population. Studying genetic, neuroanatomical and neuro-functional features related to ASD, represents the biological level of BAP research. Since the present study examines only the former two levels, the biological level BAP research will not be reviewed here (but see, e.g., Sucksmith, Roth, & Hoekstra, 2011).

In the present work, the term BAP is used interchangeably with ASD-related traits/behavioural characteristics, whereas social cognition, alexithymia and empathy are referred to as possible endophenotypes of ASD, because they lie under the level of behaviour and possibly closer to the etiological cause. The present study also examined psychiatric conditions, such as social phobia and obsessive-compulsive disorder, since these have been suggested as possible components of the BAP (e.g. Bolton, Pickles, Murphy, & Rutter, 1998). However, since results are mixed regarding the association between psychiatric conditions and genetic liability for ASD (Bolton et al., 1998; Piven

& Palmer, 1999), mental health conditions/traits are included as a component of wellbeing rather than BAP in the current study.

To our knowledge, few studies examining BAP in biological relatives focused specifically on older adults (aged 50 years and over), except for three studies that included grandparents in their samples. Piven and colleagues (1997a) found elevated social deficits and stereotyped behaviours (assessed by the FHI; Bolton et al., 1994) in grandparents (N=96) of children from multiple-incidence autism families compared to grandparents (N=120) of children with DS (Piven, Palmer, Jacobi, Childress, & Arndt, 1997a). In the same sample, Piven and Palmer (1999) reported high rates of depression and anxiety (assessed by the Family History Interview: FHI; Bolton et al., 1994; Piven et al., 1997b) in grandparents (the age of the group was not specified) in multiple incidence autism families compared to age-matched control grandparents of those with Down Syndrome (Piven & Palmer, 1999). The last study, by Baron-Cohen and colleagues (1997), showed that grandfathers (as well as fathers) of individuals with autism were more likely to work in engineering compared to grandfathers (and fathers) of individuals with Tourette Syndrome (TS), suggesting that their understanding of physical systems might be better than their understanding of the social world. These findings were interpreted as supporting Baron-Cohen's: 'empathising versus systemising' or "folk-psychology / folk-physics theory" (Baron-Cohen et al., 1997, 2005; Wheelwright & Baron-Cohen, 2001).

Due to the scarce literature about old age and BAP, the literature review here was extended to BAP features, possible endophenotypes and wellbeing in adult biological relatives of individuals with ASD. Although there is also an extensive research literature about the BAP in younger siblings of children with ASD, this was beyond the scope of

the current review, given the adult focus of the present study. To our knowledge, studies examining milder forms of autistic features in adult relatives did not analyse possible age-effects, although they usually matched groups on the basis of age or controlled age as a possible covariate.

7.1.1.1 Behavioural Characteristics in Adult Relatives of Probands with ASD

In line with behavioural manifestation of ASD, behavioural characteristics of the BAP can be grouped as social and communication features (e.g. aloof personality traits and difficulties with the use of pragmatic language) and rigidity. These features have been reported at elevated levels in autism families (e.g., Dawson et al., 2007a). For example, in a recent study Maxwell and colleagues (2013) found that a higher number of parents (10% of mothers and 22% of fathers out of 245 parents) of individuals with autism met criteria for BAP (based on the criteria by Sasson et al., 2013a on the BAPQ; Hurley, Losh, Parlier, Reznick, & Piven, 2007) compared to non-clinical control parents (1% of mothers 7% of fathers out of 129 parents) (Maxwell, Parish-Morris, Hsin, Bush, & Schultz, 2013).

In the following section, a review of specific behavioural characteristics of the BAP together with gender-specific effects is been provided.

7.1.1.1.1 Social and Communication Features

Social and communication difficulties, manifested in different forms, have been extensively reported in adult relatives of people with ASD. Social difficulties were present in parents of autistic probands compared to NT control parents (e.g., Bishop et al., 2004; Hurley et al., 2007; Ruta, Mazzone, Mazzone, Wheelwright, & Baron-Cohen, 2011; Wheelwright, Auyeung, Allison, & Baron-Cohen, 2010; Whitehouse, Coon, Miller, Salisbury, & Bishop, 2010) as well as clinical control parents of children with

Down's syndrome (e.g., Piven et al., 1994; Murphy et al., 2000; Narayan, Moyes, & Wolff, 1990; Wolff et al., 1988), epilepsy (e.g., Narayan et al., 1990; Wolff, Narayan, & Moyes, 1988). One of the most commonly observed communication features, assessed on various measures, is pragmatic language problems (but see Whitehouse et al., 2010), although other forms of language impairments (which are beyond the scope of this work) were also reported in parents (e.g. Folstein et al., 1999; Landa, Folstein, & Isaacs, 1991; Lindgren, Folstein, Tomblin, & Tager-Flusberg, 2009). Pragmatic language difficulties have also been widely reported in parents of autistic children compared to NT control parents (e.g., Bishop et al., 2004; Hurley et al., 2007; Ruta et al., 2011; Wheelwright et al., 2010, but see Whitehouse et al., 2010) as well as clinical control parents of children with Down's syndrome (e.g., Landa et al., 1992; Narayan et al., 1990; Ruser et al., 2007; Wolff et al., 1988), epilepsy (e.g., Narayan et al., 1990; Wolff et al., 1988), specific language impairment (e.g., Whitehouse, Barry, & Bishop, 2007, but see Ruser et al., 2007) .

Social (Losh et al., 2008; Piven et al., 1997b; Piven et al., 1997a) and communication difficulties (Losh et al., 2008; Piven et al., 1997b, but see Piven et al., 1997a) were also reported as more common in multiple incidence autism families compared to parents of children with Down's syndrome and compared to parents from single incidence autism families (e.g., Losh et al., 2008).

Gender differences in social and communication difficulties in adult biological relatives of individuals with ASD have usually been investigated in parents. Studies testing gender differences only in index families reported elevated social BAP traits in fathers compared to mothers (Dawson et al., 2007a; Klusek, Losh, & Martin, 2014; Losh et al., 2009), whereas results for communication difficulties were somewhat

mixed. Male predominance in communication problems have been reported in multiple-incidence autism families (Dawson et al., 2007a; Losh et al., 2009), as well as no significance difference between mothers and fathers (Klusek et al., 2014). In a recent study, Seidman and colleagues (2012) found that fathers and mothers (N=38 in each group, fathers: $M_{age}=45.21$, $SD=6.18$ and mothers: $M_{age}=43$, $SD=5.97$) of individuals with ASD did not differ in terms of meeting BAP criteria on the aloofness and pragmatic language subscales of the Broad Autism Phenotype Questionnaire (BAPQ; Hurley et al., 2007) (Seidman, Yirmiya, Milshtein, Ebstein, & Levi, 2012). Results did not differ across self-, informant- or best estimate report forms of the scores. However, fathers and mothers differed not in self-rated scores but in the best estimate (i.e. average self-and informant-report scores) and informant-rated scores of aloofness, indicating that fathers had more aloof personality traits than mothers. It should be noted that the fathers were significantly older than mothers, yet this was not controlled in analyses. However, the authors reported that BAPQ scores were not significantly associated with age in the whole group.

Male predominance in in social and communication skills have been reported in autism families compared to clinical (Losh et al., 2008; Piven et al., 1997b; Ruser et al., 2007) and/or non-clinical control parents (Bishop et al., 2004; Ruta et al., 2011; Wheelwright et al., 2010). Studies also reported male predominance in both index and nonclinical control parents (Maxwell et al., 2013; Ruta et al., 2011). An indication of opposite-sex effect on pragmatic language difficulties was reported by Piven et al. (1997a). They found that while a higher number of autism mothers (N=23) had problems with communication skills (on the Family History Interview for Developmental Disorders of Cognition and Social Functioning; Bolton et al., 1994) than

DS mothers (N=30), the difference was not significant for fathers (N=23 and N=30, respectively). It should be noted that the significant difference between mothers might be because no control mothers had communication difficulties.

It should be noted that these studies indicated no specific gender-effect in social and communication difficulties in clinical control parents (i.e. in contrast to mixed findings in non-clinical control groups), but Murphy et al. (2000) found a general gender-specific profile of social-impairment related personality traits ('withdrawn' factor i.e. includes traits like aloof and shy based on the Modified Personality Assessment Schedule: M-PAS; Murphy et al., 2000; Tyrer, 1988), showing an increased manifestation in male adults relatives of individuals with ASD as well as DS controls.

7.1.1.1.2 Rigid and Stereotyped Features

In parallel with the diagnostic criteria of ASD, rigid personality traits have also been reported in biological relatives of individuals with ASD (Dawson et al., 2007a). Elevated rigid and stereotyped characteristic have been reported in parents of individuals with ASD compared to nonclinical (e.g., Bernier et al., 2012; Hurley et al., 2007), or clinical control parents (e.g., Losh et al., 2008; Piven et al., 1997b; Wolf et al., 1988, but see Bernier et al., 2012; Murphy et al., 2000 and Piven et al., 1994) . It has also been shown that parents from multiple incidence families have more rigid personality traits than parents from single incidence families (Bernier, Gerdts, Munson, Dawson, & Estes, 2012; Losh et al., 2008). Piven et al. (1997a) showed that not only parents but also grandparents, aunts and uncles from multiple-incidence autism families had more stereotyped behaviours (assessed by the Family History Interview for Developmental Disorders of Cognition and Social Functioning; Bolton et al., 1994) than

clinic control relatives (of offspring with Down syndrome), showing a strong genetic liability.

Gender specific differences in terms of rigid and inflexible personality traits have generally not been detected in studies examining adult relatives of individuals with ASD (Dawson et al., 2007a; Klusek et al., 2014; Losh et al., 2009). Non-significant difference between males and females were also reported in nonclinical control group (e.g., Maxwell et al., 2013). However, significant gender difference was found in rigid personality traits in a recent study by Seidman et al. (2012). They found that higher number of mothers of individuals with ASD met cut-off criteria for BAP in terms of rigid personality traits (on the Broad Autism Phenotype Questionnaire: BAPQ; Hurley et al., 2007) compared to fathers. Same results were found when scores from self-, informant- or best estimate reports were tested. When scores were tested on a continuum, fathers and mothers had similar scores of rigid personality when self-report measure was used; however, fathers reported mothers as more rigid than mothers did fathers. Results based on best-estimate scores were in parallel with the informant-report scores. Significant difference between fathers' and mother's age should be taken into consideration when interpreting these results since the authors did not control this age difference during analysis as indicated before.

7.1.1.2 Milder forms of possible Endophenotypes of ASD in Adult Relatives

Cognitive skill deficits, such as in theory of mind, emotion recognition and executive functions, have been suggested as possible endophenotypes of ASD. It was suggested that milder forms of these deficits may also be represented in biological relatives of probands.

Difficulties with understanding thoughts and emotional states have been found in adult relatives of individuals with ASD compared to clinical/nonclinical control parents (e.g., Baron-Cohen and Hammer, 1997; Gokcen, Bora, Erermis Kesikci, & Aydin, 2009 but see Gokcen et al., 2009; Losh & Piven, 2007). Decoding emotions from faces were also reported to be poorer in index parents compared to nonclinical controls (e.g., Palermo, Pasqualetti, Barbati, Intelligente, & Rossini, 2006; Wallace, Sebastian, Pellicano, Parr, & Bailey, 2010, but see Bölte & Poutska, 2003; Gokcen et al., 2009; Smalley & Asarnow, 1990) and parents from single incidence Autism families (e.g., Bölte & Poutska, 2003). Male predominance was usually found in difficulties with emotion recognition (Gokcen et al., 2009; Palermo et al., 2006; Wallace et al., 2010) and weak central coherence (Happé, Briskman, & Frith, 2001).

Understanding own emotions has also been found poorer in autism parents compared to clinical control parents. Szatmari et al. (2008) compared a group of 439 parents (age range=25-68 years, $M_{age}=39.23$ years, $SD=6.67$) of children with ASD (202 fathers and 237 mothers) to 45 parents (age-range=32-63 years, $M_{age}=44.96$ years, $SD=8.14$) of children with Prader Willi Syndrome (17 fathers and 28 mothers) in terms of their alexithymia symptoms. Results showed that autism parents scored higher on the 20-Item Toronto Alexithymia Scale (TAS-20; Bagby et al., 1994) than controls, showing more problems with understanding emotions in the index parent group. At subscale level, the only significant difference was in terms of difficulties with identifying feelings; however, the difference disappeared after controlled for multiple comparisons.

7.1.1.3 Inter-relations between BAP and Milder Forms of Possible Endophenotypes

Inter-correlation between BAP personality traits assessed on various measures (e.g. AQ; Baron-Cohen et al., 2001; BAPQ; Hurley et al., 2007; MPAS-R; Piven et al., 1997b; Losh et al., 2008), and NEO-PI; Costa & McCrae, 1985) have been reported in combined samples of ASD and control parents (e.g. Bishop et al., 2004; Piven et al., 1997b), but also in the index parents compared to non-clinical controls (Sasson, Lam Parlier, Daniels, & Piven, 2013b). On the other hand, studies reported that adult relatives manifest only single domain of the BAP traits and presence of distinct factor structures in ASD-like personality traits suggested that these milder forms of the condition may be independent from each other (e.g. Losh et al., 2008; Murphy et al., 2000; Whitehouse et al., 2010).

Findings showing that biological relatives of individuals with ASD often had more than one BAP or milder form of ASD endophenotypes (as detailed above), indicated inter-correlation between different domains. Similarly, studies that separated groups based on having BAP before examining other possible endophenotypes, have provided evidence for inter-relations between various milder forms of ASD phenotype and endophenotypes in adult relatives of those with ASD as well as in the general population samples (e.g. Sasson, Nowlin & Pinkham, 2012). Mixed results have been reported for gender effects on the increased representation of BAP inter-correlation, with male predominance (Klusek et al., 2014; Murphy et al., 2000) as well as equal gender representation between males and females (e.g., Dawson et al., 2007a; Hurley et al., 2007).

Associations between BAP traits and possible cognitive endophenotypes have been reported in a comprehensive study by Losh et al. (2009). They found that autism parents (N=83, $M_{age}=46.6$ years, $SD=6.7$, m:f=37:44) who had social BAP, (i.e. BAP(+)) (N=22), assessed by the MPAS-R; Losh & Piven, 2007; Murphy et al., 2000; Piven et al., 1997b) had lower performance in a number of social cognition tasks compared to parents who did not have BAP (N=40) and non-clinical controls (N=32; $M_{age}=46.7$, $SD=7.5$, m:f=13:19). Similarly, Losh and Piven (2007) found among parents (N=48, $M_{age}=46.4$ years, $SD=6.7$, m:f=23:5) of individuals with autism who had aloof personality traits (N=13; assessed by MPAS-R, Piven et al., 1994) had also higher number of difficulties with understanding emotions and thoughts from the eyes (assessed on the Eyes Test, Baron-Cohen et al., 2001) compared to both autism parents who had only rigid personality traits (N=11) or who had neither aloof or rigid personality features (n=24) and a mixed group of NT and DS control parents (N=22, $M_{age}=48$ years, $SD=7.1$, m:f=9:13). They also found that low performance on the Eyes Test was significantly associated with both pragmatic language difficulties (on the Pragmatic Rating Scale: PRS; Landa et al., 1992; Piven et al., 1997b) and poor quality of friendship (on the Friendship Interview; Santangelo & Folstein, 1995) which were driven by the aloof personality traits.

Although there are other possible endophenotypes (e.g. attention to detail, other personality traits, face processing and executive functions) were investigated in adult relatives of individuals with ASD, these are beyond the scope of this work. Reader may refer to detailed reviews of BAP (e.g. Sucksmith et al., 2011) for further information.

7.1.2 Wellbeing in Relatives of People with ASD

Although a range of psychiatric conditions (e.g. schizophrenia, personality disorders, and alcoholism) were examined in adult relatives of individuals with ASD (e.g. Bölte, Knecht, & Poustka, 2007), anxiety, depression and OCD (which were also of interest in the present work) were the most commonly reported since early studies (see Lainhart, 1999 and Yirmiya & Shaked, 2005 for detailed investigation of early findings). Aggregated psychiatric conditions in adult relatives of individuals with ASD have been assessed in different ways, such as testing psychiatric personality traits (e.g. anxious and paranoid) (e.g. Murphy et al., 2000; Piven et al., 1994) or symptoms of specific disorders more directly (e.g. depression and OCD) (e.g. Hollander, King, Delaney, Smith, & Silverman, 2003; Piven et al., 1990).

Psychiatric conditions have been reported in autism relatives both compared to NT controls (e.g., Daniels et al., 2008) and clinical control parents (Bolton et al., 1998) usually parents of children with Down's syndrome). Elevated rates and symptoms of anxiety (Piven et al., 1991, but see Bolton et al., 1998) and depression (Bolton et al., 1998; Gokcen et al., 2009; Fisman et al., 1996; Ingersoll & Hambrick, 2011, but see Piven et al., 1991) have been reported in parents of individuals with Autism compared to controls. Although studies examining parents from multiple incidence Autism families have also reported higher depression and social phobia in index parents compared to clinical control parents (of children with Down's syndrome), they did not find difference between groups in terms of OCD and anxiety (Piven & Palmer, 1999). Others studies using different clinical control groups (e.g., LD or tuberous sclerosis complex (TBC)) reported similar results, with no significant difference in obsessive symptoms (O'Hanrahan, Fitzgerald, & O'Regan, 1999) or anxiety (Smalley,

McCracken, & Tanguay, 1995) but higher rates of depression in index parents (Smalley et al., 1995).

Although studies above used different control groups, they suggest similar profile of aggregated psychiatric conditions in autism families. Still, there might be a role of using different clinical control group. In a meta-analysis study, Yirmiya and Shaked (2005) showed that parents of children with autism had elevated rates of depression and anxiety compared to both DS and NT parents. Index parents' depression also differed from parents of people with mental retardation, but not so from parents of those with LD. Elevated obsessions in autism parents were observed only compared to MR parents. Autism and DS parents did not differ significantly, whereas LD parents had more obsessions than autism parents. This was explained by an effect of comparison group, indicating a possible reason for differences between studies using different control groups.

Gender-specific effects on psychiatric conditions in autism relative have not been widely examined, but elevated rates of depression (Bolton et al., 1998; Dumas, Wolf, Fisman, & Culligan, 1991; Micali, Chakrabarti, & Fombonne, 2004) and anxiety (Micali et al., 2004) in females compared to males have been reported in parents of children with ASD compared to clinical control parents or healthy controls. The high rates of psychiatric symptoms could be due to parenting stress. Greater parenting stress was found in mothers than fathers (Dumas et al., 1991; Fisman et al., 1996) in parents of children with Autism compared to both clinical and nonclinical parent groups.

Associations between BAP and psychiatric conditions and/or parenting stress have also been reported (e.g., Ingersoll & Hambrick, 2011; Murphy et al., 2000; Wallace, Budgett, & Charlton, 2016, but see Piven & Palmer, 1999). Wallace and

colleagues (2016) showed in a mixed group of elderly with or without a relative with ASD ($N=66$, $M_{age}=70.8$ years, $SD=6.92$) that BAP traits (on the BAPQ, Hurley et al., 2007) were the strongest predictors of depression and anxiety symptoms. Ingersoll and Hambrick (2011) showed that parents' BAP (measured by the Autism Spectrum Quotient: AQ; Baron-Cohen et al., 2001) was significantly associated with depression and parenting stress, which were partially mediated by coping strategies (on the Brief-COPE; Carver, 1997) and social support (on the Medical Outcome Study-Social Support Survey; MOS-SSS, Sherbourne & Stewart, 1991) of parents. At the level of ASD endophenotypes, Gokcen et al. (2009) found that depression score was significantly and negatively correlated with performance on the Unexpected Outcomes Test (UOT; Dyck, Ferguson, & Shochet, 2001) tapping emotional state reasoning (i.e. related to empathy skill) in the index parent group, while it was not in the control parents. This indicated that depressive symptoms are related to poor reasoning of emotional states in parents of individuals with ASD.

7.2 Aims

The present work aimed to investigate the BAP in relation to wellbeing in grandparents of children with ASD. It was planned to explore the relationship between the BAP traits, possible endophenotypes of ASD (e.g. social cognition) and quality of life and wellbeing in these older adults. Primary research questions and objectives were as follows:

1. To explore the association between age and BAP, possible endophenotypes, stressful life events and wellbeing (quality of life, mental and physical health)

2. To investigate the relationship in older adults between subclinical traits of ASD (BAP) and possible endophenotypes (e.g. social cognition, alexithymia and empathy deficits)

3. To investigate the relationship in older adults between wellbeing (quality of life, mental and physical health) and both BAP and possible endophenotypes of ASD (e.g. social cognition, alexithymia and empathy deficits)

4. To investigate relationship between stressful life events and wellbeing (quality of life, mental and physical health)

5. To explore the role of gender on the BAP, possible endophenotypes, stressful life events and wellbeing (quality of life, mental and physical health)

Although analyses were mainly exploratory, tentative hypotheses for the research objectives detailed above were as follows:

Hypotheses for aim 1:

No specific prediction is made regarding the association with age; these analyses were exploratory.

Hypotheses for aim 2:

1. BAP traits will be negatively related to social cognition, ability to understand emotions, and empathy skills
2. ToM will be positively associated with cognitive empathy skills and understanding inner emotional states will be positively associated with affective empathy skills and negatively associated with alexithymia
3. Affective empathy skills and alexithymia will be negatively related

Hypotheses for aim 3:

1. BAP will be negatively associated with wellbeing (QoL, physical and mental health)

2. Social cognition and empathy skills will be positively related to wellbeing (QoL, physical and mental health)
3. Alexithymia will be negatively associated with wellbeing (QoL, physical and mental health)

Hypotheses for aim 4:

1. Stressful life events will be negatively related to wellbeing (QoL, physical and mental health)
2. QoL will be positively related to physical and mental health

Hypothesis for aim 5:

1. Males are expected to have more BAP than females.

7.3 Method

7.3.1 Ethics

Ethical Approval was granted by the Psychiatry, Nursing and Midwifery Research Ethics Subcommittee (PNM RESC) at King's College London (PNM/13/14-56); copies of study information sheet, and the letter of ethics approval can be found in Appendix J.

7.3.2 Design

The current study was conducted via postal-survey, in which participants were sent a booklet of questionnaires and tasks and asked to send them back to a free-post address upon completion. BAP along with possible endophenotypes of ASD, quality of life and symptoms of psychiatric conditions were assessed, and compared across gender groups as well as in relation to age. Correlations between the variables were explored, and predictors established using multiple regression. Sample size of the current study was adequate to detect medium to large effects for correlation and multiple regression

analysis, large effects for t-test and ANCOVA with a statistical power of .80 to avoid type II error.

7.3.3 Participants

Biological grandparents of individuals with ASD were recruited via research advertisements, which were facilitated by the National Autistic Society (NAS) and the British Autism Study of Infant Siblings (BASIS) network. Inclusion criteria were: aged 50 years or over and having a (biologic) grandson/granddaughter with ASD. Exclusion criteria were having a formal diagnosis of bipolar disorder or psychosis.

A group of 43 grandparents (aged 53-85 years), comprising 20 grandfathers (aged 57-84 years) and 23 grandmothers (aged 53-85 years), participated in the research. Gender groups were matched on age, $t(41) = 0.02$, $p = .99$, $d = 0.01$. Table 7-1 shows ages in the whole sample and across gender groups.

Table 7-1 Age (in years) in the whole group and gender groups (male / female): Mean and SD

		Overall	Male	Female
Age (in years)	Mean	70.28	70.30	70.26
	SD	7.89	7.80	8.14

15 (35%) grandparents (7 grandfathers and 8 grandmothers) came from 24 multiplex families (i.e. identified more than one relative with ASD), whereas 28 (65%) were from simplex families (13 grandfathers and 15 grandmothers). 33 (77%) grandparents were currently married (17 grandfathers and 16 grandmothers), 3 (7%) were divorced (2 grandfathers and 1 grandmother), and 7 (16%) were widowed (1 grandfather and 6 grandmothers).

Level of education (developed for the purpose of this study, see Appendix K for scoring system) did not differ between grandfathers and grandmothers, $t(41) = 1.38$, $p =$

.61, $d = 0.42$. Table 7-2 shows levels of education in the whole sample and across gender groups.

Table 7-2 Level of education in the whole group and gender groups (male / female): Mean and SD

		Overall	Male	Female
Age (in years)	Mean	2.37	2.70	1.53
	SD	1.46	2.09	1.38

7.3.4 Measures

The set of questionnaires was selected to provide data on autism-related traits (BAPQ) and possible cognitive endophenotypes underlying the BAP including social cognition (including a new Cartoon Stories task created by the researcher), physical and mental health status, and quality of life. The questionnaires listed below were chosen with the following criteria in mind: good psychometric properties; widely used in either autism or old-age literature; short and easy to complete; suitable for the age group; and suitable for use as a postal measure.

7.3.4.1 ASD-Related Traits

7.3.4.1.1 The Broad Autism Phenotype Questionnaire (BAPQ) (Hurley et al., 2007)

The BAPQ is a 36-item self- and/or informant-report questionnaire, designed to assess the broad autism phenotype. It contains 3 subscales (12 items in each): social aloofness, pragmatic language, and rigidity. Scores on subscale level can be interpreted in parallel with the autism symptoms (i.e. social and communication difficulties and restricted and repetitive patterns of behaviour, interests, or activities). Items are rated on a 6-point Likert scale: from “very rarely (1)” to “very often (6)”. Summary scores, on subscale level and/or overall, are calculated by averaging items, resulting in scores ranging from 1 – 6. The BAPQ has demonstrated good psychometric characteristics with high internal-consistency (0.85 – 0.95), sensitivity and specificity (>70% – 80%)

with suggested gender-specific cut-off scores (e.g. a minimum average total score of 3.25 for females and 3.35 for males) (Hurley et al., 2007; Sasson et al., 2013a). In the current study, only self-report version of the questionnaire was used.

7.3.4.2 ASD-related Endophenotypes

7.3.4.2.1 Social Cognition

7.3.4.2.1.1 The Reading the Mind in the Eyes Test - Revised (Baron-Cohen et al., 2001)

The task includes 36 black-and-white photographs of eye region of different human faces and 4 words for each from which participants choose one to describe what the person is thinking or feeling in the photograph. In the present study, the size of the photographs was set to 6.3 x 2.5 cm in the present study to fit them in questionnaire booklets. Further details of this test can be found in Chapter 5 and 6.

7.3.4.2.1.2. The Cartoon Stories Task (ToM-CSt)

For the purpose of the present research, a novel picture-sequencing task was designed by the author in order to assess Theory of Mind (ToM) ability. More detailed description of the task and its development can be found in Chapter 5 and 6. As indicated previously in Chapter 6, the Cartoon Stories Task was designed to be suitable for in-person testing as well as for postal/on-line data collection. In the present study, a postal version of the task was used. The size of each picture was set to 8.3 x 5.5cm to fit them in questionnaire booklets (please see Appendix E). Performance was evaluated based on accuracy of sequencing stories, identification of the main point and use of psychological state talk in the explanation of the main point.

7.3.4.2.2 Alexithymia

7.3.4.2.2.1 The 20–Item Toronto Alexithymia Scale (TAS-20) (Bagby et al., 1994)

The TAS-20 is a self-report measure consisting of 20 items tapping emotional understanding. Further details of this task can be found in Chapter 6.

7.3.4.2.3 Empathy

7.3.4.2.3.1 The Interpersonal Reactivity Index (IRI) (Davis, 1983)

The IRI is a 28-item self-report questionnaire measuring a range of empathy-related skills or traits, including both cognitive and emotional components of empathy. The questionnaire has 4 subscales, but for the purpose of the current study only the “perspective taking” and “empathic concern” subscales (in total 14 items) were used. Further details of this questionnaire can be found in Chapter 6.

7.3.4.3 Wellbeing

7.3.4.3.1 Physical and Mental Health

7.3.4.3.1.1 SF-12 Health Survey (Ware, Kosinski, & Keller, 1996)

The SF-12 is a brief form of the 36-Item Health Survey (SF-36; Ware & Sherbourne, 1992). The questionnaire assesses daily functioning of participants based on general mental and physical health. It is a self-report survey and includes 12 items (e.g. “During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?”). Answers are rated on 3-, 5-, and 6-point Likert scale (e.g. 4 “not at all” to 0 “extremely”) and yes/no. The SF-12 creates two summary scores: physical health and mental health, both ranging from 0 to 100. Higher scores indicate better health conditions. The SF-12 has been demonstrated to have good psychometric properties, with validity and reliability values $>.70$ in

several studies with different sample populations including mental health studies (Luo et al., 2003; Salyers, Bosworth, Swanson, Lamb-Pagone, & Osher, 2000).

7.3.4.3.1.2 The Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983)

This scale consists of 14 items, 7 for depression (e.g. “I still enjoy the things I used to enjoy”) and 7 for anxiety (e.g. “I feel restless as if I have to be on the move”), rated on a 4-point Likert scale from 0 (e.g. not at all) to 3 (e.g. most of the time). Scores range from 0 to 21 for each subscale with higher score indicating more severe depression and/or anxiety symptoms. Based on specific cut-off points, scores can be interpreted as indicating which individuals are likely to have depression and/or anxiety. The HADS is a valid and reliable instrument, widely used in many studies, including in autism research (e.g. Hastings & Brown, 2002). The scale has been demonstrated to have high sensitivity and specificity (~.80) with a cut-off point of 8, and good internal consistency, with Cronbach α between .68 and .93 (mean = .83) for anxiety and .67 to .90 (mean = .82) for depression (Bjelland, Dahl, Haug, & Neckelmann, 2002). Correlation between HADS and other commonly used questionnaires (e.g. BDI, Beck, Steer, & Brown, 1987; GHQ-28, Goldberg, 1972; and STAI, Spielberger, Gorsuch, & Lushene, 1970) is high (.49-.83) (Bjelland et al., 2002).

7.3.4.3.1.3 The Obsessive-Compulsive Inventory-Revised (OCI-R; Foa et al., 2002)

The Obsessive-Compulsive Inventory-Revised (OCI-R; Foa et al., 2002) is the short version of the Obsessive-Compulsive Inventory (OCI; Foa et al., 1998), a self-rated measure by which symptoms of obsessive compulsive disorder (OCD) are investigated. It has 18 items and 6 domains (i.e. washing, obsessing, hoarding, ordering,

checking, and neutralizing), and answers are rated based on a 5-point Likert scale. Further details of this questionnaire can be found in Chapter 4.

7.3.4.3.1.4 The Barkley ADHD Current Symptoms Scale (BCS; Barkley & Murphy, 1998)

The BCS is a self-report measure for ADHD symptoms consisting of 18 items rated on a 4-point Likert scale ranging from “0” (never or rarely) to “3” (very often). An informant-report version of the scale is also available, although only the self-report one was used in the current study. Half of the questions in the scale are about hyperactivity (e.g. “Fidget with hands or feet or squirm in seat”), and half about inattention (e.g. “Have difficulty sustaining my attention in tasks or fun activities”). Total score for each subscale (i.e. “Inattention” and “Hyperactivity/Impulsivity”) varies between 0 and 27, with higher score indicating more severe ADHD symptoms. If six or more items are scored as 2 (often) or 3 (very often), an individual can be considered to show clinically significant symptoms. Scores can also be interpreted as summary scores considering age-specific cut-off points. The BCS has been reported to have good psychometric properties with satisfactory results from validity analyses (e.g. factor analysis and concurrent validity), high internal consistency (Cronbach α of .92 for current ADHD symptom score), good inter-observer agreement (a correlation of .67 to .70 across scales), and high test–retest reliability over a 2–3 week interval (a correlation of .75 for current ADHD symptom score) (Barkley & Murphy, 1998).

7.3.4.3.1.5 The Dysexecutive Questionnaire (DEX; Burgess, Alderman, Evans, Emslie, & Wilson, 1998; Wilson, Alderman, Burgess, Emslie, & Evans, 1996)

The DEX (Wilson et al., 1996) is a 20-item questionnaire measuring possible changes at behaviour level due to the dysexecutive syndrome (i.e. executive function

problems in their everyday lives). The questionnaire has self- and informant-report versions, the former being used here. The 5-item clusters of the DEX are inhibition, intentionality, executive memory, positive affect, and negative affect. Each item is required to be rated on a 5-point Likert scale (from “never (0)” to “very often (4)”). Total score ranges from 0 to 80, with higher score indicating more severe dysexecutive problems. Specific cut-off values have been reported for total scores as well as on cluster level, resulting in three severity categories: mild, moderate, and strong (Bodenburg & Dopsloff, 2008). The DEX has been demonstrated to have satisfactory psychometric properties, (e.g. .85 overall reliability and good ecological validity) (Bodenburg & Dopsloff, 2008; Burgess et al., 1998; Kenworthy, Yerys, Anthony, & Wallace, 2008).

7.3.4.3.2 Quality of Life

7.3.4.3.2.1 4-Item Subjective Happiness Scale (SHS; Lyubomirsky & Lepper, 1999)

This is a 4-item self-report measure of global subjective happiness. Participants answer items such as “In general, I consider myself ...not a very person/a very happy person” by using a 7-point Likert scale (e.g. from “not a very happy person” to “a very happy person”). A single composite score ranging from 1 to 7 is calculated by averaging the total score, with higher scores reflecting greater happiness. The scale has been reported to have well to excellent psychometric characteristics, such as test-retest reliability, construct and discriminant validity (Lyubomirsky & Lepper, 1999).

7.3.4.3.2.2 Satisfaction with Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985):

The Satisfaction with Life Scale is a 5-item self-report questionnaire assessing participants’ satisfaction with their life in general. Each item (e.g. “In most ways my life

is close to my ideal”) is responded to on a 7-point Likert scale from “strongly disagree (1)” to “strongly agree (7)”. Scores are calculated by summing up all item scores. Individuals can be considered extremely dissatisfied if their scores fall between 5 and 9; slightly dissatisfied if they fall between 15 and 19; satisfied if between 21 and 30; and extremely satisfied if between 31 and 40. A total score of 20 is interpreted as being neither satisfied nor dissatisfied with life. The Life Satisfaction Scale has demonstrated satisfactory psychometric properties, with sufficient convergent and discriminant validity, and good test-retest reliability (Diener et al., 1985; Pavot & Diener, 1993; Pavot, Diener, Colvin, & Sandvik, 1991).

7.3.4.3.2.3 Life Orientation Test–Revised (LOT-R) (Scheier, Carver, & Bridges, 1994)

The LOT-R is a 10-item self-report measure of optimism and pessimism. Participants are required to answer each question (e.g. “In uncertain times, I usually expect the best”) using a 5-point Likert scale from “I disagree a lot (0)” to “I agree a lot (4)”. Total scores range from 0 - 32, with higher scores indicating more optimistic thoughts. Scores are interpreted continuous; no cut-off point has been demonstrated for being optimistic/pessimistic. Psychometric properties of the LOT-R have been reported to be good (discriminant validity, $r = -.65$ with hopelessness and $-.60$ with depression; internal consistency, an alpha coefficient of $.78$; and test-retest reliability, $.79$) (Hirsch, Britton, & Conner, 2010; Scheier, Carver & Bridges, 1994).

7.3.4.3.2.4 Perceived Stress Scale (PSS-10) (Cohen & Williamson, 1988)

The 10-Item Perceived Stress Scale is a self-report measure assessing the degree to which situations in one's life are considered stressful. Each item (e.g. “In the last month, how often have you been upset because of something that happened

unexpectedly”) is rated on a 5-point Likert scale from “never” (0) to “very often” (4). Total score ranges from 0 to 40, with higher score indicating a higher degree of perceived stress. The PSS-10 has demonstrated good psychometric properties with high internal consistency (Cronbach $\alpha = .78$), and moderate construct validity.

7.3.4.3.2.5 The Abbreviated Duke Social Support Index (Koenig et al., 1993)

This is an 11-item self-rated questionnaire assessing social support. The questionnaire includes two subscales: 4-item social interaction subscales (e.g. “About how often did you go to meetings of social clubs, religious meetings, or other groups that you belong to in the past week?”) and 7-item social satisfaction (e.g. “Can you talk about your deepest problems with at least some of your family and friends most of the time, some of the time, or hardly ever?”). In the social interaction subscale, answers are number entries in the boxes provided and scores for each item varies between 1 to 3 based on specific cut-offs (e.g. 0 is scored as 1, 1 or 2 is scored as 2, and 3 and over is scored as 3). Answers in the social satisfaction subscale are rated on a 3-point Likert scale from “hardly ever” (0) to “most of the time” (3). Total score ranges from 4-12 for social interaction subscale and 7-21 for social satisfaction subscale.

7.3.4.3.3 Stressful Life Events

7.3.4.3.3.1 The Holmes and Rahe Stress Scale (HRSS; Holmes & Rahe, 1967):

Also known as the Social Readjustment Rating Scale (SRRS), this scale assesses stress levels associated with stressful life events, and allows an estimate of the chance of having mental/physical health problems related to experiencing of these stressful life events. Participants are required to check boxes next to 43 life events (e.g. “death of spouse”) if they have experienced them. Considering the age range of participants, 40 life events were used in the proposed study (“pregnancy”, “begin or end

school/college”, and “change in school/college” were dropped as being inappropriate for the age group in the study). Summary scores are calculated by summing up item values (ranging from 12 to 100 for each) that are previously reported, with higher scores indicating more stress. Based on their summary scores individuals fall into three different groups: high or very high risk, moderate to high risk, and low to moderate risk groups.

7.3.5 Procedure

Participants were sent a booklet of questionnaires with a free-post return envelope. After they completed the booklet (expected time needed was 60-90 minutes), they sent them back to the researcher. In total 90 booklets were sent and 43 were returned. Three grandparents who sent the booklets back did not complete the RMET and the ToM-CSt.

7.3.6 Statistical Analysis

Measures (e.g. for the BAP and psychiatric conditions) were used as continuous trait measures rather than to create categories based on established cut-off scores, due to relatively small numbers in such groups. For descriptive purposes, number of people and percentages passing established cut-offs are given where relevant.

To reduce the number of comparisons made, subscales were only explored where total scores on a measure showed significant effects, unless an a priori prediction was made about specific subscale differences or profiles.

Associations among age, BAP, possible endophenotypes, and wellbeing scores were examined primarily using correlation analyses. Stepwise regression analysis was used to evaluate strongest associates of QoL. Differences between males and females on

the BAP, possible endophenotypes, and wellbeing measures were tested using independent t-test and ANCOVA where age was a covariate.

Assumptions of each test were examined carefully. Unless stated, assumptions underlying parametric tests were met for all variables. When data were not normally distributed (decided based on the criteria detailed in Chapters 3, 4 and 6), bootstrap technique was used for group comparisons and non-parametric Spearman's Rho correlation coefficients are reported. Bootstrap derived confidence intervals and *p* values are reported with a superscript letter where relevant.

7.4 Results

7.4.1 Correlations with Age in the Whole Group

7.4.1.1 Age Effects on BAP and Possible ASD Endophenotypes

As the correlations in Table 7-3 show, Age was not significantly associated with BAP, ToM, alexithymia or self-rated empathy skills. There was a significant and negative correlation between age and understanding emotions and thoughts from the eyes. 5 (12%) grandparents were above cut-off for alexithymia; 4 of them were above the BAP cut-off as well.

Table 7-3 Correlations between age and total BAP (BAPQ) and possible ASD endophenotypes scores: total alexithymia (TAS-20), empathy (IRI), social cognition (RMET and ToM-CSt)

	BAPQ	RMET	ToM-CSt_Exp			TAS-20	IRI	
	Total		Seq	Accu	PST	Total	PT	EC
Age	0.17 (p=.27)	-.40*	-21 ^(a) (p=.20)	-.18 ^(a) (p=.26)	-.01 (p=.95)	.07 (p=.64)	-.13(a) (p=.43)	-.26(a) (p=.10)
			ToM-CSt_Ctrl					
			Seq	Accu	PST			
			-.01 ^(a) (p=.97)	.14 ^(a) (p=.38)	.11 (p =.50)			

^(a) Spearman's *Rho*

* *p* < .05

Exp: Experimental Cartoon Stories; Ctrl: Control Cartoon Stories; Seq: Sequencing; Accu: Accuracy; PST: Psychological State Talk; PT: Perspective Taking; EC: Empathic Concern

7.4.1.2 Age and Wellbeing: Physical and Mental Health, Stressful Life Events and QoL

Since more than one QoL measure was used in the present study, to reduce multiple comparisons a composite score of QoL was calculated by using principal component analysis (PCA) on scores from the 6 different QoL measures. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO = .81, and all KMO values for individual scores were > .72, which is above the acceptable limit of .50 (Field, 2009). Bartlett's test of sphericity $\chi^2(15) = 139.844$, *p* < .001, indicated that the correlations between measures were sufficiently large for PCA. An initial analysis was run to obtain eigenvalues for each component in the data. A single component had eigenvalue over Kaiser's criterion of 1 and in combination explained 62.38% of the variance. The scree plot was in line with Keiser's criterion. Table 7-4 below shows the factor loadings. A composite QoL score was created based on a composite of factor-weighted scores.

Table 7-4 Summary of exploratory factor analysis results for the composite QoL score

	SHS	SWLS	LOT-R	DSSI-SI	DSSI-SAT	PSS-10
Factor loadings (Comp_QoL)	.84	.67	.92	.71	.81	-.77

Age was significantly and negatively associated with physical health but not with mental health, stressful life events, or QoL (see Table 7-5).

Table 7-5 Associations between age and wellbeing: physical health (SF-12_PCS), mental health (SF-12_MCS, stressful life events (HRSS) and QoL (Comp_QoL)

	SF-12		HRSS	Comp_QoL
	PCS	MCS		
Age	-.43**	.02 ^(a) (<i>p</i> =.92)	-.23 ^(a) (<i>p</i> =.14)	-.10 (<i>p</i> =.52)

^(a) Spearman's *Rho*

***p* < .01

7.4.2 BAP, Possible ASD Endophenotypes and Wellbeing

One of the aims of the current work was to investigate the wellbeing of grandparents in relation to BAP and possible ASD endophenotypes. To this end, first associations between wellbeing (QoL, physical and mental health) and both BAP and possible ASD endophenotypes were tested, and then the predictors of QoL were examined.

7.4.2.1.1 Relationship between BAP or Possible ASD Endophenotypes and Physical and Mental Health

7.4.2.1.1.1 BAP and Physical and Mental Health

Associations between the BAP and both physical and mental health scores were examined in the whole group. Physical and mental health were significantly and negatively associated with broad autism phenotype. This was also the case at subscale level; grandparents who reported more autistic-like traits also reported poorer physical and mental health (Table 7-6).

Table 7-6 Associations between total BAP (BAPQ) and both physical (SF-12_PCS) and mental (SF-12_MCS) health in grandparents

		PCS	MCS
BAP	Total	-.37*	-.52*** ^(a)

^(a) Spearman's *Rho*.

p* < .05, **p* < .001.

Table 7-7 shows that the association between BAP and physical and mental health scores were similar at subscale level (except for the association between aloofness and physical health, which was not significant).

Table 7-7 Associations between BAP subscale scores (BAPQ) and both physical (SF-12_PCS) and mental (SF-12_MCS) health in grandparents

		PCS	MCS
BAP	Aloof	-.19 (<i>p</i> = .24)	-.36 ^{*(a)}
	PL	-.35 [*]	-.35 ^{*(a)}
	Rigid	-.37 [*]	-.52 ^{***(a)}

^(a) Spearman's *Rho*.

p* < .05, **p* < .001.

Aloof: Aloofness; PL: Pragmatic Language; Rigid: Rigidity

Given that a significant association was found between mental health and BAP in grandparents, relationships between BAP and symptom severity scores of specific psychiatric conditions (i.e. anxiety, depression, OCD, ADHD, and dysexecutive syndrome) were investigated. Numbers and percentages of grandparents who met the cut-off criteria for these psychiatric conditions were as follows: 10 (23%) grandparents met cut-off for anxiety, 10 (23%) for depression, 8 (19%) for OCD, 5 (12%) for ADHD and 16 (37%) for dysexecutive syndrome. Due to small numbers, psychiatric symptom scores were examined dimensionally in relation to BAP; significant positive correlation were found with severity scores of all psychiatric conditions tested (Table 7-8).

Table 7-8 Associations between total BAP (BAPQ) and symptom severity of psychiatric conditions (anxiety and depression (HADS), obsessive-compulsive disorder (OCI-R), attention deficit hyperactivity disorder (BCS) and dysexecutive syndrome (DEX)) in grandparents

		Anxiety	Depression	OCD	ADHD	Dysexecutive Syndrome
BAP	Total	.49 ^{***}	.66 ^{***}	.56 ^{***}	.56 ^{***}	.78 ^{***}

All correlation coefficients are Spearman's *Rho*.

****p* < .001.

Similar results were found when BAP was investigated at subscale level with the exception of the relationship between aloofness and anxiety which remained below the critical level of significance (Table 7-9).

Table 7-9 Associations between BAP subscale scores (BAPQ) and symptom severity of psychiatric conditions (anxiety and depression (HADS), obsessive-compulsive disorder (OCI-R), attention deficit hyperactivity disorder (BCS) and dysexecutive syndrome (DEX)) in grandparents

		Anxiety	Depression	OCD	ADHD	Dysexecutive Syndrome
BAP	Aloof	.24 (<i>p</i> = .12)	.50***	.30***	.32***	.51***
	PL	.40**	.48**	.52***	.57***	.72***
	Rigid	.47**	.56***	.51***	.45**	.66***

All correlation coefficients are Spearman's Rho.

p* < .05, *p* < .01, ****p* < .001.

Aloof: Aloofness; PL: Pragmatic Language; Rigid: Rigidity

7.4.2.1.1.2 Social Cognition and Physical and Mental Health

The relationship between performance on social cognition tasks and physical and mental health in grandparents was investigated. No significant correlation was detected, showing that performances of grandparents on the social cognition tasks were not significantly associated with their physical or mental health (Table 7-10).

Table 7-10 Association between social cognition (RMET and ToM-CSt) and both physical (SF-12_PCS) and mental (SF-12_MCS) health in grandparents

		PCS	MCS
RMET		.18 (<i>p</i> = .27)	.13 ^(a) (<i>p</i> = .44)
ToM-CSt_Exp	Seq	.20 ^(a) (<i>p</i> = .21)	.09 ^(a) (<i>p</i> = .57)
	Accu	.21 ^(a) (<i>p</i> = .20)	.05 ^(a) (<i>p</i> = .77)
	PST	.03 (<i>p</i> = .84)	.10 ^(a) (<i>p</i> = .56)

^(a) Spearman's Rho.

Exp: Experimental Cartoon Stories; Seq: Sequencing; Accu: Accuracy; PST: Psychological State Talk

7.4.2.1.1.3 Alexithymia and Empathy and Physical and Mental Health

Associations between the ability to understand own feelings and self-rated empathy, on the one hand, and physical and mental health, on the other, were examined in grandparents. A significant and negative relationship was found between alexithymia and both physical and mental health, while the correlations between empathy and health were nonsignificant (see Table 7-11).

Table 7-11 Relationship of total alexithymia (TAS-20) and empathy (IRI) to both physical (SF-12_PCS) and mental (SF-12_MCS) health of grandparents

		PCS	MCS
Alexithymia	Total	-.35*	-.33*(a)
Empathy	PT	.19 ^(a) (<i>p</i> = .23)	.04 ^(a) (<i>p</i> = .81)
	EC	.18 ^(a) (<i>p</i> = .26)	.07 ^(a) (<i>p</i> = .67)

^(a) Spearman's Rho

**p* < .05

PT: Perspective Taking; EC: Empathic Concern

Associations at subscale level showed that grandparents who had difficulties with identifying feelings had poorer physical and mental health. Difficulties with describing emotions were significantly related to poor physical health but not to mental health. Tendency to externally orientated thinking was not significantly associated with physical or mental health (Table 7-12).

Table 7-12 Relationship of alexithymia subscale scores (TAS-20) and both physical (SF-12_PCS) and mental (SF-12_MCS) health of grandparents

		PCS	MCS
Alexithymia	IF	-.35*	-.40**(a)
	DF	-.33*(a)	-.22 ^(a) (<i>p</i> = .17)
	EOT	-.22 (<i>p</i> = .16)	-.09 ^(a) (<i>p</i> = .56)

^(a) Spearman's Rho

p* < .05, *p* < .01

IF: Difficulties with Identifying Feelings; DF: Difficulties with Describing Feelings; EOT: Externally Oriented Thinking

Given that there was a significant association between mental health and alexithymia in grandparents, relationship between alexithymia and symptom severity scores of psychiatric conditions (i.e. anxiety, depression, OCD, ADHD, and dysexecutive syndrome) were investigated. Results showed that alexithymia was significantly and positively associated with severity scores of all psychiatric conditions tested. This indicated that grandparents who had difficulties with understanding own

emotions had a higher number of symptoms of anxiety, depression, OCD, ADHD and dysexecutive syndrome (Table 7-13).

Table 7-13 Associations between total alexithymia (TAS-20) and symptom severity of psychiatric conditions (anxiety and depression (HADS), obsessive-compulsive disorder (OCI-R), attention deficit hyperactivity disorder (ADHD) and dysexecutive syndrome (DEX)) in grandparents

		Anxiety	Depression	OCD	ADHD	Dysexecutive Syndrome
Alexithymia	Total	.32*	.58***	.36*	.47**	.71***

All correlation coefficients are Spearman's Rho

* $p < .05$, ** $p < .01$, *** $p < .001$

At the subscale level, associations with psychiatric symptoms were investigated just for the difficulties with identifying feelings subscale given that mental health score was only associated with this subscale significantly. It was found that difficulties with identifying feelings was significantly and positively associated with all severity scores (Table 7-14).

Table 7-14 Associations between Difficulties with Identifying Feelings subscale score (TAS-20) and symptom severity of psychiatric conditions (anxiety and depression (HADS), obsessive-compulsive disorder (OCI-R), attention deficit hyperactivity disorder (ADHD) and dysexecutive syndrome (DEX)) in grandparents

		Anxiety	Depression	OCD	ADHD	Dysexecutive Syndrome
Alexithymia	IF	.58***	.55***	.48**	.65***	.80***

All correlation coefficients are Spearman's Rho.

** $p < .01$, *** $p < .001$.

IF: Difficulties with Identifying Feelings

7.4.2.1.2 Relationship between QoL and BAP or Possible ASD Endophenotypes

7.4.2.1.2.1 QoL and BAP

The association between QoL and the BAP was examined. QoL was significantly and negatively correlated with the BAP; grandparents who had higher BAP self-report scores had poorer QoL. Results at subscale level were in parallel with this (Table 7-15).

Table 7-15 Relationship between QoL (Comp_QoL) and total BAP (BAPQ) in grandparents

	BAP			
	Total	Aloof	PL	Rigid
Comp_QoL	-.71***	-.63***	-.55***	-.50***

All correlation coefficients are Spearman's Rho

*** $p < .001$.

Aloof: Aloofness; PL: Pragmatic Language; Rigid: Rigidity

7.4.2.1.2.2 QoL and Social Cognition

The association between performance on social cognition tests and QoL was tested. Correlations between QoL and performance on the RMET and ToM-CSt were not significant (Table 7-16).

Table 7-16 Association between QoL (Comp_QoL) and social cognition (RMET and ToM-CSt) in grandparents

	RMET	ToM-CSt_Exp.		
		Seq.	Accu.	PST
Comp_QoL	.02 ($p = .91$)	.29 ($p = .07$)	.18 ($p = .26$)	.17 ($p = .30$)

All correlation coefficients are Spearman's Rho.

Exp: Experimental Cartoon Stories; Seq: Sequencing; Accu: Accuracy; PST: Psychological State Talk

7.4.2.1.2.3 QoL and Alexithymia or Empathy

The relationship of QoL with both alexithymia and empathy was investigated. QoL was significantly and negatively correlated with alexithymia, indicating that grandparents who had more difficulties with understanding own emotions had poorer quality of life. However, cognitive and affective empathy scores were not significantly correlated with QoL score (Table 7-17).

Table 7-17 Association between QoL (Comp_QoL) and total alexithymia (TAS-20) and empathy scores (IRI) in grandparents

	Alexithymia	Empathy	
	Total	PT	EC
	-.63***	.26 ($p = .09$)	.11 ($p = .49$)

All correlation coefficients are Spearman's Rho.

*** $p < .001$.

PT: Perspective Taking; EC: Empathic Concern

Associations between QoL and subscale scores of alexithymia showed that all subscale scores were significantly and negatively correlated with QoL; difficulties with identifying and describing own emotions as well as externally oriented thinking were associated with poor QoL (Table 7-18).

Table 7-18 Association between QoL (Comp_QoL) and alexithymia subscale scores (TAS-20) in grandparents

Comp_QoL	Alexithymia		
	IF	DF	EOT
	-.53***	-.56***	-.43**

All correlation coefficients are Spearman's Rho.

***p < .01, ***p < .001.*

IF: Difficulties with Identifying Feelings; DF: Difficulties with Describing Feelings; EOT: Externally Oriented Thinking

7.4.3 Associations among Wellbeing Measures: QoL, Stressful Life Events and Physical and Mental Health

Associations between QoL and both stressful life events and physical and mental health were examined. There was a significant and negative relationship between stressful life events and QoL, showing reduced QoL with more stressful events in life. Quality of life was also significantly and positively related to both physical and mental health, indicating a better quality of life with better physical and/or mental health in grandparents. Stressful life events were not significantly associated with either physical or mental health score (Table 7-19).

Table 7-19 Associations among QoL (Comp_QoL), stressful life events (HRSS) and physical (SF-12_PCS) and mental (SF-12_MCS) health

	Comp_QoL	HRSS	PCS	MCS
Comp_QoL	-	-.34*	.34*	.67***
HRSS	-	-	-.05 (<i>p</i> = .73)	-.23 (<i>p</i> = .13)
PCS	-	-	-	.24 (<i>p</i> = .13)
MCS	-	-	-	-

All correlation coefficients are Spearman's Rho.

p* < .05, **p* < .001.

Given that there was a significant relationship between mental health and QoL, associations between QoL and symptom severity of psychiatric conditions (i.e. anxiety, depression, OCD, ADHD and dysexecutive syndrome) were also investigated. QoL was significantly and negatively associated with severity of anxiety, depression, OCD, ADHD, and dysexecutive syndrome (Table 7-20).

Table 7-20 Associations between QoL (Comp_QoL) and symptom severity of psychiatric conditions (anxiety and depression (HADS), obsessive-compulsive disorder (OCI-R), attention deficit hyperactivity disorder (ADHD) and dysexecutive syndrome (DEX)) in grandparents

	Anxiety	Depression	OCD	ADHD	Dysexecutive Syndrome
Comp_QoL	-.57***	-.84***	-.34*	-.47**	-.63***

All correlation coefficients are Spearman's Rho.

p* < .05, *p* < .01, ****p* < .001.

7.4.4 Regression analyses

Since significant correlations were found between QoL and both BAP and one possible ASD endophenotype (i.e. alexithymia) and other wellbeing scores (i.e. stressful life events, physical and mental health), multiple regression analysis was conducted to find the best predictors of QoL in grandparents. Since age was not associated with QoL significantly, age was not included as a possible predictor. The sample size allowed for up to four possible predictors to be included in the analysis; therefore, first QoL was regressed on other wellbeing measures.

A multiple linear regression analysis (stepwise) was run to predict QoL score based on stressful life events, physical and mental health scores. A significant regression equation was found ($F(1, 41) = 47.27, p < .001$) with an $R^2 = .54$. The only significant predictor of QoL score was mental health score ($\beta = .73, p < .001, 95\% \text{ CI } [0.05, 0.10]$) (Table 7-21).

Table 7-21 Multiple regression results to predict QoL (Comp_QoL) based on stressful life events (HRSS), physical health (SF-12_PCS) and mental health (SF-12_MCS) scores

Step 1	B	SE B	β
(Constant)	-3.75	0.56	
MCS	0.074	0.01	.73***

Dependent Variable: Comp_QoL

Note: $R^2 = .54, ***p < .001$.

Then, a multiple regression analysis was conducted to predict QoL based on the BAP, alexithymia and mental health score. A significant regression equation was found ($F(2, 40) = 37.80, p < .001$) with an $R^2 = .65$. It was found that both mental health ($\beta = .53, p < .001, 95\% \text{ CI } [0.03, 0.08]$) and BAP ($\beta = -.40, p < .001, 95\% \text{ CI } [-0.98, -0.29]$) were significant and independent predictors of QoL (Table 7-22).

Table 7-22 Multiple regression results to predict QoL (Comp_QoL) based on BAP (BAPQ), total alexithymia (TAS-20), and mental health (SF-12_MCS) scores in grandparents

Step 1	B	SE B	β
(Constant)	-3.75	0.56	
MCS	0.07	0.01	.73***
Step 2			
(Constant)	-0.93	0.91	
MCS	0.05	0.01	.53***
BAP	-0.63	0.17	-.40***

Dependent Variable: Comp_QoL

Note: $R^2 = .54$ for Step 1, $\Delta R^2 = .12$ for Step 2 ($p < .001$), $***p < .001$.

A further multiple regression analysis was run to predict mental health of grandparents based on BAP and alexithymia. A significant regression equation was found ($F(1, 41) = 14.55, p < .001$) with an $R^2 = .26$. It was found that only BAP was a

significant predictor of mental health ($\beta = -.51$, $p < .001$, 95% CI [-12.28, -3.78]) (Table 7-23).

Table 7-23 Multiple regression results to predict mental health score (SF-12_MCS) based on total BAP (BAPQ) and total alexithymia (TAS-20) scores

Step 1	B	SE B	β
(Constant)	73.47	6.05	
BAP	-8.03	2.11	-.51***

Dependent Variable: SF-12_MCS

Note: $R^2 = .26$, *** $p < .001$.

7.4.5 Inter-correlations among BAP measures

Associations between different aspects of the BAP and possible ASD endophenotypes were examined in the whole group and, further below, in the group split by gender.

7.4.5.1 Correlations between the BAP and Possible ASD Endophenotypes

7.4.5.1.1 BAP and Social Cognition

RMET and ToM-CSt performances were not significantly associated with total BAP score (Table 7-24).

Table 7-24 Relationship between total BAP (BAPQ) and social cognition (RMET and ToM-CSt) in grandparents

		RMET	ToM-CSt_Exp.		
			Seq.	Accu.	PST
BAP	Total	.05 (<i>p</i> = .74)	-.27 ^(a) (<i>p</i> = .09)	-.16 ^(a) (<i>p</i> = .32)	.02 (<i>p</i> = .89)

^(a) Spearman's Rho

Exp: Experimental Cartoon Stories; Seq: Sequencing; Accu: Accuracy; PST: Psychological State Talk

7.4.5.1.2 BAP and Alexithymia or Empathy

BAP was significantly and positively correlated with total alexithymia score, and all three subscales. BAP was also significantly correlated with self-reported 'cognitive empathy' skills, with grandparents who had more BAP traits also reporting more

difficulties with taking other people's perspectives. The association between the BAP and 'affective empathy' score was not significant (Table 7-25).

Table 7-25 Association of the total BAP (BAPQ) with both alexithymia (TAS-20) and empathy (IRI) in grandparents

		Alexithymia				Empathy	
		Total	IF	DF	EOT	PT	EC
BAP	Total	.65***	.52*** ^(a)	.64*** ^(a)	.52***	-.39* ^(a)	-.16 ^(a) (<i>p</i> = .29)

^(a) Spearman's Rho

p* < .05, **p* < .001.

IF: Difficulties with Identifying Feelings; DF: Difficulties with Describing Feelings; EOT: Externally Oriented Thinking; PT: Perspective Taking; EC: Empathic Concern

Since relationships were significant between the BAP and both alexithymia and cognitive empathy scores, further investigations were made at subscale level of the BAP and alexithymia. Results were similar to those found for the total score, except for a non-significant association between rigidity and both making decisions based on emotions and taking other people's perspectives (Table 7-26).

Table 7-26 Association of the BAP subscale scores (BAPQ) with both alexithymia (TAS-20) and cognitive empathy (IRI) in grandparents

		Alexithymia				Empathy
		Total	IF	DF	EOT	PT
BAP	Aloof	.73***	.63*** ^(a)	.68*** ^(a)	.53***	-.42** ^(a)
	PL	.59***	.39** ^(a)	.68*** ^(a)	.48**	-.46** ^(a)
	Rigid	.52***	.59*** ^(a)	.38* ^(a)	.28 (<i>p</i> = .07)	-.25 ^(a) (<i>p</i> = .11)

^(a) Spearman's Rho

p* < .05, *p* < .01, ****p* < .001.

Aloof: Aloofness; PL: Pragmatic Language; Rigid: Rigidity; IF: Difficulties with Identifying Feelings; DF: Difficulties with Describing Feelings; EOT: Externally Oriented Thinking; PT: Perspective Taking

7.4.5.1.3 Social Cognition and Alexithymia or Empathy

The experimental sequence score of the ToM-CSt was significantly and negatively correlated with total alexithymia score. Interestingly, cognitive empathy score was not significantly correlated with any social cognition score, but affective empathy score was significantly and positively related to performance on the RMET

and on the accuracy scale of the ToM-CSt. This indicated that grandparents who reported more empathic concern for others, showed objectively better understanding of feelings and thoughts from the eyes, and understanding of the mental states of characters in the cartoon sequencing test (Table 7-27).

Table 7-27 Associations between social cognition (RMET and ToM-CSt) and both total alexithymia (TAS-20) and empathy (IRI) in grandparents

		Alexithymia	Empathy	
		Total	PT	EC
RMET		-.02 (<i>p</i> = .90)	.01 ^(a) (<i>p</i> = .96)	.45**^(a)
ToM-CSt_Exp.	Seq.	-.37*^(a)	.19 ^(a) (<i>p</i> = .25)	.26 ^(a) (<i>p</i> = .10)
	Accu.	-.24 ^(a) (<i>p</i> = .14)	.18 ^(a) (<i>p</i> = .28)	.34*^(a)
	PST	-.02 (<i>p</i> = .92)	-.01 ^(a) (<i>p</i> = .94)	.17 ^(a) (<i>p</i> = .29)

^(a) *Spearman's Rho.*

p* < .05, *p* < .01.

Exp: Experimental Cartoon Stories; Seq: Sequencing; Accu: Accuracy; PST: Psychological State Talk; PT: Perspective Taking;

EC: Empathic Concern

Correlations with the experimental sequence score of the ToM-CSt were also significant at subscale level, except for the difficulties with describing feelings. Results showed that grandparents who did poorly in sequencing the experimental cartoon stories had more difficulties with understanding own emotions, namely describing feelings and making decisions based on emotions (Table 7-28).

Table 7-28 Associations between social cognition (ToM-CSt) and alexithymia subscale scores (TAS-20) in grandparents

		Alexithymia		
		IF	DF	EOT
ToM-CSt_Exp.	Seq.	-.39 ^(a)	-.25 ^(a) (<i>p</i> = .12)	-.35 ^(a)

^(a) Spearman's Rho.

p* < .05, *p* < .01.

Exp: Experimental Cartoon Stories; Seq: Sequencing; IF: Difficulties with Identifying Feelings; DF: Difficulties with Describing Feelings; EOT: Externally Oriented Thinking

7.4.6 Gender Group Differences

BAP and ASD endophenotypes, quality of life and physical/mental health of grandparents were investigated across gender groups.

7.4.6.1 Gender Group Differences in BAP

Grandfathers had higher self-rated BAP scores than grandmothers. Further investigations were made on each aspect of the BAP (i.e. aloofness, rigidity and pragmatic language deficits) Grandfathers rated themselves as significantly more aloof than grandmothers. There was no significant difference between grandfathers and grandmothers in terms of pragmatic language deficits, however the gender difference (males worse than females) was of medium effect size. Grandfathers and grandmothers did not differ significantly in terms of rigidity (Table 7-29).

Table 7-29 BAP scores (BAPQ) in grandmothers and grandfathers: Mean (SD)

		Male N=20	Female N=23	<i>t</i>	df	<i>p</i>	<i>d</i>	95% CI
BAP	Total	3.02 (0.59)	2.62 (0.62)	2.18	41	.035	0.66	0.03 - 0.78
	Aloof	3.29 (0.80)	2.64 (0.74)	2.76	41	.009	0.84	0.17 - 1.12
	PL	2.69 (0.73)	2.28 (0.74)	1.84	41	.07	0.56	-0.04 - 0.86
	Rigid	3.08 (0.71)	2.93 (0.85)	0.65	41	.52	0.19	-0.33 - 0.64

Aloof: Aloofness; PL: Pragmatic Language; Rigid: Rigidity

7.4.6.2 Gender Group Differences in Possible ASD Endophenotypes

7.4.6.2.1 Gender Group Differences in Social Cognition

Performance by grandfathers and grandmothers on the RMET was not significantly different, despite a medium-sized effect for females to perform better. There was no significant gender difference on the performance on either the experimental cartoon stories or on the control cartoon stories (Table 7-30).

Table 7-30 Performances of grandfathers and grandmothers on social cognition tasks (RMET and ToM-CSt): Mean (SD)

			Male N=19	Female N=21	<i>t</i>	df	<i>p</i>	<i>d</i>	95% CI
RMET			24.37 (5.32)	27.00 (3.55)	-1.86	38	.07	0.58	-5.40 - 0.35
ToM-CSt ^a	Exp	Seq	37.70 (7.21)	37.10 (8.86)	0.24	38	.82	0.07	-4.57 - 5.77
		Accu	9.10 (5.84)	9.90 (5.20)	-0.46	38	.65	0.14	-4.30 - 2.63 ^b
		PST	15.50 (5.31)	15.30 (4.91)	0.12	38	.90	0.04	-3.07 - 3.47
	Ctrl	Seq	21.75 (3.51)	20.60 (3.63)	1.02	38	.32	0.32	-1.10 - 3.34 ^b
		Accu	7.15 (2.68)	7.60 (2.33)	-0.57	38	.57	0.18	-2.04 - 1.02 ^b
		PST	5.55 (2.50)	5.85 (2.56)	-0.38	38	.71	0.12	-1.92 - 1.32

^a N = 20 for both males and females

^b Bootstrap derived

Exp: Experimental Cartoon Stories; Ctrl: Control Cartoon Stories; Seq: Sequencing; Accu: Accuracy; PST: Psychological State Talk

7.4.6.2.2 Gender Group Differences in Alexithymia and Empathy

No significant difference was found between grandfathers and grandmothers in terms of total alexithymia score, despite a medium effect-size trend for grandfathers to have more difficulties with understanding own emotions than grandmothers (Table 7-31).

Table 7-31 Alexithymia (TAS-20) and empathy (IRI) scores in grandfathers and grandmothers: Mean (SD)

		Male (N=20)	Female (N=23)	t	df	p	d	95% CI
Alexithymia	Total	46.85 (10.64)	40.35 (14.66)	1.64	41	.11	0.51	-1.50 - 14.50
	IF	12.75 (4.80)	11.96 (7.06)	0.42	41	.68 ^a	0.13	-2.85 – 4.06 ^a
	DF	12.75 (3.57)	10.00 (5.14)	2.06	39.21	.046	0.62	0.05 - 5.33 ^a
	EOT	21.35 (4.61)	18.39 (5.27)	1.94	41	.06	0.60	-0.12 - 6.03
IRI	PT	17.45 (5.23)	18.22 (6.69)	-0.42	41	.66 ^a	0.13	-4.70 - 2.68 ^a
	EC	20.00 (4.13)	23.87 (4.07)	-3.09	41	.003 ^a	0.94	-6.21 - (-1.29) ^a

^a Bootstrap derived

IF: Difficulties with Identifying Feelings; DF: Difficulties with Describing Feelings; EOT: Externally Oriented Thinking; PT: Perspective Taking; EC: Empathic Concern

Perspective taking ability showed no significant effect of gender (Table 7-31).

7.4.6.3 Gender Group Differences in Wellbeing: Physical and Mental Health, Stressful Life Events and QoL

Since age was associated with physical health significantly, ANCOVA was run to test gender differences in physical health. The covariate age was significantly related to physical health in grandparents, $F(1, 40) = 9.11$, $p < .01$, 95% CI [-1.12, -0.22], $\eta^2 = .19$. No significant difference was found between grandfathers and grandmothers in terms of physical health after controlling for the effect of age, $F(1, 40) = 0.16$, $p = .69$,

95% CI [-5.65, 8.42], $\eta^2 = .004$. Similarly, gender groups did not differ in mental health score (Table 7-32).

Table 7-32 Physical (SF-12_PCS) and mental health (SF-12_MCS), stressful life events (HRSS) and QoL (Comp_QoL) of grandfathers and grandmothers: Mean (SD)

		Male (N=20)	Female (N=23)	<i>t</i>	df	<i>p</i>	<i>d</i>	95 % CI
SF-12	PCS	43.26 (11.11)	41.91 (13.51)	N/A	N/A	N/A	N/A	N/A
	MCS	50.26 (9.10)	51.55 (10.78)	-0.42	41	.65 ^a	0.13	-6.85 - 5.15 ^a
HRSS		692.55 (156.03)	709.43 (134.46)	-0.38	41	.72 ^a	0.12	-101.30 - 74.13 ^a
Comp_QoL		-0.01 (0.92)	0.01 (1.08)	-0.09	41	.93 ^a	0.02	-0.56 - 0.60 ^a

N/A: ANCOVA rather than t-test was used for this analysis.

Stressful life events and QoL scores also did not differ significantly by gender (Table 7-32).

7.4.7 Results Summary Table

Variable	Correlation with age	Gender effect	Other significant correlates
BAP (BAPQ)	Ns.	m > f (medium effect)	• Alexithymia (+) • Cognitive empathy (-) • Physical and mental health (-) • QoL (-)
Alexithymia (TAS-20)	Ns.	m = f (medium effect: m > f)	• BAP (+) • ToM (sequencing) (-) • Physical and mental health (-) • QoL (-)
Cognitive empathy skills (IRI)	Ns.	m = f	• BAP (-)
Affective empathy skills (IRI)	Ns.	m < f (large effect)	• Understanding inner thoughts and emotional states (+) • ToM (accuracy) (+)
Understanding inner thoughts and emotional states (RMET)	(-)*	m = f (medium effect: m < f)	• Affective empathy skills (+)
ToM (ToM-CSst)	Ns.	m = f	• Alexithymia (with ToM sequencing) (-) • Affective empathy skills (with ToM accuracy) (+)
Physical health (SF-12)	(-)**	m = f	• BAP (-) • Alexithymia (-) • QoL (+)
Mental health (SF-12)	Ns.	m = f	• BAP (-) • Alexithymia (-) • QoL (+)
QoL (Comp_QoL)	Ns.	m = f	• BAP (-) • Alexithymia (-) • Physical health (+) • Mental health (+) • Stressful life events (HRSS) (-)

^{ns} $p > .05$, * $p < .05$, ** $p < .01$

(-) negative relationship

7.5 Discussion

The present study examined a number of ASD-related traits and possible endophenotypes in a group of elderly biological relatives (i.e., grandparents) of individuals with ASD. Age-related effects and associations among different aspects of BAP or possible endophenotypes in relation to wellbeing were tested.

Age was not significantly associated with BAP or possible ASD endophenotypes, except for understanding others' thoughts and feelings as measured in the Reading the Mind in the Eyes Test. There was a negative correlation between age and this test performance. However, no age-related effects were detected for ToM tasks or empathy skills. This finding may indicate attenuated age-related effects on ToM in elderly biological relatives of individuals with ASD, since reduced ToM performance has widely been reported in healthy ageing (see chapter 2 for review). However, lack of control group in the present research limits further elaboration of this finding. Age was not related to QoL, stressful life events or mental health, but an advanced age was associated with poorer physical health. Results show that age was not associated with BAP in elderly relatives of people with ASD, in general. To our knowledge age-effects on BAP have not been investigated specifically in adult relatives of people with ASD, so BAP and ASD-related endophenotypes should be explored as a function of age in future studies.

BAP and some of the possible endophenotypes were significantly related to each other. Grandparents who had more BAP also had more difficulties with understanding own emotions. BAP was also related to poor cognitive empathy skills, whereas the association between the BAP and affective empathy skills was not significant. Social cognition, including ToM, was also not significantly related to the BAP, but ToM was

associated with less alexithymia. This result was in contrast with previous research which found association between BAP and both social cognition and decoding emotions (Losh et al., 2009; Losh & Piven, 2007). Possible endophenotype scores were also found to be related to each other, e.g., positive relationship between self-rated social cognition skill and affective empathy. Mixed findings of inter-correlations among BAP and ASD-related endophenotypes can be interpreted with fractionation of ASD-related characteristics (see Brunsdon & Happé, 2014 for a review) at BAP and cognitive level. Future studies should replicate these findings using different tasks for social cognition and also include other cognitive skills, such as executive function and weak central coherence tasks.

Poorer physical and mental health were related to higher BAP. A closer look at subscale scores showed that grandparents who had more pragmatic language problems and rigid personality traits had poorer physical and mental health, whereas aloof personality traits were associated with mental health only. BAP was associated with higher number of anxiety, depression, OCD, ADHD and dysexecutive syndrome symptoms. This was similar when it was examined at subscale level, except for a non-significant association between aloof personality traits and anxiety. These results were in line with previous research which found elevated level of anxiety and depression in grandparents of people with ASD compared to grandparents of individuals with DS (Piven & Palmer, 1999) and which showed association between the BAP and elevated depression in parents (Ingersoll & Hambrick, 2011).

To our knowledge, alexithymia has not previously been examined in grandparents of those with ASD. In the present study, only alexithymia among possible endophenotypes was significantly related to grandparents' physical and mental health.

Specifically, grandparents who had more problems with identifying and describing own emotions had poorer physical health whereas poorer mental health was only related to the former. Difficulties with identifying feelings was significantly and positively correlated with symptom severity of anxiety, depression, OCD, ADHD and dysexecutive syndrome. Externally oriented thinking, on the other hand, was not associated with physical or mental health significantly. Neither ToM nor empathy skills were associated with physical or mental health. Although, in this study alexithymia was examined under social cognition category, alexithymia is a condition affecting other populations not only people with ASD. It is known to be associated with depression and other mental health problems (e.g., anxiety, depression, eating disorders and post-traumatic stress disorder) in general (e.g., Berthoz, Pouga, & Wessa, 2011; Lumley, Neely, & Burger 2007).

Negative association between alexithymia and physical health can be thought as a function of mental health. However, present study did not find significant association between mental and physical health. The negative association between physical health and alexithymia may be explained by ‘interoception’, knowing the inner state of your body. High level of alexithymia may limit recognition of inner states, and also may cause somebody to think an emotion is a physical symptom/problem (e.g., Brewer, Cook, & Bird, 2016; Brewer, Happé, Cook, & Bird, 2015). It should be noted that other significant associates of physical health were also found (i.e., BAP and QoL), so future research should explore this association further.

There was a significant relationship with more BAP and poorer QoL. Only alexithymia among possible ASD endophenotypes was associated with QoL significantly. Experiencing stressful life events, poorer physical and mental health (with

severity of self-reported symptoms of anxiety, depression, OCD, ADHD and dysexecutive syndrome) were also related to poorer QoL. Regression results revealed that the best predictors of QoL was mental health and BAP.

7.5.1 Gender effects

Gender effects on the BAP, possible endophenotypes and wellbeing were also investigated in the current research. Grandfathers reported more BAP compared to grandmothers in line with previous findings on parents of individuals with ASD: higher aloof personality traits (Klusek et al., 2014; Losh et al., 2009) and problems with pragmatic use of language (Dawson et al., 2007a). However, results were in contrast to what Seidman and colleagues (2012) found. Using the same measure, they reported self-report aloof personality traits and pragmatic language difficulties did not differ between mothers and fathers. Although they found more aloof personality characteristics in fathers than mothers when they used best estimate scores (i.e. average self-and informant-report scores), pragmatic language difficulties remained similar between fathers and mothers. One possible reason for this discrepancy is that the ages of mothers and fathers significantly differed in their sample. Even though they reported age was not associated with the BAP, there might be age by gender interaction effects on the BAP. Results were also in line with what was found in studies testing gender differences in parents of people with ASD compared to clinic or healthy control parents (Ruser et al., 2007; Ruta et al., 2011, but Losh et al., 2008), although male predominance in both case and control groups was also reported (Bishop et al., 2004; Murphy et al., 2000; Ruta et al., 2011).

That there was no gender difference in terms of rigid personality traits was also found in parents of individuals with ASD by previous research groups (Dawson et al.,

2007a; Klusek et al., 2014; Losh et al., 2009). However, it should be noted that non-significant gender difference in rigidity was reported to be present not only in autism parents but also in non-clinical control parents (Maxwell et al., 2013). Results were also in line with Seidman et al. (2012) who found no gender difference in self-report data (using the same measure as in the present study), but when they used informant- and best-estimate data (i.e. average self-and informant-report scores) they found that mothers had more rigid personality traits than fathers. Significant age differences between gender groups, again, might be the reason for the discrepancy in the results.

For possible endophenotypes, males reported more problems with understanding own emotions. Again, due to small sample size the difference did not reach the critical level of significance, despite a medium effect size. Specifically, males had more difficulties with describing own emotions than females. Males and females did not differ in cognitive empathy skills, but did in affective empathy skills. Affective empathy skills of females were significantly higher than males. Profile in social cognition was in parallel with this. There was a trend showing that females were better at guessing feelings combined with thoughts compared to males. However, they did equally well in theory of mind test. Previous research in parent groups showed that fathers were poorer at labelling emotions from faces/ facial expressions than mothers not only in the ASD families, but also in non-clinical control parents (Gokcen et al., 2009; Palermo et al., 2006). Future studies should replicate these findings using clinical and nonclinical control grandparent groups.

Wellbeing was similar in males and females. Quality of life, objective life stress level, physical and mental health did not differ between grandfathers and grandmothers. Results were in line with previous research, in which significant gender differences

were not found in terms of psychiatric conditions in parents of people with ASD as well as clinical (Dumas et al., 1991; Losh et al., 2009) and non-clinical control parents (Losh et al., 2009). However, findings of the present work were not in parallel with studies which found gender effects on psychiatric symptoms (i.e. anxiety and depression) compared to clinical (Piven et al., 1997b) or non-clinical parents groups (Dumas et al., 1991), with elevated symptoms in mothers compared to fathers in almost all (but see Bolton et al., 1998). Similar level of life stress and QoL was also in parallel with parenting stress research, in which no gender differences emerged when mothers and fathers in autism families were compared to parents of people with DS or behaviour disorders. However, this group found higher parenting stress caused by parental stressors (but not by child stressors) when autism families were compared to non-clinical control parents. The difference is likely to be due to differences in sample groups: stress and detrimental effect on QoL would be expected to be higher among parents than grandparents, given the formers' everyday exposure to the challenges of looking after a child with difficulties.

7.5.2 Limitations

This study has several limitations. First of all, the sample size was small and may not have had enough power to detect small effects and associations. The present sample size did not allow further and more-detailed analyses, such as mediation analyses, which would be helpful in future research. The present results should be interpreted with caution and await replication with larger samples. Another limitation is use of a cross-sectional design. Longitudinal methods would help to elucidate developmental trajectories, and control for individual differences and cohort effects (Hofer & Sliwinski, 2001). However, cross-sectional designs are also useful when time and

expenses and practice effects are considered (Salthouse & Nesselroade, 2002). Data in the current work were collected via postal survey and based on self-report questionnaire measures and tasks. More objective assessment methods (e.g. one on one testing sessions) could be used in future research.

No control group was used in the current study, which limits generalisability of the results. It is possible that these effects and associations found could be observed also in grandparents of children without ASD. Future studies should include control groups in their design and test whether these effects were specific to biological relatives of individuals with ASD. It would also be interesting to examine nonbiological relatives of ASD children to test effects of experience rather than shared genetics. Intellectual ability could not be assessed due to the nature of the study: a postal survey. However, level of education, which can be considered as a proxy of intellectual ability, was similar between males and females. Also, no diagnostic screening was applied to the families. However, grandparents reported that their grandchild/children had formal diagnosis from clinicians. Grandparents, themselves, were also not screened for ASD, but they confirmed that they did not receive formal ASD diagnosis except one grandfather who was diagnosed with ASD recently.

7.6 Conclusion

This study examined BAP, possible ASD endophenotypes and wellbeing in a group of elderly people enriched for ASD-related characteristics: biological grandparents of individuals with ASD. Results showed that ASD endophenotypes similar to ASD-like traits could be seen in milder forms in elderly relatives of individuals with ASD. Inter-relations between BAP and possible ASD endophenotypes

were found. Few age effects were found but BAP was found to be related to poorer QoL in the grandparents of people with ASD.

Chapter 8 General Discussion

ASD is a life-long neurodevelopmental condition (APA, 2013), but what we know about old adults with ASD is very limited compared to what we know about children with ASD. Young adult studies reported that ASD-related difficulties continue into adulthood; however, what happens to ASD symptoms, cognitive skills and wellbeing when these adults become elderly is as yet unknown (Magiati et al., 2014; Mukaetova-Ladinska et al., 2012). In this thesis these questions were investigated. In this chapter, a brief summary and discussion of the studies presented in this thesis has been provided with suggestions for future research directions.

8.1 ASD Symptoms/Traits

For ASD symptoms, it was found that older adults still had social and communication difficulties and experienced restricted and repetitive patterns of behaviour and interests. These difficulties were more marked in adults with ASD compared not only to healthy controls (Chapter 4) but also to adults referred to a tertiary referral centre on suspicion of ASD (but who did not receive this diagnosis; Chapter 3). Age-related abatement of core symptoms was not found in the studies presented in this thesis. This is in line with previous reports from some young adult studies (e.g., Bastiaansen et al., 2011 and Bishop & Seltzer, 2012); but conflicts with reported improvement with age in young adults in other samples (e.g. Esbensen et al., 2009; Gray et al., 2012; Howlin et al., 2013; Seltzer et al., 2003; Shattuck et al., 2007; Woodman et al., 2015). Differences in results can be explained by heterogeneity of autism suggesting individual differences at the level of difficulties.

8.2 Co-occurring Psychopathology: Diagnoses and Symptoms

When focusing on additional mental health difficulties, both young and old adults with ASD in the present studies had additional mental health disorders (Chapter 3) and/or suffered from a number of self-reported mental health difficulties (Chapter 3 and 4). Almost half of both age groups had an additional diagnosis of anxiety and about a third had depression in the clinic-based study (Chapter 3). Similarly, almost half of both age groups in the experimental study scored above the suggested clinical cut-off scores for self-reported depression and ADHD, and around a third reported OCD and anxiety (Chapter 4). As shown in Chapter 3, compared to a clinic control group additional mental health conditions were more common in adults with ASD. Also, severity of ASD traits were significantly associated with severity of self-reported OCD, anxiety and depression symptoms in both adults with ASD and healthy controls (Chapter 4). Similarly, RRBI symptoms were significantly associated with having OCD in both the ASD and clinic control groups (Chapter 3). No significant age-related effects were found in co-occurring psychopathology (Chapter 3) or self-reported mental health difficulties (Chapter 4) in the present studies. Previous studies examining age-related effects on psychiatric conditions in adults with ASD have reported mixed findings: fewer psychiatric symptoms in older ASD adults compared to young adults (e.g., Lever & Geurts, 2016; Totsika et al., 2010), or just the opposite (e.g., Davis et al., 2011; van Heijst & Geurts, 2014). Longitudinal studies are needed to clarify these mixed results.

8.3 Cognitive Skills: Social Cognition and Local-Global Processing

Age-related effects on ToM and visual local-global processing in the ASD group compared to NT group supported the ‘safeguard hypothesis’ (Geurts & Vissers, 2012). A possible ‘protective’ age-related effect was found on these skills in the ASD group,

whereas there was an age-related decline in the NT adults. With regards to ToM, results supported an earlier study by Lever and Geurts (2015) which found evidence for an attenuated ToM decline in old adults with ASD compared to controls. To our knowledge, age-related effects on local-global processing skills in old adults with ASD have not been studied previously. When results were compared against healthy ageing studies, the findings of the present work partly support earlier reports. An age-related decline in visual global processing in the present NT group supports earlier findings showing a reduced global processing bias in the elderly (Lux et al., 2008; Oken et al., 1999). However, young NT adults in the present study were also better at visual and auditory local processing tasks compared to old NT adults. It might be speculated that this is a result of better processing speed in young compared to old adults. Further studies with different visual and local processing tasks (e.g. untimed) are needed, plus control conditions or tasks assessing other skills that might affect performance (e.g., working memory). Diagnostic group differences remained below the critical level of significance for ToM. This might be partly due to reduced age-related decline in the ASD group compared to NT group. Indeed, when differences between young study groups only were examined, ToM performance of the ASD group was poorer than NT group, as expected from the literature.

Adults with ASD had more alexithymia and worse self-rated empathy skills compared to NT adults, and no age effects were seen (Chapter 6). ASD-traits were also significantly associated with poor ToM performance, more alexithymia and less empathy. However, it should be noted that the ASD group reported more personal distress (a subscore of affective empathy) than the NT group. This suggests that different facets of empathy should be explored in future studies with adults with ASD,

using experimental measures and multiple informants. Inter-correlations among cognitive skills were also found, such as between ToM and empathy. These results partly support earlier finding by Rogers et al. (2007).

8.4 Wellbeing: Life Outcome and QoL

Life outcome of old adults was better than young adults, regardless of diagnostic group in the clinic study (Chapter 3), whereas no age effect was found on self-reported QoL except for the social relationship sub-domain in the experimental study (Chapter 4). Normative life-outcome (Chapter 3) and self-reported QoL (Chapter 4) were poorer in adults with ASD compared to control groups, as expected from the literature. There was a significant age group by diagnostic group interaction showing that old adults with ASD had better QoL in social relationships than younger adults; whereas it was the opposite in the NT group (although differences between groups were non-significant the effect sizes were medium). This might be because adults with ASD feel under less social pressure in older (versus younger) age, whereas NT elderly feel lonelier than they did when young. More in depth qualitative work would be needed to find out why age has a different apparent relationship with social QoL in NT and ASD adults. QoL results in general were parallel with previous research with old (e.g., van Heijst & Geurts, 2014; Totsika et al., 2010) and young ASD adults (e.g., Renty & Roeyers, 2006 but see also Howlin et al., 2013; Orsmond et al., 2004). Adults with ASD were also more vulnerable to risks from others than the clinic control group (Chapter 3). Intellectual level was not associated with self-reported QoL, but was associated with alexithymia in both study groups and visual global processing skill in the NT group only. Life outcome of adults with ASD was predicted mainly by social skills, total years of education and severity of OCD symptoms (Chapter 3). Significant predictors of self-

reported QoL were severity of self-reported depression symptoms in the ASD group and OCD symptoms in the healthy controls (Chapter 4 and 6).

8.5 Broad Autism Phenotype and Wellbeing of Grandparents of Individuals with ASD

The study presented in Chapter 7 examined ASD-like traits, ASD-related cognitive endophenotypes (ToM, alexithymia and empathy) and QoL in a group of elderly who are likely to be enriched for ASD characteristics: biological grandparents of offspring with ASD. Although results were discussed in detail in Chapter 7, a brief summary of the main findings is worth mentioning here.

In general, age was not associated with BAP nor with ASD endophenotypes, although a significant negative correlation suggested age-related decline in understanding emotions and mental states from the eyes (the RMET; Baron-Cohen et al., 2001). Significant positive associations were found between BAP and ASD endophenotypes, specifically self-rated alexithymia and difficulties with cognitive empathy.

Wellbeing (QoL, physical and mental health) was associated with BAP and to some extent with ASD endophenotypes (alexithymia). Wellbeing measures were also inter-correlated among themselves. Significant predictors of QoL were mental health and BAP, and these two were inter-related. Results were in parallel with studies reporting elevated mental health difficulties in parents and grandparents of individuals with ASD (Ingersoll & Hambrick, 2011; Piven & Palmer, 1999). Relatively small sample size unfortunately prevented more indepth analyses, e.g. mediation analyses, to explore these relationships.

Results suggested there were a few characteristics on which grandmothers and grandfathers differed significantly. Grandfathers had more aloof personality traits and greater difficulties with describing own emotions and with feeling empathic concern for others, compared to grandmothers. These results partly support the mixed findings in the literature (e.g., Dawson et al., 2007a; Klusek et al., 2014; Losh et al., 2009; Maxwell et al., 2013; Ruser et al., 2007; Ruta et al., 2011, but see Bishop et al., 2004; Losh et al., 2008; Murphy et al., 2000; Ruta et al., 2011). No gender difference was detected in wellbeing, in line with results from some of earlier studies with parents (Dumas et al., 1991; Losh et al., 2009), although results contradict studies reporting elevated mental health problems in mothers compared to fathers (e.g., Dumas et al., 1991; Piven et al., 1997b). However, it should be noted that these studies were with parents who were under daily pressure and stress of looking after a child with difficulties.

8.6 Limitations and Future Directions

As listed in the study chapters (Chapter 3, 4, 6 and 7), limitations should be considered when interpreting the results presented. Cross-sectional design was used in all analyses presented in this thesis, so findings may be subject to cohort effects. To reduce bias in young and old group selection, participants were recruited from similar sources. Considering our limited knowledge about the elderly with ASD, results of the studies presented may still provide an initial step to understand age-related effects in the elderly with ASD. Future studies examining age-related effects on functioning of old adults with ASD using longitudinal designs are needed.

Small sample size may have limited power to detect significant results and prevented some further analyses that would have been helpful in interpreting the patterns of associations (e.g., mediation analysis or a more detailed regression analyses).

Also, the number of tests that were run was high, although we attempted to reduce the number of tests by using composite scores (Chapter 6 and 7) and/or examining primarily total/global scores. Conservative p values were not used, since the analyses were mainly exploratory. Results should be interpreted with caution, however, and await replication in larger samples.

Although the best available measures were chosen in the studies, psychometric properties were in some cases limited or unknown. Assessments were largely dependent on self-reported measurements. Although data presented in chapter 4 and 6 were collected through in person testing sessions carried out by the author, data used in Chapter 3 were dependent on clinic case reports, and those in Chapter 7 were from postal survey. Future studies should use different data collection methods, and multiple informants, to compare findings.

A cut-off age of 50 was used to separate young and old adults in Chapter 3, 4 and 6. Similarly, inclusion criteria for participants included being aged 50 and over in the study presented in Chapter 7. In most samples we did not have large numbers of ‘old-old’ adults (70+ year). Future studies should also look at age-related changes in later ages.

Adults in the studies presented here were high-functioning, which may limit the generalisability of our results to adults with a lower IQ. Future research should extend the range of intellectual levels included in participant samples to understand age-related effects in a wider population with ASD.

Overall, the results reported in this thesis although requiring replication, advance our understanding of ageing in the elderly with ASD. These findings can be used in

developing support and services for individuals with ASD over the lifespan with necessary adjustments according to their age-related needs.

Appendix A. ICD-10 Symptom Sheet

Qualitative abnormalities in reciprocal social interaction, manifest in at least one of the following areas:

failure adequately to use eye-to-eye gaze, facial expression, body posture and gesture to regulate social interaction;

failure to develop (in a manner appropriate to mental age, and despite ample opportunities) peer relationships that involve a mutual sharing of interests, activities and emotions

A lack of socio-emotional reciprocity as shown by an impaired or deviant response to other people's emotions; or lack of modulation of behaviour according to social context, or a weak integration of social, emotional and communicative behaviours.

Qualitative abnormalities in communication, manifest in at least two of the following areas:

A delay in, or total lack of development of spoken language that is not accompanied by an attempt to compensate through the use of gesture or mime as alternative modes of communication (often preceded by a lack of communicative babbling);

Relative failure to initiate or sustain conversational interchange (at whatever level of language skills are present) in which there is reciprocal to and from responsiveness to the communications of the other person

Stereotyped and repetitive use of language or idiosyncratic use of words or phrases

Abnormalities in pitch, stress, rate, rhythm and intonation of speech

Restricted, repetitive, and stereotyped patterns of behaviour, interests and activities, manifest in at least two of the following areas:

An encompassing preoccupation with one or more stereotyped and restricted patterns of interest that are abnormal in content or focus; or one or more interests that are abnormal in their intensity and circumscribed nature although not abnormal in their content or focus.

Apparently compulsive adherence to specific, non-functional, routines or rituals;

Stereotyped and repetitive motor mannerisms that involve either hand or finger flapping or twisting, or complex whole body movements;

Preoccupations with part-objects or non-functional elements of play materials (such as their odour, the feel of their surface, or the noise or vibration that they generate);

Distress over changes in small, non-functional, details of the environment.

Appendix B. Life Outcome Scoring System

Sub-domains	Level	Score
Independence	• Living independently; living with parents if 25-year-old or younger; living with parents in order to look after them; still in education and living with parents if aged 18-29 years	0
	• Living independently or with parents if younger than 30-year-old, but need occasional help (with daily living skills, e.g. shopping, cooking, managing finances, cleaning etc.) from state/institutional parties/family/friends/partner	1
	• Semi-sheltered accommodation but with high degree of autonomy • Living independently or with parents if younger than 30 year-old, but reliant on regular help from state/institutional parties/family/friends/partner (with e.g. shopping, cooking, managing finances, cleaning, shopping etc) • Getting disability allowance	2
	• Living with parents if older than 30-year-old, some limited autonomy/In residential accommodation with some limited autonomy	3
	• In specialist autistic or other residential accommodation with little or no autonomy / in hospital care or at home because nowhere else would accept the individual	4
Friendships	• 1/+ close reciprocal relationships, in own age group	0
	• 1/+ close reciprocal relationships but limited in terms of restricted interests or less than normal reciprocity • 1/+ close friends in the recent past (middle-old adulthood for old adults; young adulthood for middle-old adults; and teenage years for young adults) but not now • Online close friends with some direct personal contact	1
	• Seeking of contact but only in group situation/school/work • 1/+ close friends/friends in far past (young adulthood or before for old adults; teenage years or before for middle-old adults; and childhood for young adults) • Only online friends/close friends without any direct personal contact	2
	• No peer relationships that involves selectivity	3
Current Employment	• Regularly employed or self-employed, or in In full time mainstream education (College/university if >19) • Employed until 50+ years and retired • Out of work < 1 year	0
	• Out of work >1 year or in and out of work (more than one break)	1
	• Sheltered or voluntary employment	2
	• Never had a job	3
	• No educational or job placement	3
Relationships	• Has maintained reciprocal relationships	0
	• Reciprocal relationships but less than 6 months for individuals aged 18-29 and less than a year for those aged 30 and over years • Online reciprocal relationships with direct personal contact	1
	• No enduring relationships / very brief relationships with reduced sharing • Only online reciprocal relationships	2
	• Never had a relationship	3

Appendix C. Mental Health Services History / Forensic Service Use History Scoring System

- 0:** No current/past MH or forensic involvement or identified need
- 1:** Seeing GP regularly or specialist services on occasional basis regarding MH issues or MHS (involvement in various degrees) and/or forensic history in the past only
- 2:** Regular outpatient MH services and/or some continuing contact with forensic services
- 3:** Inpatient MH / custodial sentence ever/ suspended sentence

Appendix D. Risk Assessment Scoring System

- 0:** No risk
- 1:** Negligible risk
- 2:** Low risk
- 3:** Moderate risk
- 4:** High risk

Appendix E. The ToM Cartoon Stories Task: Postal Version

Cartoon Stories Task

Instructions

Please turn the booklet horizontally during the following task. In this test, the pictures on each page tell a different story. Please put pictures on each page in order by assigning them numbers from 1 to 5 to complete the story in the best way possible. Put the appropriate number in the box below each picture.

For example:

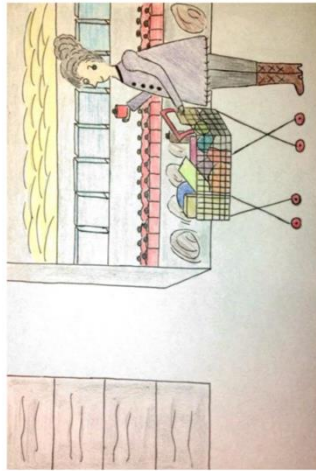
1

 under the picture you think gets first in the story.

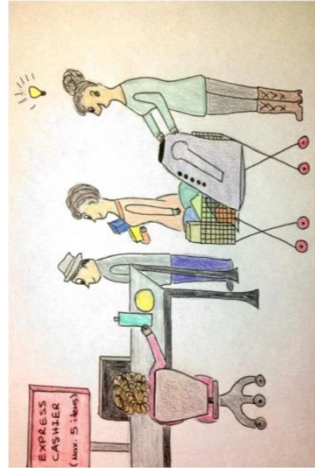
Below the pictures is a space for you to write what you think is going on in the story. Please explain what the main point is for each story using the space provided at the bottom of each page below the question: "What's the main point of this story?"

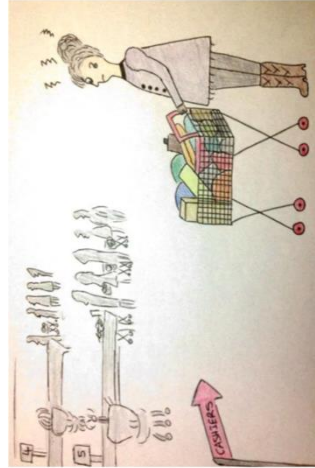
Your explanation should be **a brief summary of the story** explaining the main point. If you are not sure, please still write what you think is going on in the picture story



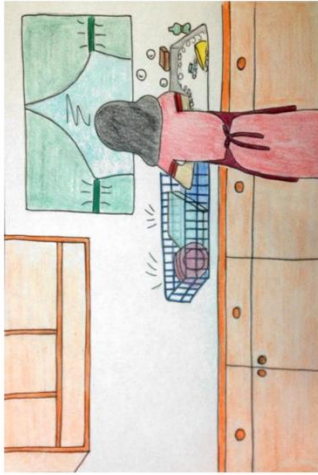


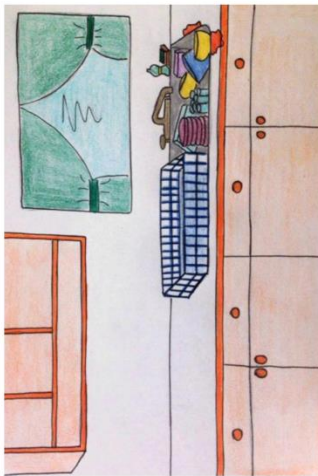






What's the main point of this story?





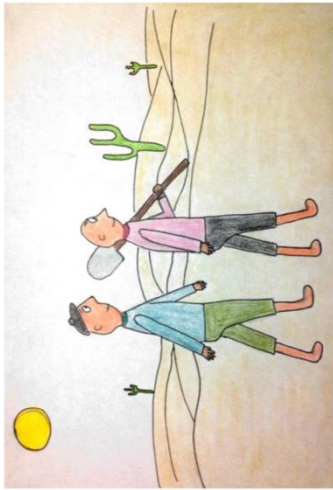






What's the main point of this story?



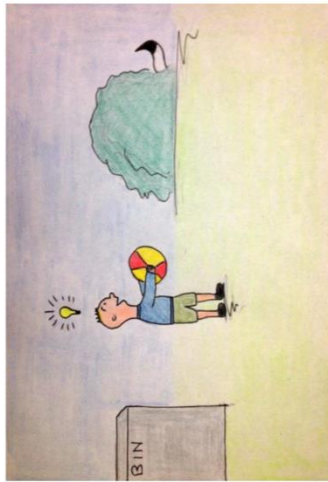








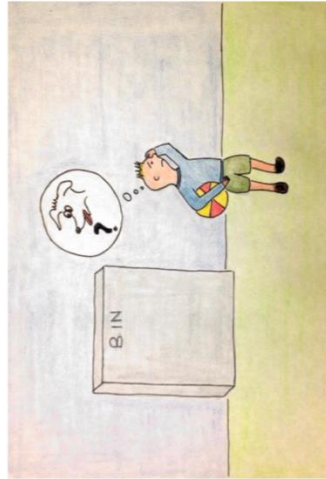
What's the main point of this story?











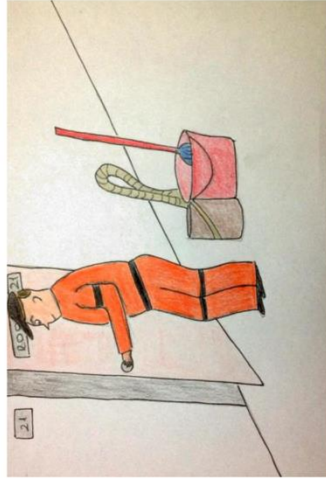
What's the main point of this story?



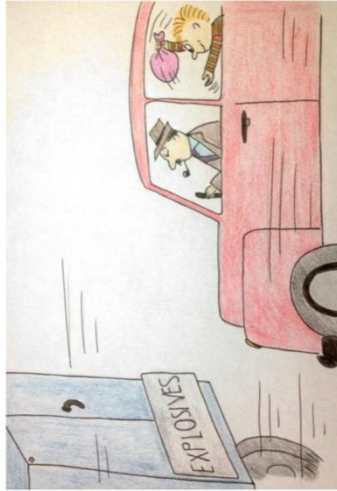


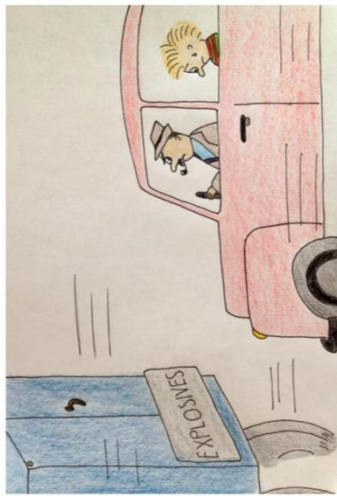


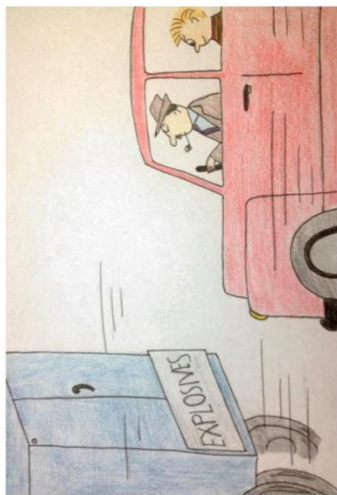


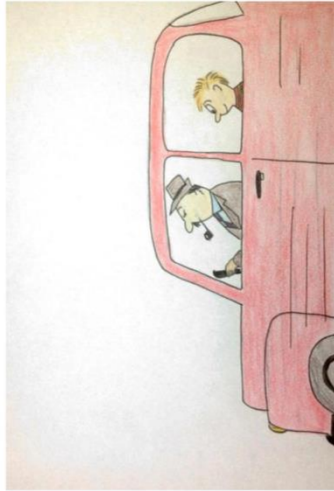


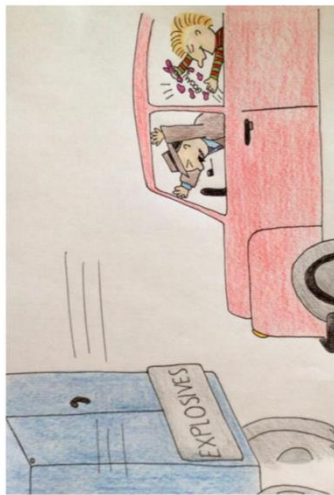
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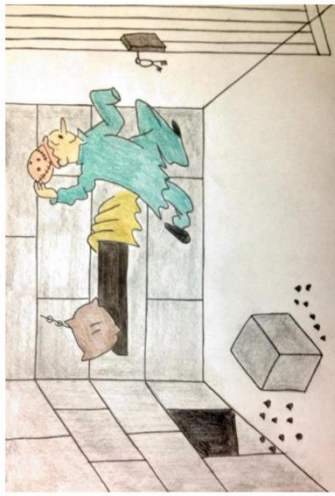




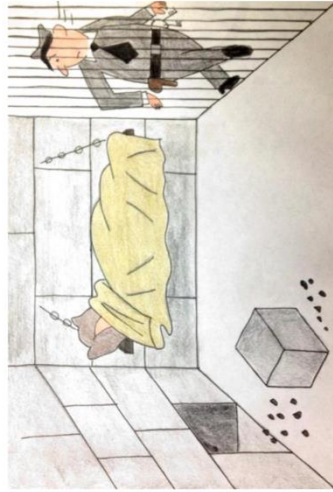


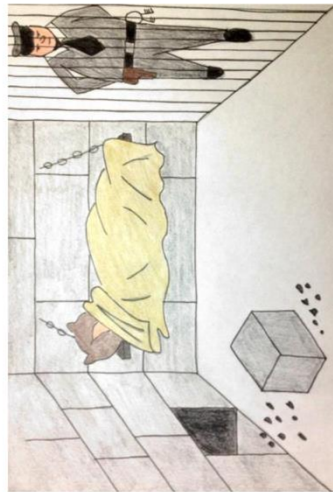
What's the main point of this story?











What's the main point of this story?







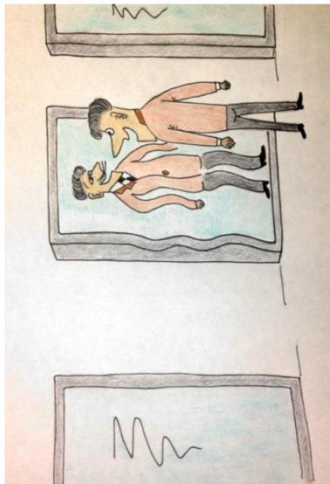




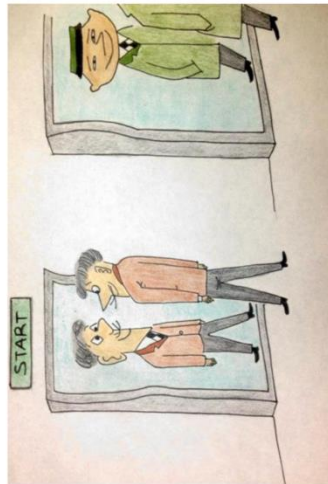
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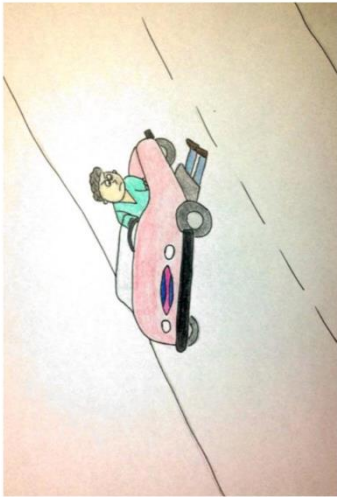


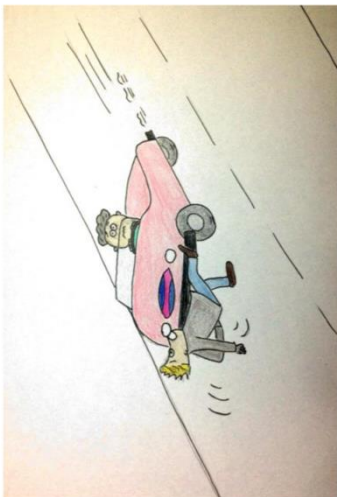


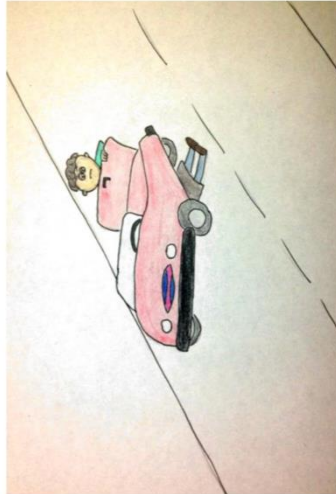


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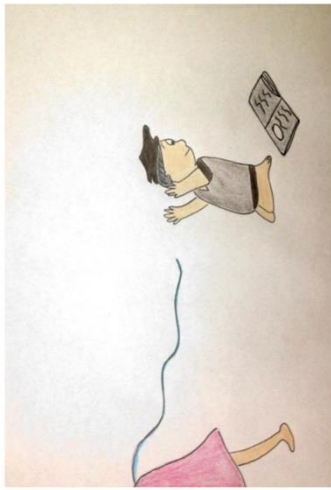






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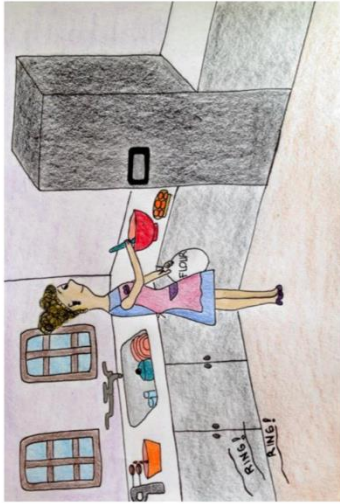


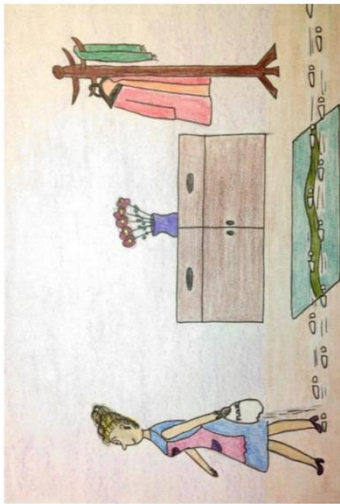


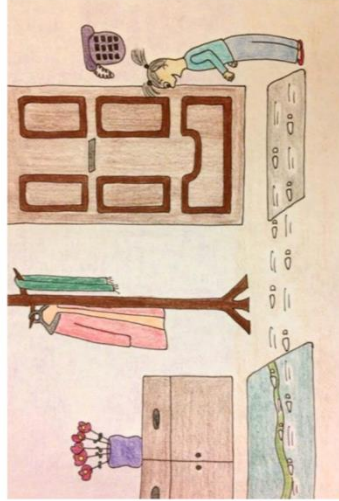


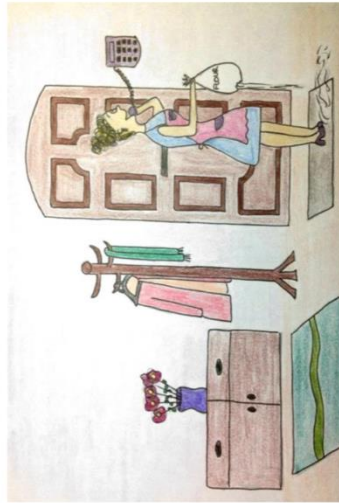
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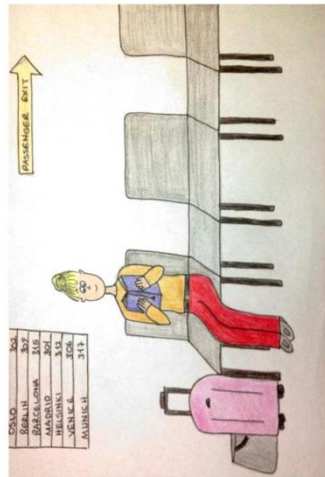


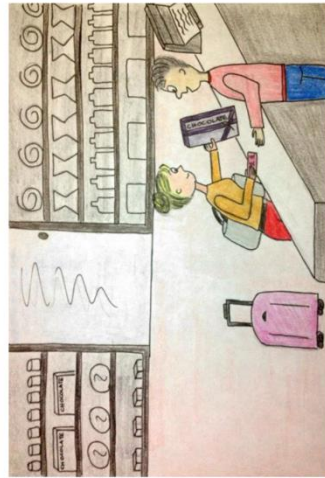






What's the main point of this story?





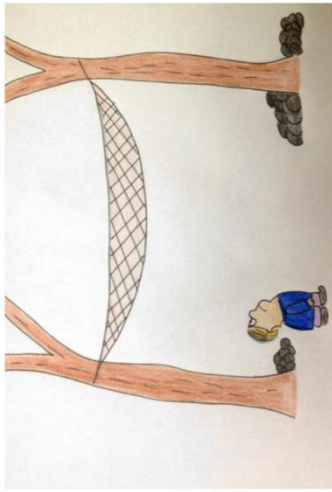






What's the main point of this story?











What's the main point of this story?

Appendix F. Information Sheets, Consent Form and Ethical Approval Letter (Chapter 4 & 6)



**MRC SOCIAL, GENETIC &
DEVELOPMENTAL PSYCHIATRY CENTRE**
Institute of Psychiatry, Psychology and Neuroscience
King's College London
DeCrespigny Park, Denmark Hill
London, SE5 8AF
+44 (0)20 7848 0873

THE AUTISM RESEARCH GROUP
School of Arts & Social Sciences
Department of Psychology
City University London
Whiskin Street
London, EC1R 0JD
+44 (0)20 7040 8380

Information Sheet – Participant

Title of Project: Age-related Effects on Cognition and Quality of Life in Adults with Autism Spectrum Disorder

Ethical Approval References: PNM/13/14-26 (Psychiatry, Nursing and Midwifery (PNM) Research Ethics Subcommittee (RESC) at King's College London)

PSYETH(UPTD) 13/14 28 (City University London School of Arts & School of Social Sciences Research Ethics Committee)

Researcher: Miss Esra Zivrali (MRC SGDP Centre, Institute of Psychiatry, Psychology & Neuroscience)

Supervisors: Professor Francesca Happé (MRC SGDP, Institute of Psychiatry, Psychology & Neuroscience); Professor Patricia Howlin (Department of Psychology, Institute of Psychiatry, Psychology & Neuroscience)

Collaborators: Professor Dermot Bowler (City University London), Ms Amanda Roestorf (City University London)

Information about the Research

Participant Information Leaflet, Version 2.0.0b, date 26 November 2014

Introduction

We would like to invite you to take part in our research study. Before you decide if you want to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully, and discuss it with others if you wish. Ask us if there is anything that is not clear or you would like more information.

What is the purpose of the study?

Autism Spectrum Disorder (ASD) is a life-long condition, and therefore it is important to understand how the process of ageing affects individuals with autism. This research project will explore how the symptoms associated with autism change over the lifespan. For example, this research will look at the changes in mental health and physical well-being and cognitive skills such as language and memory are affected in ageing. The study will also explore how social functioning such as independent living, relationships and social communication affect quality of life.

The aim of this research is to obtain information that will help us to understand the possible changes that occur with age and how this affects the quality of life for individuals with autism. In this way, the study will enable us to identify ways in which support services can be improved to help older adults with autism to lead healthy and fulfilling lives.

Why have I been invited?

We are inviting adults (aged 18+) who have an autism spectrum disorder (i.e. autism or Asperger syndrome) to participate in this study. Whether you received a childhood diagnosis, or one in later-life, we welcome your involvement in this research project.

Do I have to take part?

No. It is entirely up to you whether or not you decide to take part. If you do decide to take part, you are still free to withdraw at any time without giving a reason and without penalty. We will destroy the information we have about you, if you so wish.

What will happen to me if I take part?

If you are recruited into the study, you will be invited to attend two research sessions, held on separate days. These will take place at either the MRC Social Genetic and Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience or at the Autism Research Group at City University London and will be a time that fits in best with your other commitments. The research sessions will usually involve you meeting with just one researcher. You are welcome to bring someone you know with you.

First research session will take about 4-5 hours, and the second one will take about 2-3 hours. During the research sessions you will be asked to fill in some questionnaires. Questions will be about your preferences, emotions, wellbeing, and health. There will also be other computer-tests and puzzles testing your memory, language and social functioning. In addition, if you received your autism diagnosis more than 5 years ago, or you do not have any details about your diagnosis, we may need to confirm your diagnosis via the Autism Diagnostic Observation Schedule (ADOS). This will be done by trained practitioners at the MRC Social Genetic and Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience or at the Autism Research Group at City University London. No additional time is needed, as this has been planned into the overall time for the research sessions. During the research sessions lunch and/or refreshments will be provided in comfort breaks.

We may also require some additional information from a person who has known you for 5 years or longer, and is in regular contact with you. This person may be a spouse or partner, friend, carer, parent or brother or sister. If you agree to us contacting them, please provide their name and contact details to the researcher.

What will happen to the audio or videotape if my interview is recorded?

We will ask for your permission to participate in audio and video recording for some parts of the research. You have the choice to refuse permission for both audio and video, or you may choose to allow either audio or video recordings. The recordings will be reviewed only by researchers in the MRC Social, Genetic and Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience and the Autism Research Group at City University London. All tapes will be labelled with an ID number, rather than your name and no other personal information about you will be included with the tapes. Once the tapes have been transcribed and analysed, they will be destroyed.

Will I be compensated for my time?

To thank you for your time and involvement we will offer you £25 per research session. If you choose to participate in both research sessions, you will therefore be paid £50 in total for your time. We will also provide lunch and/or refreshments during each session and pay for any reasonable travel costs. This will be paid to you directly at the end of each session.

You may be asked to participate in additional research sessions, which will be held at on a separate day and time, at your convenience. You will be remunerated for each session that you attend at the pro-rated rate of £8/hour.

What are the possible benefits of taking part?

Taking part in research projects is often a rewarding and interesting experience. For this research project, in particular, you will contribute to research that aims to create an awareness of how ageing affects individuals with autism, in order to support people such as yourself long into later-life.

What are the possible disadvantages of taking part?

There are no likely risks in taking part in the study, however we appreciate the demands on your time required for the duration of the testing sessions. If at any time you feel any discomfort or anxiety, please let the researcher know and the research session will end immediately.

What if something goes wrong?

In the unlikely event of you suffering any adverse effects as a result of your participation in this research, compensation will be made available through the 'No Fault' Compensation Scheme available from either King's College London (for the MRC Social Genetic and Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience), or through City University London (for the Autism Research Group), depending on where you attended your research session. This scheme includes payment of damages or compensations in respect of any claim made by research participants for bodily injury arising out of participation in any human volunteer study. In the unlikely event that you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence, then you may have grounds for legal action but you may have to pay legal costs.

What if I have any concerns or would like to make a complaint?

If you have a concern about any aspect of this study, please ask to speak to the researchers, or the research supervisors, who will do their best to answer your questions. If you remain unhappy and wish to complain formally, you may do so by contacting the individuals listed below.

For the MRC Social Genetic and Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience:

Dean's office at King's College London

Tel: +44 (0)20 7848 0154

For the Autism Research Group at City University London:

Ms Anna Ramberg, Secretary to Senate Research Ethics Committee

Tel: +44 (0)20 7040 3040 / Email: anna.ramberg.1@city.ac.uk

Will my taking part in the study and my information be kept confidential?

Yes. We will follow ethical and legal practice. All personal information is regarded as strictly confidential and will be held securely until the research is completed. All data for analysis will be anonymised, in other words it will contain only information about the scores and results from questionnaires and other tests, but will not contain any personal information to identify you. We will keep any information we have about you in a safe and secure place. We will erase audio and video tapes once we have transcribed and analysed the data.

Will you tell my GP that I am taking part in this study?

GP's will not be routinely informed about the study, but we will be happy to let your GP know if you wish us to. This would not be done without your knowledge.

Consent

In terms of the Mental Capacity Act Code of Practice (2005), "Every adult has the right to make his or her own decisions and must be assumed to have capacity to make them unless it is proved otherwise". In the unlikely event that you were to lose capacity to act independently and make informed decisions,

once the study had begun, the researcher(s) would end the session immediately and exclude your further participation. Furthermore, any identifiable data that relates to you would be either anonymised or disposed of. The researchers would also be required to seek further assistance and refer you for further care to a clinical practitioner either at the Institute of Psychiatry, Psychology and Neuroscience or City University London and may also advise your carer and/or GP.

What will happen after this research study?

This study is the first stage of a larger research project that aims to understand the effects of the ageing process on psychological, social and physical well-being in people with autism spectrum disorder, and how this relates to overall quality of life. We will also ask for your permission to contact you in the future about additional research sessions related to this project, as well as whether you would be interested in being involved in other research studies. It is entirely up to you if you would like to give permission for us to contact you in the future, and will not affect your participation in this research study. Consent to be contacted again about new projects does not in any way affect you taking part in any future studies.

What will happen to the results of the research study?

We will aim to publish the study findings in scientific journals, and present them at academic conferences and other public seminars related to autism spectrum disorder. The researchers will also include the findings in their Master's and PhD theses. Furthermore, key highlights from the research findings will be made available for public access through the National Autistic Society. All publications will contain anonymous data from the tests and questionnaires used in the study, so that no one else will be able to identify you or know that you have taken part in this study, unless you tell them. We may ask for your permission to use anonymous quotes in any publications. If you would like to be sent a summary of the overall study findings, once the research has been completed, we will ask you to provide your contact details, which will be stored securely in the research offices of the Social, Genetic and Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience and the Autism Research Group at City University London.

Who is organising and funding the research?

This research study is being organised by researchers working at King's College London and City University London. The study has been funded by the Republic of Turkey Ministry of Education for King's College London and the Medical Research Council (MRC UK) for City University London in collaboration with the National Autistic Society.

Who has reviewed this study?

This research study has been reviewed and approved by the King's College London (KCL) College Research Ethics Committee (CREC)-Psychiatry, Nursing, & Midwifery Review Subcommittee/Panel (PNM RESC) (PNM/13/14-26) and City University London School of Arts and School of Social Sciences Research Ethics Committee (project reference: PSYETH(UPTD) 13/14 28).

If you would like any further information about this study please contact:

Miss Esra Zivrali, email: esra.zivrali@kcl.ac.uk; Tel: +44 (0)20 7848 5401; Mobile: +44 (0)79 3365 9264

Thank you for reading this information sheet.

Please keep this in a safe place, in case you need to refer to it at a later time.

**MRC SOCIAL, GENETIC &
DEVELOPMENTAL PSYCHIATRY CENTRE**
Institute of Psychiatry, Psychology and Neuroscience
King's College London
DeCrespigny Park, Denmark Hill
London, SE5 8AF
+44 (0)20 7848 0873

THE AUTISM RESEARCH GROUP
School of Arts & Social Sciences
Department of Psychology
City University London
Whiskin++ Street
London, EC1R 0JD
+44 (0)20 7040 8380

Information Sheet – Participant (Controls)

Title of Project: Age-related Effects on Cognition and Quality of Life in Adults with Autism Spectrum Disorder

Ethical Approval References: PNM/13/14-26 (Psychiatry, Nursing and Midwifery (PNM) Research Ethics Subcommittee (RESC) at King's College London)

PSYETH(UPTD) 13/14 28 (City University London School of Arts & School of Social Sciences Research Ethics Committee)

Researcher: Miss Esra Zivrali (MRC SGDP Centre, Institute of Psychiatry, Psychology & Neuroscience)

Supervisors: Professor Francesca Happé (MRC SGDP, Institute of Psychiatry, Psychology & Neuroscience); Professor Patricia Howlin (Department of Psychology, Institute of Psychiatry, Psychology & Neuroscience)

Collaborators: Professor Dermot Bowler (City University London), Ms Amanda Roestorf+ (City University London)

Information about the Research

Participant Information Leaflet, Version 2.0.0b, date 26 November 2014

Introduction

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What is the purpose of the study?

Autism Spectrum Disorder (ASD) is a life-long condition, and therefore it is important to understand how the process of ageing affects individuals with autism. This research project will explore how the symptoms associated with autism change over the lifespan. For example, this research will look at the changes in mental health and physical well-being and cognitive skills such as language and memory are affected in ageing. The study will also explore how social functioning such as independent living, relationships and social communication affect quality of life.

The aim of this research is to obtain information that will help us to understand the possible changes that occur with age and how this affects the quality of life for individuals with autism. In this way, the study will enable us to identify ways in which support services can be improved to help older adults with autism to lead healthy and fulfilling lives.

Why have I been invited?

We are inviting adults (aged 18+) who do not have any known psychiatric disorder, and who have a good understanding written and verbal English to participate in this study.

Do I have to take part?

No. It is entirely up to you whether or not you decide to take part. If you do decide to take part, you are still free to withdraw at any time without giving a reason and without penalty. We will destroy the information we have about you, if you so wish.

What will happen to me if I take part?

If you are recruited into the study, you will be invited to attend two research sessions, held on separate days. These will take place at either the MRC Social Genetic and Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience or at the Autism Research Group at City University London and will be a time that fits in best with your other commitments. The research sessions will usually involve you meeting with just one researcher.

First research session will take approximately 3-4 hours, and the second one will take about 2-3 hours. During the research sessions you will be asked to fill in some questionnaires. Questions will be about your preferences, emotions, wellbeing, and health. There will also be other computer-tests and puzzles testing your memory, language and social functioning. During the research sessions lunch and/or refreshments will be provided in comfort breaks.

We may also require some additional information from a person who has known you for 5 years or longer, and is in regular contact with you. This person may be a spouse or partner, friend, carer, parent or brother or sister. If you agree to us contacting them, please provide their name and contact details to the researcher.

What will happen to the audio or videotape if my interview is recorded?

We will ask for your permission to participate in audio and video recording for some parts of the research. You have the choice to refuse permission for both audio and video, or you may choose to allow either audio or video recordings. The recordings will be reviewed only by researchers in the the MRC Social, Genetic and Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience and Autism Research Group at City University London. All tapes will be labelled with an ID number, rather than your name and no other personal information about you will be included with the tapes. Once the tapes have been transcribed and analysed, they will be destroyed.

Will I be compensated for my time?

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Will my taking part in the study and my information be kept confidential?

Yes. We will follow ethical and legal practice. All personal information is regarded as strictly confidential and will be held securely until the research is completed. All data for analysis will be anonymised, in other words it will contain only information about the scores and results from questionnaires and other tests, but will not contain any personal information to identify you. We will keep any information we have about you in a safe and secure place. We will erase audio and video tapes once we have transcribed and analysed the data.

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Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience, and the Autism Research Group at City University London.

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If you have a concern about any aspect of this study, please ask to speak to the researchers, or the research supervisors, who will do their best to answer your questions.

Professor Patricia Howlin, email: patricia.howlin@kcl.ac.uk; Tel: +44(0)20 8674 4099

Professor Francesca Happé, email: francesca.happe@kcl.ac.uk; Tel: +44 (0)20 7848 0928

Professor Dermot Bowler, email: d.m.bowler@city.ac.uk; Tel: +44 (0)20 7040 0153

If you remain unhappy and wish to complain formally, you may do so by contacting the individuals listed below.

For the MRC Social Genetic and Developmental Psychiatry Centre at the Institute of Psychiatry, Psychology and Neuroscience:

Dean's office at King's College London

Tel: +44 (0)20 7848 0154

For the Autism Research Group at City University London:

Ms Anna Ramberg, Secretary to Senate Research Ethics Committee

Tel: +44 (0)20 7040 3040 / Email: anna.ramberg.1@city.ac.uk

If you would like any further information about this study please contact:

Miss Esra Zivrali, email: esra.zivrali@kcl.ac.uk; Tel: +44 (0)20 7848 5401; Mobile: +44 (0)79 3365 9264

Thank you for reading this information sheet.

Please keep this in a safe place, in case you need to refer to it at a later time.

**MRC SOCIAL, GENETIC &
DEVELOPMENTAL PSYCHIATRY CENTRE**
Department of Psychology
Institute of Psychiatry, Psychology and Neuroscience
King's College London
DeCrespigny Park, Denmark Hill
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THE AUTISM RESEARCH GROUP
School of Arts & Social Sciences
Department of Psychology
City University London
Whiskin Street
London, EC1R 0JD
+44 (0)20 7040 8380

Consent Form-Participant

Title of Project: Age-related Effects on Cognition and Quality of Life in Adults with Autism Spectrum Disorder

Ethical Approval References: PNM/13/14-26 (Psychiatry, Nursing and Midwifery (PNM) Research Ethics Subcommittee (RESC) at King's College London)

PSYETH(UPTD) 13/14 28 (City University London School of Arts & School of Social Sciences Research Ethics Committee)

Researchers: Miss Esra Zivrali (MRC SGDP Centre)

Supervisors: Professor Francesca Happé (MRC SGDP, Institute of Psychiatry, Psychology & Neuroscience); Professor Patricia Howlin (Department of Psychology, Institute of Psychiatry, Psychology & Neuroscience)

Collaborators: Professor Dermot Bowler (City University London), Ms Amanda Roestorf (City University London)

Thank you for considering taking part in this research. The person conducting the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

Please complete this form after you have listened to an explanation about the research and/or read and understood the Information Sheet.

Please tick (or initial)

I confirm that I have read the information sheet dated **[26.11.14]** for the above named study. I have had the opportunity to consider the information and ask questions and have had these answered satisfactorily by one of the researchers.

☐

I understand that if I decide at any time during the research that I no longer wish to participate in this project, I can notify the researchers involved and withdraw from it immediately without giving any reason. Furthermore, I understand that I will be able to withdraw my data up to the point of publication. Withdrawal from the study will not in any way affect my access to any ongoing treatment or intervention.

☐

I understand what I will be asked to do during the study.

☐

I understand that all individual information collected about me in this study will be kept strictly confidential. The information collected about me will only be used for research purposes and my personal details will only be available to members of the MRC SGDP Centre at the Institute of Psychiatry, Psychology and Neuroscience and the Autism Research Group at City University London.

☐

I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the UK Data Protection Act 1998.

☐

I understand that the results of this study may be shared with other research groups but that these results would be anonymised. My personal details will never be passed on to other researchers unless I give my written consent.

☐

I consent to being contacted in the future by the MRC SGDP Centre or Department of Psychology at the Institute of Psychiatry, Psychology and Neuroscience and/or the Autism Research Group or Department of Psychology at City University London researchers if new studies arise that are related to this project. I understand that giving consent to being contacted does not commit me in any way to taking part in any such future studies.

☐

I agree that the research team may use my anonymised data for future research. Any such data would only be used if the new study was reviewed and approved by the relevant research ethics committee.

☐

I agree that my GP may be contacted if any unexpected results are found in relation to my health. This would not be done without my knowledge.

☐

Please inform the researcher if you are currently involved or have been involved in any other research studies in the last 12 months. *[This is important as it could affect the findings from other studies and to avoid making unnecessary demands of your time].*

☐

I **do / do not** *[delete as appropriate]* give consent to my participation in this research being audio recorded.

☐

I **do / do not** *[delete as appropriate]* give consent to my participation in this research being video recorded.

☐

I consent to being contacted for participation in this project, by the named researchers at: **City University London / King's College London.**

[Note: if you do not want to be contacted by either university, please delete as appropriate]

☐

Participant's Statement:

I _____ *(your name)*

agree that the research project named above has been explained to me to my satisfaction and I agree to take part in the study. I have read both the notes written above and the Information Sheet about the project. I understand what the research study involves and agree to take part in this study.

Signature

Date

Researcher's Statement:

I _____ *(researcher's name)*

Confirm that I have carefully explained the nature, demands and any foreseeable risks (where applicable) of the proposed research to the participant.

Signature

Date

**Research Ethics
Office**

5.11 Franklin Wilkins Building
(Waterloo Bridge Wing)
Stamford Street
London SE1 9NH
Tel 020 7848 4077/4070/3758
Email rec@kcl.ac.uk
www.kcl.ac.uk/research/ethics



Esra Zivrali
Social, Genetic and Developmental Psychiatry Centre
Institute of Psychiatry
King's College London
De Crespigny Park
London
SE5 8AF

24 February 2014

Dear Esra,

PNM/13/14-26 Age-related effects on cognition and quality of life in adults with autism spectrum disorder

Review Outcome: Full Approval

Thank you for sending in the "Information Sheet – Participants (Controls) for the above project. I am pleased to inform you that these meet the requirements of the PNM and therefore that full approval is now granted.

Please ensure that you follow all relevant guidance as laid out in the King's College London Guidelines on Good Practice in Academic Research (<http://www.kcl.ac.uk/college/policyzone/index.php?id=247>).

For your information ethical approval is granted until 31/01/2017. If you need approval beyond this point you will need to apply for an extension to approval at least two weeks prior to this explaining why the extension is needed, (please note however that a full re-application will not be necessary unless the protocol has changed). You should also note that if your approval is for one year, you will not be sent a reminder when it is due to lapse.

Ethical approval is required to cover the duration of the research study, up to the conclusion of the research. The conclusion of the research is defined as the final date or event detailed in the study description section of your approved application form (usually the end of data collection when all work with human participants will have been completed), not the completion of data analysis or publication of the results. For projects that only involve the further analysis of pre-existing data, approval must cover any period during which the researcher will be accessing or evaluating individual sensitive and/or un-anonymised records. Note that after the point at which ethical approval for your study is no longer

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required due to the study being complete (as per the above definitions), you will still need to ensure all research data/records management and storage procedures agreed to as part of your application are adhered to and carried out accordingly.

If you do not start the project within three months of this letter please contact the Research Ethics Office.

Should you wish to make a modification to the project or request an extension to approval you will need approval for this and should follow the guidance relating to modifying approved applications:

<http://www.kcl.ac.uk/innovation/research/support/ethics/applications/modifications.aspx>

The circumstances where modification requests are required include the addition/removal of participant groups, additions/removal/changes to research methods, asking for additional data from participants, extensions to the ethical approval period. Any proposed modifications should only be carried out once full approval for the modification request has been granted.

Any unforeseen ethical problems arising during the course of the project should be reported to the approving committee/panel. In the event of an untoward event or an adverse reaction a full report must be made to the Chair of the approving committee/review panel within one week of the incident.

Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

If you have any query about any aspect of this ethical approval, please contact your panel/committee administrator in the first instance (<http://www.kcl.ac.uk/innovation/research/support/ethics/contact.aspx>). We wish you every success with this work.

With best wishes

Yours sincerely



Marice Lunny, Research Integrity and Ethics Manager

For and on behalf of

Professor Gareth Barker, Chair

Psychiatry, Nursing and Midwifery Research Ethics Subcommittee (PNM RESC)

Appendix G. ToM Cartoon Stories Task (ToM-CSt) Scoring System

General Guidelines:

Accuracy Scoring:

2 points - a full and explicitly correct answer

1 point - a partially correct answer (or leaving key aspects implicit)

0 point - don't know or irrelevant/incorrect answer

Psychological State Talk Scoring:

3 points - using psychological state words to describe 2nd - order psychological state of one character about other/s (e.g. he *wanted* the guard *to think* that he escaped)

2 points - using a complex collection of psychological state words describing one or more character's psychological state/s e.g. she felt *embarrassed* and the man behind was *irritated*

1 point - using a single psychological state word or a few words that are effectively synonymous describing characters' mental states e.g. she was *nasty and mean*, or he *wanted* her to finish quickly

0 point - no use of psychological state words

Specific Guidelines:

Story 1 (ToM) – Cashier

Accuracy:

2 points - reference to the fact that the woman is hiding the number of items in her trolley in order to use the express cashier line

1 point - reference to the fact that the lady is using the express checkout with no indication of her hiding the number of items (e.g. "She is using express checkout, but she has too many items.")

OR

reference to her deceiving the cashier/other people or the cashier to be able to use the express checkout in other ways (e.g. "She jumps in the queue." OR "She spreads her items among other people.")

0 point - don't know

OR

answers without any reference to the fact that she is using the express checkout (e.g. "She is shopping and then paying.")

OR

irrelevant/incorrect answer (e.g. “She forgot/ didn’t like an item.” OR “She realises that it’s an express checkout and feels embarrassed.”)

An example answer that deserves a 3-point psychological state talk score:

“She wants them not to know that she has more than 5 items.”

Story 2 (Control) - Dishes

Accuracy:

2 points - reference to the fact that a lady is washing up the dishes and another lady comes along and helps her with drying and/or putting things away

1 point - answers indicating the fact that a lady is doing the washing-up but without clear reference to the other person’s contribution of drying the dishes/putting them away (e.g. “Lady is washing up and lady is drying up.” OR “Lady is washing up the dishes and another lady comes along and helps her.”)

0 point - don’t know

OR

irrelevant/incorrect answer (e.g. “She is washing and tidying up, but another person comes to mess around.” OR “She is washing up and another lady asks her to re-wash the tray.”)

An example answer that deserves a 3-point psychological state talk score:

“The mom *thinks* that her daughter may be *pleased* to be helped with drying up the dishes and putting them back in the cupboard.”

Story 3 (ToM) - Treasure

Accuracy:

2 points - reference to the fact that one friend is betraying/tricking the other and running away with the treasure from another hole behind the friend/without the friend knowing

1 point - mention of escaping with the treasure or betraying the friend but without any reference to using a different hole/tunnel to run away

0 point - don’t know

OR

irrelevant/incorrect answer (e.g. “They bury the treasure.” OR “He dug another hole and got the treasure.” OR “He is carrying a trunk.” OR “He runs away knocking other man over.”)

OR

answer without reference to the fact that the man is stealing/taking/escaping with the treasure etc.

An example answer that deserves a 3-point psychological state talk score:

“The man *betrays* his friend, who is *thinking* that the other is still *looking for* the treasure, by digging a tunnel and *sneaking off* with the chest from a different hole.”

Story 4 (Control) - Birthday

Accuracy:

2 points - reference to the fact that kids are having birthday party with at least three of the following details: mom brings the cake in/cake is brought out, boy makes a wish, boy blows out the candles, kids eat cake and boy opens his presents

1 point - reference to at least three details above but without any reference to ‘birthday’ (e.g. “She gets a cake and he blows out the candles and then everybody gets a slice of cake.”)

OR

reference to that kids are having birthday party with two or fewer details

0 point - don’t know

OR

answer with two or fewer details above and with no reference to ‘birthday’

OR

irrelevant/incorrect answer (e.g. “Kids are playing; family is having dinner.”)

An example answer that deserves a 3-point psychological state talk score:

“The mom puts the cake in front of the birthday boy and *wants* him to make *a wish*.”

Story 5 (ToM) - Dog

Accuracy:

2 points - reference to the fact that the dog behind the bush is not the boy’s dog / his mistaken thought as it is, and he runs away/ is scared by the dog (or similar e.g. wolf)

1 point - answer suggests that another dog chases/scares him without clear reference to the fact that the dog behind the bush turned out to be not his dog (e.g. “He thinks he sees his dog and he was chased by another dog.”)

OR

reference to the fact that the dog behind the bush is not his dog without any indication of the fact that it scares the boy/the boy is running away/it is an angry dog/it chases him etc.

0 point - don’t know

OR

simple facts (e.g. “Dog chases the cat.” OR “He doesn’t know where the dog’s gone.”)

OR

irrelevant/incorrect answer (e.g. “Dog and cat are fighting in the bush.” OR “His dog comes out of the bush/starts barking and scares him.”)

An example answer that deserves a 3-point psychological state talk score:

“He *wants* his dog to *play* with him.” OR “He *thinks* that the dog is *hiding* behind the bush.”

Story 6 (ToM) - Invitation

Accuracy:

2 points - reference to the fact that the friend who posted the letter comes back and asks about it / he tells him that he sent a letter to inform him, but the occupant never gets the letter/ doesn’t know anything about it

1 point - reference to either the inviter’s expectations (e.g. “He is annoyed /upset because his friend didn’t get the letter,” OR “The inviter comes back and asking about the letter.”) or the invitee’s ignorance (e.g. “The occupant never gets the letter.” OR “The occupant doesn’t know anything about the letter.”)

OR

reference to the fact that the occupant asks where it is and the man tells him that he posted it OR

answer suggests that the man posted it under the wrong door, so he comes back and asks about it but the other man doesn’t know

0 point - don’t know

OR

simple facts (e.g. “The cleaner hoovers the room.”)

OR

irrelevant/incorrect answer (e.g. “The occupant looks for the letter couldn’t find the letter.” OR “The person throws the letter away,” OR “The cleaner hoovers it up accidentally and returns it later.”)

An example answer that deserves a 3-point psychological state talk score:

“He doesn’t *know* that the occupant hasn’t *seen* the letter.”

Story 7 (ToM) - Explosives

Accuracy:

2 points - reference to the fact that they are driving behind an explosives van and the child plays a trick on the dad by bursting a balloon /bag and the man is angry/ tells the boy off/gives him a lecture

1 point - answers with reference to the fact that the child’s joke but without its association with the van of explosives (e.g. “The child pops the balloon and the driver is scared.”)

0 point - don’t know

OR

irrelevant/incorrect answer (e.g. “The child is playing with the balloon and it pops by accident” OR “The man makes the boy upset so the boy bursts the balloon.” OR “The boy empties the bag and upsets the driver.”)

An example answer that deserves a 3-point psychological state talk score:

“He *wants* the driver to *think* the van has exploded.”

Story 8 (ToM) - Prison

Accuracy:

2 points - reference to the fact that the prisoner tricks the guard by making him think that he has already escaped by disguising himself as a dummy and running away (through the open door) while the guard is looking for him in a fake tunnel

1 point – answer indicates that the prisoner tricks the guard and then escapes but with no clear reference to the fact that the dummy/manikin/stuffed doll etc. was actually the prisoner (e.g. “The prisoner was actually in the bed whole time / was hiding in the bed.” OR “The prisoner has made a dummy / has disguised (without further specification).” OR “The dummy runs away.”)

0 point - don't know

OR

answer with no indication of the fact that the prisoner tricks the guard (e.g. "The prisoner escapes." OR "The guard comes into the cell to check the wall and the prisoner takes the advantage and escapes.")

irrelevant/incorrect answer (e.g. "The prisoner is trying to escape and the guard is killing him." OR "The prisoner puts a dummy in his bed and leaves, then the guard comes in and looks for him in the tunnel / in the wrong place." OR "The prisoner scares the guard and then runs off." OR "The prisoner escaped through the hole.")

An example answer that deserves a 3-point psychological state talk score:

"The prisoner *wants* the guard to *think* that he has already escaped."

Story 9 (Control) - Hairdresser's

Accuracy:

2 points - reference to the fact that a lady is going to the hairdresser's / getting a haircut / getting her hair styled

1 point - answer suggests that she is going to the hairdresser's but she looks bad/weird (any negative statement) in the end

0 point - don't know

OR

answer doesn't suggest the fact that she is going to the hairdresser's (e.g. "She is going to a shop, paying and then leaving.")

irrelevant/incorrect answer (e.g. "A man vandalising a manikin then offers vouchers to an attractive woman passing by." OR "She doesn't like the service and then comes back for him to re-style her hair.")

An example answer that deserves a 3-point psychological state talk score:

"The hairdresser *guesses* which style she *likes* and does his business."

Story 10 (ToM) - Mirrors

Accuracy:

2 points - reference to the fact that the man laughed at the man behind a glass door thinking that it is his distorted reflection whereas it is a real man, and the man behind the door is angry/annoyed/offended/upset about being laughed at

1 point - answer suggests that it is not his reflection but a real man with no reference to the fact that the man behind the door is upset / angry / annoyed / offended

0 point - don't know

OR

answer doesn't suggest that it is actually not his reflection but a real man (e.g. "The man thinks how fat he looks and has fun." OR "He is looking at mirror then there is someone else in the shop." OR "He is looking at how large he is and then the door opens and a larger man comes in.")

OR

irrelevant/incorrect answer (e.g. "The guy makes a mistake and when the other guy is upset he doesn't understand what has happened." OR "The man is stuck behind the door.")

An example answer that deserves a 3-point psychological state talk score:

"He *thought* it was his reflection and didn't *know* there was another guy there *getting cross*."

Story 11 (ToM) - Accident

Accuracy:

2 points - reference to the fact that the driver is pretending to the police that the man he has run over is just a mechanic working under the car (to avoid getting arrested)

1 point - answers that convey he is hiding something but with either no reference to the police or to the fact that he is pretending as if the man under the car is fixing the car (e.g. "He stands in front of the man to hide him." OR "He pretends as if his car has just broken down." OR "He knocks the man and when police is riding by he tries to act causal.")

0 point - don't know

OR

answer doesn't suggest the fact that he is hiding something (e.g. "The man runs somebody over and stops to get some tools out then police rides by.")

OR

irrelevant/incorrect answer (e.g. "The car is broken down and a friend helps the man with fixing it." OR "The man tries to fix the situation after he hits a man." OR "He knocks somebody over and calls the police.")

An example answer that deserves a 3-point psychological state talk score:

“He *assumes* that the policemen wouldn’t *think* he has hit somebody.”

Story 12 (Control) – Help

Accuracy:

2 points – reference to the fact that the boy continues reading his book/comic/newspaper while helping the lady (may specify with winding/unwinding wool/knitting etc.)

1 point – answer suggests that he is helping her (may specify with winding/unwinding wool/knitting etc.) but with no reference to the fact that the boy is reading at the same time (e.g. “The little boy is reading and his mom wants him to help her, then she walks off.”)

OR

answer suggests that they are playing

0 point - don’t know

OR

irrelevant/incorrect answer (e.g. “The mother checks what the boy is doing and then boy starts messing around with wool.” OR “The woman needs help but the boy doesn’t want to help her and just reads his book.” OR “The boy doesn’t do what he has been asked to do.” OR “The boy is trapped in wool and the lady helps him.”)

An example answer that deserves a 3-point psychological state talk score:

“The girl *wants* the boy to *help* him with winding some wool while he is reading his book.”

Story 13 (ToM) - Flour

Accuracy:

2 points - reference to the fact that the girl thinks that the flour on the floor is snow and goes outside with winter clothes but finds out it’s sunny / hot AND she is confused / surprised

1 point - reference to only one of the two elements listed above for a 2-point answer; i.e. either reference to the girl’s being confused / surprised to see it’s sunny / hot outside or the girl thinks that it is snowing/ the flour is snow

0 point - don’t know

OR

answer with no reference to either of the details above (e.g. “The daughter notices a trail of flour.”)

OR

irrelevant/incorrect answer (e.g. “The man walking past tries to understand what’s going on there.”)

An example answer that deserves a 3-point psychological state talk score:

“The girl doesn’t *know* that her mother *unintentionally left* floury footprints on the floor, so she *assumes* that these white prints are snow.”

Story 14 (ToM) - Chocolate

Accuracy:

2 points - reference to the fact that the woman assumes that the chocolate box sitting between her and the man is hers and feels annoyed with the man for eating her chocolates, until she realizes that her box of chocolate was in her bag and she has actually been eating his chocolates

1 point - answer suggests a misunderstanding but rather vague/unclear (e.g. “She finds her chocolates in her bag and realizes her mistake / it wasn’t him.” OR “The man is confused maybe he bought the same as well.”)

OR

answer suggests that the man might have put a box of chocolate into the woman’s bag to apologise for eating her chocolates

0 point - don’t know

OR

answer with no reference to misunderstanding (e.g. “She is annoyed and leaves the chocolate box behind.” OR “She is angry because all the chocolates have been eaten.” OR “They eat the chocolates and she gets on the plane.”)

OR

irrelevant/incorrect answer (e.g. “She is scared of flying.” OR “She goes to buy more and takes them to the plane.” OR “She realizes on the plane that she doesn’t have any chocolates left.”)

An example answer that deserves a 3-point psychological state talk score:

“She *realizes* that she was wrong when she *thought* that the man was *greedily* eating all her chocolates.”

Story 15 (Control) - Stones

Accuracy:

2 points - response that states that kids are throwing stones (or similar, coconuts, coals) into the hammock/net to weigh it down/so he can reach it AND once the boy gets in, he throws the stones out

1 point - reference to filling the hammock/net up with stones (or similar, coconuts, coals) bring it down without reference to throwing them out afterwards

0 point - don't know

OR

irrelevant/incorrect answer (e.g. "Kids are playing by throwing rocks into the net.")

An example answer that deserves a 3-point psychological state talk score:

"The boys *wants* her to *help* him to get into the hammock."

Appendix H. The Strange Situations Film Task Scoring System

In all cases participants are awarded points for their best answer when multiple answers are given.

Psychological State Talk Scoring:

3 points - using psychological state words to describe 2nd - order psychological state of one character about other/s (e.g. she *wanted* him to *feel* guilty)

2 points - using a complex collection of psychological state words describing one or more character's psychological state/s e.g. she felt both squeamish and curious at the same time

1 point - using a single psychological state word or a few words that are effectively synonymous describing characters' mental states e.g. she was *nasty and mean*, or she *wanted* him not to smoke

0 point - no use of psychological state words

Accuracy Scoring:

Video 1 (Experimental) - Idiom

Why?:

2 points –reference to Alice thinking that Max is also to blame for what has happened between them; any reference that doesn't imply that only John is at fault

Key words: blame, equal responsibility, guilty as well, fault

1 point – Partly correct response (there is two sides in every story / she wants him to see things from John's point of view); simple description of events (things are complicated, it's a figure of speech); response that describes Alice's position but doesn't suggest shared responsibility (she is taking / defending John's side, she disagrees with Max, she thinks he should make more effort / take responsibility); mention of shared responsibility but responsibility is placed on Alice rather than Max (without clearly referencing she was involved with John).

0 point – irrelevant or incorrect information (e.g. she had an affair with John / she thinks John is to blame).

An example answer that deserves a 3-point psychological state talk score:

“She wants max to know that she is also responsible for what has happened.”

“Max obviously feels as if he is in the wrong and Alice is implying max is also in the wrong because he cooperated in some way or is partially responsible for the thing that has happen.”

What Next?:

2 points – a response that acknowledges implication of blame and attempts to clarify, reconcile or defend self in situation

1 point - poorly elaborated description (e.g. id get defensive), or direct speech (e.g. I disagree it's just John's fault or I agree it does take two to tango).

0 point – don't know, response that shows incomplete understanding e.g. what do you mean?; socially inappropriate e.g. nothing, or irrelevant response e.g. 'its their problem let them sort it out'. Statement that incorporates Alice as having role in situation.

Memory:

1 point - mention of Max needing to own up, confess or admit to what he had done.

0 point – don't know or can't remember or incorrect recall.

Video 2 (Control) – Soup

Why?:

2 points – reference to soup being solution to dilemma of feeling full but not wanting to waste food; he can use the leftovers to make soup.

1 point – reference to facts (there is food left); states (he and Alice are full; not needing to eat anymore). Traits (being practical, kind or nice) or feelings (guilty).

0 point – reference to irrelevant or incorrect factors (he had to do something, not cause an argument, soup is lighter).

An example answer that deserves a 3-point psychological state talk score:

“He was suggesting a way of overcoming their dilemma of not wanting to eat and not wanting to waste anything.”

What Next?

2 points –response that shows acknowledgement of solution even if person doesn’t agree or provides alternative solution.

1 point – no acknowledgment of solution e.g. go ahead, stating preference without acknowledgment e.g. I don’t like soup.

0 point – don’t know, socially inappropriate in the context of the clip e.g. ‘let’s just finish it’, irrelevant or incorrect response e.g. don’t throw it away.

Memory:

1 point - soup

0 point – don’t know or can’t remember or incorrect recall.

Video 3 (Experimental) - Mixed Emotions

Why?:

2 points – reference to curiosity getting the better of her or overriding/co-occurring with her squeamishness or reservation.

1 point - mention of just curiosity or squeamishness; mentions both curiosity and squeamishness, but where squeamishness or curiosity is thought to be feigned; facts e.g. it's a gruesome picture.

0 point – irrelevant/incorrect factors or facts

An example answer that deserves a 3-point psychological state talk score:

“Presumably she was inquisitive about the injury but also had a sense of reluctance and fear maybe.”

What Next?:

2 points – acknowledgement of reluctance or mixed feelings. Response that highlights that her curiosity got the better of her squeamishness.

1 point – no acknowledgment of emotions but just showing her the picture, commenting on the picture or saying ‘have a look’. Statement that suggests squeamishness was feigned.

0 point – don’t know, socially inappropriate e.g. we can’t watch it until you beg, irrelevant response or response that doesn’t comprehend holding both emotions ‘why would you look if you are squeamish?’

Memory:

1 point- mentions or describes accident or injury.

0 point – don’t know or can’t remember or incorrect recall.

Video 4 (Experimental) - Misunderstanding

Why?:

2 points – reference to Alice mistaking or thinking Max was a burglar or that she thought she or somebody’s house was being burgled.

1 point - reference to facts (someone was going in the window), state (she was surprised) or descriptions (it looked like someone was breaking into or climbing

through or breaking in the house) or statement of Alice not knowing it was Max without articulating her misunderstanding.

0 point – factually incorrect or irrelevant answers; mentions thinking that someone was going to burgle her house.

An example answer that deserves a 3-point psychological state talk score:

“She felt a sense of fear/anxiety about what she thought was someone breaking into her house so she threatened calling the police.”

What Next?:

2 points – statement or action that resolves misunderstanding by revealing identity or explaining situation e.g. don’t worry it’s only me’ or ‘I forgot my keys’ or ‘It’s me’

1 point – minimal statement that is partially correct e.g. I live here

0 point – don’t know, inappropriate to the social context e.g. nothing, or showing annoyance with Alice for the misunderstanding, irrelevant response.

Memory:

1 point – any response iterating he was trying to enter the house e.g. climbing through a window or trying to get into the house. NB if participant believes character was a burglar breaking into the house then is awarded memory point for articulating this.

0 point – don’t know, can’t remember or incorrect recall.

Video 5 (Experimental) - Lie

Why?:

2 points - reference to her lying or that she doesn’t want him to know she is in the pub or where she is.

1 point – partially correct e.g. cover up she is in the pub or making an excuse or altering his belief, reference to feelings without elaboration e.g. she feels guilty; facts (she is in a pub, she was supposed to be home for dinner); giving him information (she is going to be home soon), but which doesn't imply wanting to alter his belief.

0 point – incorrect intentions are assumed (e.g. having an affair, hide drinking habit), without mention of a lie or statement taken literally or irrelevant facts/factors.

An example answer that deserves a 3-point psychological state talk score:

“She was lying about where she was cos she didn't want him to know she was in the pub.”

What Next?:

2 points – statement that accepts information and articulates opinion regarding situation or requests more information e.g. ‘Oh okay, do you know what time you're coming back?’ or response that questions Alice's lie in a socially appropriate manner or makes a joke out of situation e.g. ‘I can hear the fruit machines’.

1 point – minimal response that is still socially appropriate e.g. okay. dinners on the Table.

0 point – don't know, inappropriate to the social context e.g. accepts lie but is still annoyed or states utterance is a lie, or irrelevant response.

Memory:

1 point – in a bar or a pub.

0 point – don't know, can't remember or incorrect recall.

Video 6 (Experimental) - Forget

Why?:

2 points – any response that references forgetting, misheard or not paying attention.

1 point – partial description that misses central point of forgetting e.g. she was justifying her purchase; state (she is surprised, he was annoyed), he looked at her questioningly; facts (e.g. she bought a cake).

0 point – incorrect factors (e.g. she didn't want to buy potatoes or was only thinking of herself), or facts (e.g. 'she couldn't find anything else for pudding').

An example answer that deserves a 3-point psychological state talk score:

“She didn't know what she had forgotten.”

What Next?:

2 points – statement that acknowledges Alice forgetting and/or clarifies original request/Max's previous statement appropriately or an appropriate joke that references forgetting e.g. of course you remembered the cake.

1 point – simple reassurance e.g. don't worry, just leave it, or positive regard for decision without clarification that something was forgotten e.g. great.

0 point – don't know, inappropriate e.g. implying that forgetting was intentional, or irrelevant response.

Memory:

1 point - cake or pudding

0 point – don't know, can't remember or incorrect recall.

Video 7 (Experimental) - Appearance Reality

Why?

2 points – reference to him making a joke about the fact he is dressed as a women or they have switched roles and are pretending to be in character.

1 point – desire (he needs the toilet, he doesn't want to put the lipstick on), physical state (he is wearing women's clothing), trait (he is a comedian).

0 point – irrelevant or incorrect answers.

An example answer that deserves a 3-point psychological state talk score:

“He was joking about wanting to go to the toilet dressed as a lady.”

What Next?:

2 points – statement that acknowledges or carries on the joke of being dressed in women's clothing/'being a woman' and that he needs the toilet e.g. 'will you do it sitting down now then?'

1 point – minimal response of what would do/say but still recognizes joke e.g. laugh, state it's funny.

0 point – don't know, inappropriate (e.g. simple acceptance of request) or takes statement literally with no appreciation of joke/role play, or irrelevant answer.

Memory:

1 point – lipstick

0 point – don't know, can't remember or incorrect recall.

Video 8 (Experimental) – Irony

Why?

2 points – any mention of him being sarcastic; he is saying the opposite to what he feels /expressing the contrary; he is ironic.

1 point – reference to being unwell (diabetes) or he is diabetic, a physical act (he just injected himself) or statements that highlight his thoughts or intentions behind making his comment without mention of irony or sarcasm (he doesn't really like doing it, it's a

chore/drag, he has to do this every day, sharing his thoughts, make light of the situation (e.g. joke or make a joke out of it)

0 point – incorrect factors e.g. he enjoys it, or facts e.g. he is taking drugs, or irrelevant answers.

An example answer that deserves a 3-point psychological state talk score:

“He was being sarcastic because he doesn’t really like it and wants his girlfriend to feel sorry for him.”

What Next?:

2 points – statement that expresses sympathy or understanding at how hard it is or trying to make him feel better while reminding him of the importance of doing it.

1 point – simple reminder of importance of using the injection e.g. ‘it’s for your own health’ or that situation could be worse ‘it’s keeping you alive’. Minimal statement of sympathy that shows comprehension of sarcasm (e.g. sorry).

0 point – don’t know, inappropriate e.g. nothing or patronizing or jovial remark or dismisses of character’s emotion e.g. ‘get on with it’, or irrelevant answer.

Memory:

1 point - injecting himself, using insulin, taking medication or related to diabetes (a sugar boost). NB If they believed he was taking drugs then taking drugs is awarded point.

0 points – don’t know, can’t remember or incorrect recall.

Video 9 (Experimental) - Control / Line rental

Why?:

2 points – statements that mention it is cheaper or more economical, they save £30 or money or it’s a better deal or monthly is more expensive / costs more.

1 point – expressing her opinion, reference to having the money now and/or it being more convenient/ practical / sensible /making financial sense or not wanting to worry about the money without mention of it being cheaper (e.g. they can afford it).

0 point – incorrect or inappropriate response.

An example answer that deserves a 3-point psychological state talk score:

“She wants Max to know that she would prefer to save the money and pay up front.”

What Next?:

2 points – statement that acknowledges idea, shows agreement with option chosen and/or with proviso e.g. checking finances.

1 point – minimal description of what would say or do.

0 point – don’t know, socially inappropriate e.g. disagreeing without an explanation or clarification; irrelevant response

Memory:

1 point - mention of any communication provider e.g. BT, broadband, or line rental company.

0 point – don’t know, can’t remember or incorrect recall.

Video 10 (Experimental) - Persuasion

Why?:

2 points - reference to her desires, beliefs or intention to affect his actions or feelings e.g. she wants him to stop smoking, she wants him to not smoke / smoking or doesn’t want him smoke (around her), she is trying to make him feel guilty.

1 point – facts (he is smoking, she is pregnant, he is going to be a dad, to stop), outcomes (to stop him smoking), statements about him being a father and smoking (its

irresponsible, he needs to grow up, it's not a good influence on the child, its bad for his health / smoking is bad / unhealthy), but do not reference her intentions. She doesn't want smoke around her / her child

0 point - incorrect or irrelevant facts or factors.

An example answer that deserves a 3-point psychological state talk score:

“She wants to make him feel bad for smoking.”

What Next?:

2 points – statement that responds to Alice's wanting him to give up or showing a desire or commitment to quit even if smoking now.

1 point – response that shows will change behaviour e.g. smoking outside, without acknowledgement of Alice wanting to stop. Minimal responses that are still socially appropriate e.g. you're right. Asking for Alice to sympathise/minimizing e.g. its only one, without acknowledgement of wanting to quit.

0 point – don't know, socially inappropriate e.g. it's my decision or my choice, or irrelevant comments that don't respond to Alice's previous statement e.g. I'll try.

Memory:

1 point – a father, dad.

0 point – don't know, can't remember or incorrect recall.

Video 11 (Experimental) - Joke

Why?:

2 points – he is joking or an explanation of the joke e.g. he thinks / is saying or indicating that the politicians are full of rubbish or are rubbish / all shit / just like bins.

1 point – facts (he is commenting on politics or situation), feelings (he is annoyed), traits (he is being cynical), Max's intentions/opinion of politicians that miss desire to be humorous (they are rubbish (ppt's opinion), politicians lie, he doesn't like / has low

opinions about politicians or politics, he thinks the politicians should change, politicians don't tell the truth, discredit the party / party should change).

0 point – don't know, incorrect answers, e.g., because bins are full of garbage and before they stink too much it should be cleaned

An example answer that deserves a 3-point psychological state talk score:

“He wants Alice to know that he thinks the politicians are full of rubbish.”

What Next?:

2 points – statement that acknowledges joke and either agrees, asks for clarification, more information or challenges his opinion stated in the joke; responds to his joke with a second appropriate joke e.g. ‘I hate talking politics with you’.

1 point – simple description of what would say or do e.g. laugh, sigh; statement that makes no explicit reference to the presence of a joke.

0 point – don't know, response that shows no understanding of the joke e.g. what does that mean? or directly challenges him missing the point of the joke e.g. ‘that's not the answer to the question’ or irrelevant comments.

Memory:

1 point – newspaper, paper or reading.

0 point – don't know, can't remember or incorrect recall.

Video 12 (Experimental) - Double Bluff

Why?:

2 points – mention of double bluff or reference to Max saying the truth in such a way (e.g. sarcasm) that Alice will think he is joking/not telling the truth or an expression that conveys this e.g. hiding in plain sight.

1 point – reference to him joking/trying to be funny without reference to Alice not believing him (e.g. he is having fun), facts (he was looking at a dating website, it's what he was doing), feelings (guilty), or trying to mislead her e.g. didn't want her to know, pretend doing nothing or play an emotional game (e.g. teasing her).

0 point – incorrect e.g. to try and break up with Alice, he is overly honest or is shocking her. Irrelevant answers.

An example answer that deserves a 3-point psychological state talk score:

“Max wanted Alice to think he was joking so she wouldn't believe that he would be looking at an online dating website.”

What Next?:

2 points – statement that assumes he is joking and/or makes a second joke in response e.g. ‘I have been looking for another boyfriend’.

1 point – simple description of what would say or do e.g. laugh. Socially appropriate response that doesn't acknowledge joke e.g. how was your day?'. Response that asks for clarification whether he was joking.

0 point – don't know, response that assumes statement is sincere, socially inappropriate to the situation or irrelevant comments.

Memory:

1 point – dating website or name of website or response that implies other women.

0 point – don't know, can't remember or incorrect recall.

Video 13 (Experimental) - Pretence

Why?:

2 points - reference to Alice pretending they were rowing a boat; they are playing make believe/imaginary game; role play.

1 point - facts (they bumped into each other), simple intention (she is joking, flirtatious, affectionate, being surreal), states (she is being silly, playful, amused), actions (messing around, playing a game) or just stating they are rowing without mental state words e.g. pretence.

0 point – incorrect or irrelevant response.

An example answer that deserves a 3-point psychological state talk score:

“Alice was playing make believe and wanted Max to think he had splashed her.”

What Next?:

2 points – statement that continues the make believe scenario or makes a joke out of the scenario or appropriate pretence through action e.g. pretending to splash with an imaginary oar.

1 point – simple description of what would say or do that makes no acknowledgement of joke e.g. I really enjoyed that

0 point – don’t know, response that understands comment as the truth e.g. apologizes sincerely, socially inappropriate or irrelevant comments.

Memory:

1 point – mention of a chair.

0 point – don’t know, can’t remember or incorrect recall.

Video 14 (Experimental) - White Lie

Why?:

2 points - reference to white lie or making her feel good or not wanting to hurt Alice’s feelings or not to make her feel bad

1 point - response that states simple traits (he is nice, being supportive, encouraging, polite) or is simply relational (he likes her). Incomplete response (offering fake praise, flatter or he had to say something / didn't know what to say) or solely motivational (so she won't be annoyed, avoid an argument, reassure her).

0 point – incorrect e.g. 'he thought it was good' or only 'he didn't like it', or irrelevant responses.

An example answer that deserves a 3-point psychological state talk score:

"He doesn't want to hurt her feelings."

What Next?:

2 points – statement that acknowledges that Max's comment might not have been completely honest *and* either asks for additional clarification or additional feedback in socially appropriate manner 'do you really mean that?'; sarcastic agreement with his opinion that implies it could be improved.

1 point – incomplete response e.g. thank you, that doesn't appreciate white lie.

0 point – don't know, socially inappropriate e.g. response that sees comment as unsupportive or misses intention of white lie, or irrelevant comments.

Memory:

1 point – mentions guitar.

0 point – don't know, can't remember or incorrect recall.

Video 15 (Experimental) - Control Plant

Why?:

2 points – response that states the tropical plant requires sunlight, warmth / heat and humidity (2 needed) and that in the bathroom the plant will get these due to it being south facing.

1 point - reference to only sun, warmth, sunlight or humidity (due to either it being south facing or the bathroom). Reference to facts (it's a tropical plant, she's giving advice, it'll look nice); simple intentions (she is being helpful, letting him know she agrees, supportive, she thinks it's the best place) incomplete answers that do not mention important factors (it will grow there).

0 point - incorrect e.g. she doesn't like the plant, or irrelevant responses.

An example answer that deserves a 3-point psychological state talk score:

"She thinks the upstairs bathroom will be the best environment for the plant to survive in and for Max to know she is being helpful."

What Next?:

2 points – statement that shows agreement with option chosen or provides alternative that has a rational e.g. kitchen windows.

1 point – simple alternative without explanation.

0 point – don't know, socially inappropriate e.g. disagreeing without an explanation, or irrelevant response.

Memory:

1point - mentions the bathroom.

0 point – don't know, can't remember or incorrect recall

Appendix I. Group and Age Effects on ToM Performance on Separate Tasks

Table I-1 Performance of young and old adults in ASD and NT groups on traditional ToM/social cognition measures: Mean (SD)

		ASD		NT		F ²	p-value	effect size: η^2
		Young N = 29	Old N = 29	Young N = 20	Old N = 19			
Frith-Happé Triangles	Accuracy	4.97 (2.13)	3.69 (1.87)	5.90 (1.74)	3.95 (2.12)	2.12 ^{group} 15.52 ^{age} 0.68 ^{agexgroup}	.15 ^{group} <.001 ^{age} .41 ^{agexgroup}	.02 ^{group} .14 ^{age} .01 ^{agexgroup}
	PST ¹	4.86 (2.59)	5.10 (2.47)	6.65 (1.69)	5.58 (2.50)	5.29 ^{group} 0.71 ^{age} 1.78 ^{agexgroup}	<.05 ^{group} .40 ^{age} .19 ^{agexgroup}	.05 ^{group} .01 ^{age} .02 ^{agexgroup}
Eyes Test	Accuracy	24.38 (5.44)	25.38 (4.70)	30.15 (2.64)	26.74 (3.89)	14.87 ^{group} 1.70 ^{age} 5.70 ^{agexgroup}	<.001 ^{group} .20 ^{age} <.05 ^{agexgroup}	.14 ^{group} .02 ^{age} .06 ^{agexgroup}

¹ Psychological State Talk

² All $df_M s = 1$ and $df_R s = 93$

^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group

Table I-2 Performance of young and old adults in ASD and NT groups on the Strange Situations Film task (SSFt): Mean (SD)

		ASD		NT		F ²	p-value	effect size: η^2
		Young N = 29	Old N = 29	Young N = 20	Old N = 19			
Experimental Clips	Intention (max 24)	16.00 (3.61)	15.00 (3.39)	19.15 (2.28)	15.37 (4.07)	6.20 ^{group} 11.44 ^{age} 3.87 ^{agexgroup}	<.05 ^{group} <.01 ^{age} .052 ^{agexgroup}	.06 ^{group} .11 ^{age} .04 ^{agexgroup}
	PST ¹ (max 36)	15.97 (5.31)	15.28 (3.87)	18.30 (3.10)	15.42 (4.68)	1.87 ^{group} 3.87 ^{age} 1.46 ^{agexgroup}	.18 ^{group} .052 ^{age} .23 ^{agexgroup}	.02 ^{group} .04 ^{age} .02 ^{agexgroup}
	Interaction (max 24)	10.97 (3.92)	12.28 (3.26)	15.40 (1.64)	13.84 (3.93)	18.44 ^{group} 0.03 ^{age} 4.21 ^{agexgroup}	.001 ^{group} .86 ^{age} <.05 ^{agexgroup}	.17 ^{group} <.001 ^{age} .04 ^{agexgroup}
	Memory (max 12)	11.52 (0.69)	11.34 (0.86)	11.90 (0.45)	11.32 (0.95)	1.26 ^{group} 5.78 ^{age} 1.71 ^{agexgroup}	.26 ^{group} <.05 ^{age} .19 ^{agexgroup}	.01 ^{group} .06 ^{age} .02 ^{agexgroup}

Table continued on the next page

		ASD		NT		F ²	<i>p</i> -value Young N = 29	effect size: η^2 Old N = 29
		Young N = 29	Old N = 29	Young N = 20	Old N = 19			
Control Clips	Intention (max 6)	3.72 (1.00)	4.38 (1.08)	3.90 (1.12)	4.11 (1.10)	0.05 ^{group} 3.78 ^{age} 1.03 ^{agexgroup}	.83 ^{group} .06 ^{age} .31 ^{agexgroup}	.001 ^{group} .04 ^{age} .01 ^{agexgroup}
	PST ¹ (max 9)	1.41 (1.50)	0.90 (1.11)	1.25 (1.02)	1.37 (1.30)	0.35 ^{group} 0.58 ^{age} 1.48 ^{agexgroup}	.56 ^{group} .45 ^{age} .23 ^{agexgroup}	.004 ^{group} .01 ^{age} .02 ^{agexgroup}
	Interaction (max 6)	4.59 (1.43)	4.86 (1.27)	5.60 (0.60)	5.47 (1.22)	10.53 ^{group} 0.09 ^{age} 0.64 ^{agexgroup}	<i>p</i> < .01 ^{group} .77 ^{age} .42 ^{agexgroup}	.10 ^{group} .001 ^{age} .01 ^{agexgroup}
	Memory (max 3)	2.79 (0.56)	2.97 (0.19)	2.90 (0.31)	2.79 (0.42)	0.18 ^{group} 0.14 ^{age} 2.96 ^{agexgroup}	.68 ^{group} .71 ^{age} .09 ^{agexgroup}	.002 ^{group} .002 ^{age} .03 ^{agexgroup}

¹ Psychological State Talk

² All $df_M s = 1$ and $df_{RS} = 93$

^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group

Table I-3 Performance of young and old adults in ASD and NT groups on the ToM Cartoon Stories task (ToM-CSt): Mean (SD)

		ASD		NT		F ²	p-value	effect size: η^2
		Young N = 29	Old N = 29	Young N = 20	Old N = 19			
Experimental Cartoon Stories	Sequence (max 50)	40.45 (8.76)	38.55 (9.29)	43.00 (4.22)	33.26 (10.12)	0.60 ^{group} 10.88 ^{age} 4.94 ^{agexgroup}	.44 ^{group} < .01 ^{age} < .05 ^{agexgroup}	.01 ^{group} .11 ^{age} .05 ^{agexgroup}
	Accuracy (max 20)	10.34 (4.97)	9.97 (4.76)	13.45 (2.89)	8.47 (4.98)	0.73 ^{group} 8.04 ^{age} 5.92 ^{agexgroup}	.40 ^{group} < .01 ^{age} < .05 ^{agexgroup}	.01 ^{group} .08 ^{age} .06 ^{agexgroup}
	PST ¹ (max 30)	16.41 (3.79)	17.17 (3.91)	17.50 (2.24)	15.63 (3.15)	0.10 ^{group} 0.61 ^{age} 3.39 ^{agexgroup}	.75 ^{group} .44 ^{age} .07 ^{agexgroup}	.001 ^{group} .01 ^{age} .04 ^{agexgroup}
Control Cartoon Stories	Sequence (max 25)	22.17 (4.04)	20.07 (3.97)	22.65 (2.80)	17.63 (4.37)	1.50 ^{group} 19.76 ^{age} 3.31 ^{agexgroup}	.22 ^{group} $p < .001$ ^{age} .07 ^{agexgroup}	.02 ^{group} .18 ^{age} .03 ^{agexgroup}
	Accuracy (max 10)	8.86 (1.33)	8.76 (1.55)	9.00 (1.12)	8.42 (1.54)	0.12 ^{group} 1.38 ^{age} 0.67 ^{agexgroup}	.73 ^{group} .24 ^{age} .42 ^{agexgroup}	.001 ^{group} .02 ^{age} .01 ^{agexgroup}
	PST ¹ (max 15)	4.83 (2.16)	5.86 (2.37)	6.25 (1.83)	5.05 (1.31)	0.53 ^{group} 0.04 ^{age} 7.06 ^{agexgroup}	.47 ^{group} .85 ^{age} < .01 ^{agexgroup}	.01 ^{group} .000 ^{age} .07 ^{agexgroup}

¹ Psychological State Talk

² All $df_M = 1$ and $df_R = 93$

^{group} Main effect of study group

^{age} Main effect of age group

^{agexgroup} Interaction effect of age group by study group

Table I – 4 Performance of young and old adults in ASD and NT groups on the Coat Story task: Mean (SD)

Coat Story	Test Question		22 (76%)	17 (59%)	16 (80%)	11 (58%)
	Justification Question	Zero-order	6 (21%)	5 (17%)	1 (5%)	2 (11%)
		1 st -order	16 (55%)	14 (48%)	6 (30%)	9 (47%)
		2 nd -order	7 (24%)	10 (34%)	13 (65%)	8 (42%)

Coat Story performance was examined using log-linear, Chi-square and multinomial logistic regression analyses. The three-way loglinear analysis produced a final model that retained only one-way effects. The likelihood ratio of this model was $\chi^2(4) = 3.88, p = .42$. To further investigate one-way interactions, separate chi-square tests on study group and age group were performed in relation to performance on test question of the Coat Story task. There was a significant association between age group

and test question performance ($\chi^2 (1) = 4.12, p < .05$), whereas the association between study group and test question performance was not significant ($\chi^2 (1) = 0.04, p = 1$). This indicated that young adults, independent from study group, were more successful in giving correct answers to the test questions than old adults.

Due to the limited number of individuals who gave zero-order answers to justification question in study age groups, a multinomial logistic regression analysis was conducted to predict zero-, first-, or second-order answers to justification question using study group and age as predictors. A significant model was found ($\chi^2 (2) = 6.63, p < .05$) with a *Nagelkerke* $R^2 = .08$ (Table I-5). The Wald criterion demonstrated that only study group made a significant contribution to prediction of giving 2nd-order answer to the justification question ($p < .05$). Odds ratio indicates that adults without ASD were 4.53 times more likely to give 2nd-order answers to justification question of the Coat Story task than adults with ASD.

Table I-5 Multinomial logistic regression results to predict answers based on age (in years) and study group (ASD/NT)

			Lower	Odds Ratio	Upper
Zero-order vs. 1 st -order	Intercept	1.003 (0.35)**	-	-	-
	Study Group	0.61 (0.72) ^{ns}	0.44	1.83	7.58
Zero-order vs. 2 nd -order	Intercept	0.44 (0.39)	-	-	-
	Study Group	1.51 (0.73)*	1.09	4.53	18.89

Note: $R^2 = .07$ (Cox & Snell), $.08$ (Nagelkerke). ^{ns} $p > .05$, * $p < .05$, ** $p < .01$.

Appendix J. Information Sheet and Ethical Approval Letter (Chapter 7)



MRC SGDP CENTRE

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Information Sheet

Title of Project: Wellbeing in Grandparents of Children with Autism Spectrum Disorder (ASD)

Ethical Approval References: PNM/13/14-56 (Psychiatry, Nursing and Midwifery (PNM) Research Ethics Subcommittee (RESC) at King's College London)

Researchers: Miss Esra Zivrali (SGDP, IoPPN)

Supervisors: Professor Francesca Happé (SGDP, IoPPN); Professor Patricia Howlin (Department of Psychology, IoPPN)

Information about the Research

Participant Information Leaflet, Version 1.0.5, date 1 January 2016

Introduction

We would like to invite you to take part in our research study. Before you decide if you want to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully, and discuss it with others if you wish. Ask us if there is anything that is not clear or you would like more information.

What is the purpose of the study?

Autism Spectrum Disorder (ASD) is a life-long condition, and therefore it is important to understand how the process of ageing affects individuals with autism. ASD has a large genetic component, and sometimes relatives of those with ASD recognise similar but much subtler features in themselves. These ASD-related traits can be assets (e.g. eye for detail) or challenges (e.g. social difficulties). This research project will explore wellbeing in the older relatives of children with ASD. For example, this research will look at the changes in mental health, physical wellbeing and cognitive skills affected in ageing. The study will also explore how social functioning such as relationships affects quality of life.

The aim of this research is to obtain information that will help us to understand the possible changes that occur with age and how this affects the quality of life for individuals who may share more or less of the traits associated with ASD. In this way, the study will enable us to identify ways in which support services can be improved to help older adults with autism to lead healthy and fulfilling lives.

Why have I been invited?

We are inviting biologically related grandparents (aged 50+) of young people with ASD to participate in this study.

Do I have to take part?

No. It is entirely up to you whether or not you decide to take part. If you do decide to take part, you are still free to withdraw from the study at any time before 30.09.2016 without giving a reason and without penalty. We will destroy the information we have about you, if you wish.

What will happen to me if I take part?

If you are recruited into the study, you will be sent a booklet of questionnaires about your lifestyle, preferences, and wellbeing. There are also photo and cartoon puzzles developed by us for you to complete. Completion of the set of questionnaires will take approximately 60-90 minutes in total. After you have completed all of the questionnaires, we would like you to send all the materials back to us by using the enclosed envelope in the package sent to you.

Will I be compensated for my time?

To thank you for your time and involvement we will put you in a £50 Amazon voucher prize draw at the end of the year.

What are the possible benefits of taking part?

Taking part in research projects is often a rewarding and interesting experience. For this research project, in particular, you will contribute to research that aims to create an awareness of how ageing affects individuals with autism, in order to support people such as your grandchildren throughout the life-span. We cannot promise any direct benefits to you but hope our research will make a difference in the longer term.

What are the possible disadvantages of taking part?

There are no likely risks in taking part in the study, however we appreciate the demands on your time required for the duration of the questionnaires.

If at any time you feel any discomfort or anxiety, you can stop answering the questions. If you have any concerns at any time before, during or after the research session, you are welcome to contact the research supervisors at any time, at the MRC SGDP Centre at the Institute of Psychiatry, Psychology and Neuroscience.

Will my taking part in the study be kept confidential? / Will my information be kept confidential?

Yes. We will follow ethical and legal practice. All personal information is regarded as strictly confidential and will be held securely until the research is completed. All data for analysis will be anonymised, in other words it will contain only information about the scores and results from questionnaires and other tests, but will not contain any personal information to identify you. We will keep any information we have about you in a safe and secure place.

Will you tell my GP that I am taking part in this study?

GP's will not be routinely informed about the study, but we will be happy to let your GP know if you wish us to. This would not be done without your knowledge.

Consent

Your submission of the questionnaires will also be considered as your consent to participate into the study. In terms of the Mental Capacity Act Code of Practice (2005), "Every adult has the right to make his or her own decisions and must be assumed to have capacity to make them unless it is proved otherwise". In the unlikely event that you were to lose capacity to act independently and make informed decisions, once the study had begun, the researcher(s) would exclude your further participation. Furthermore, any identifiable data that relates to you would be either anonymised or disposed of. The researchers would also be required to seek further assistance and refer you for further care to a clinical practitioner at the Institute of Psychiatry, and may also advise your carer and/or GP.

What will happen after this research study?

This study is a part of a larger research project that aims to understand the effects of the ageing process on psychological, social and physical wellbeing in people with autism spectrum disorder, and how this relates to overall quality of life. We will also ask for your permission to contact you in the future about additional research sessions related to this project, as well as whether you would be interested in being involved in other research studies. It is entirely up to you if you would like to give permission for us to contact you in the future, and will not affect your participation in this research study. Consent to be contacted again about new projects does not in any way affect you taking part in any future studies.

What will happen to the results of the research study?

We will aim to publish the study findings in scientific journals, and present them at academic conferences and other public seminars related to autism spectrum disorder. The researcher will also include the findings in her PhD thesis. Furthermore, key highlights from the research findings will be made available for public access through the National Autistic Society. All publications will contain anonymous data from the tests and questionnaires used in the study, so that no one else will be able to identify you or know that you have taken part in this study, unless you tell them. We may ask for your permission to use anonymous quotes in any publications. If you would like to be sent a summary of the overall study findings, once the research has been completed, it will be provided for you.

Who is organising and funding the research?

This research study is being organised by researchers working at King's College London. The study has been funded by the Republic of Turkey Ministry of Education.

Who has reviewed this study?

This research study has been reviewed and approved by the King's College London (KCL) College Research Ethics Committee (CREC)-Psychiatry, Nursing, & Midwifery Review Subcommittee/Panel (PNM RESC).

If this study has harmed you in any way, please contact the research supervisors whose contact details are provided below.

Professor Francesca Happé, email: francesca.happe@kcl.ac.uk; Tel: +44 (0)20 7848 0928

Professor Patricia Howlin, email: patricia.howlin@kcl.ac.uk; Tel: +44(0)20 8674 4099

If you would like any further information about this study and for general queries, please contact:

Miss Esra Zivrali, email: esra.zivrali@kcl.ac.uk; Tel: +44 (0)20 7848 5401; Mobile: +44 (0)79 3365 9264

Thank you for reading this information sheet.

Please keep this in a safe place, in case you need to refer to it at a later time.

Esra Zivrali
Social, Genetic and Developmental Psychiatry Centre
Institute of Psychiatry
King's College London
De Crespigny Park
London
SE5 8AF

14 March 2014

Dear Esra Zivrali

PNM/13/14-56 Wellbeing in Grandparents of Children with Autism Spectrum Disorder (ASD)

Review Outcome: Full Approval

Thank you for sending in the amendments/clarifications requested to the above project. I am pleased to inform you that these meet the requirements of the PNM and therefore that full approval is now granted.

Please ensure that you follow all relevant guidance as laid out in the King's College London Guidelines on Good Practice in Academic Research (<http://www.kcl.ac.uk/college/policyzone/index.php?id=247>).

For your information ethical approval is granted until 14/03/2017. If you need approval beyond this point you will need to apply for an extension to approval at least two weeks prior to this explaining why the extension is needed, (please note however that a full re-application will not be necessary unless the protocol has changed). You should also note that if your approval is for one year, you will not be sent a reminder when it is due to lapse.

Ethical approval is required to cover the duration of the research study, up to the conclusion of the research. The conclusion of the research is defined as the final date or event detailed in the study description section of your approved application form (usually the end of data collection when all work with human participants will have been completed), not the completion of data analysis or publication of the results. For projects that only involve the further analysis of pre-existing data, approval must cover any period during which the researcher will be accessing or evaluating individual sensitive and/or un-anonymised records. Note that after the point at which ethical approval for your study is no longer required due to the study being complete (as per the above definitions), you will still need to ensure all research data/records management and storage procedures agreed to as part of your application are adhered to and carried out accordingly.

If you do not start the project within three months of this letter please contact the Research Ethics Office.

Should you wish to make a modification to the project or request an extension to approval you will need approval for this and should follow the guidance relating to modifying approved applications:

<http://www.kcl.ac.uk/innovation/research/support/ethics/applications/modifications.aspx>

The circumstances where modification requests are required include the addition/removal of participant groups, additions/removal/changes to research methods, asking for additional data from participants, extensions to the ethical approval period. Any proposed modifications should only be carried out once full approval for the modification request has been granted.

Any unforeseen ethical problems arising during the course of the project should be reported to the approving committee/panel. In the event of an untoward event or an adverse reaction a full report must be made to the Chair of the approving committee/review panel within one week of the incident.

Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

If you have any query about any aspect of this ethical approval, please contact your panel/committee administrator in the first instance (<http://www.kcl.ac.uk/innovation/research/support/ethics/contact.aspx>). We wish you every success with this work.

Yours sincerely

Marice Lunny, Research Integrity and Ethics Manager

For and on behalf of

Professor Gareth Barker, Chairman

Psychiatry, Nursing and Midwifery Research Ethics Subcommittee (PNM RESC)

CC. Dr Francesca Happe

Appendix K. Level of Education Scoring System (Chapter 7)

0: no qualifications

1: GSCE's/ school certificate/O levels/CSE/NVQ levels 1& 2

2: A levels/HNC/"diploma" (unless it's clear what that is for)/NVQ level 3 & 4/ HND

3: Bachelor's degree

4: Master's degree/ post grad diploma (e.g. PGCE)/NVQ level 5

5: PHD; DSc.

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