Understanding the relationship between social camouflaging in autism and safety behaviours in social anxiety in autistic and non-autistic adolescents

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SYSTEMATIC REVIEW & META-ANALYSIS

EMPIRICAL PROJECT

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Chapter 1

Systematic Review and Meta-Analysis

Examining the relationship between cognitive inflexibility and internalising and externalising symptoms in autistic children and adolescents: A systematic review and meta-analysis

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Abstract

Background: Compared to neurotypical peers, autistic adolescents show greater cognitive inflexibility (CI) which manifests at the behavioural and cognitive level and potentially increases vulnerability for the development of internalising (INT) and externalising (EXT) symptoms. This systematic review and meta-analysis explored the association between CI and INT/EXT in autistic adolescents.

Methods: PubMed, EMBASE, MEDLINE, PsycINFO and Web of Science databases were searched to identify relevant studies until April 2022 (PROSPERO protocol: CRD42021277294). Systematic review included 21 studies (n = 1608) of CI and INT, and 15 studies (n = 1115) of CI and EXT. A pooled effect size using Pearson's correlation between CI and INT/EXT was calculated and the moderating effects of age, sex, IQ and study quality were investigated using meta-regressions. Sensitivity analyses were completed to investigate the impact of measure variance for CI and co-occurring ADHD on the overall effects.

Results: Greater CI is associated with increased INT (9 studies; n = 833; r = .39 (moderate effect), 95% confidence interval [0.32, 0.46]) and EXT (6 studies; n = 295; r = .48 (large effect), 95% confidence interval [0.38, 0.58]). Results withheld when only using parental reports of CI and excluding autistic adolescents with co-occurring ADHD.

Conclusions: Increased CI may be a transdiagnostic vulnerability factor that can increase autistic adolescents' rigid or perseverative patterns of unhelpful cognition and behaviours and reduce their ability to access psychological interventions. Addressing CI may improve autistic children and adolescents' engagement with psychological therapy for co-occurring mental health difficulties.

Keywords: Autism spectrum disorder; ASD; cognitive flexibility; CI; internalising; externalising; meta-analysis; systematic review

Lay Summary

This systematic review and meta-analysis explored the relationship between cognitive inflexibility (CI) and symptoms of anxiety, depression and behavioural difficulties in autistic children and adolescents. CI refers to increased rigidity and perseveration in thinking and behaviour and was found to be associated with increased mental health symptoms in autistic adolescents. Addressing and targeting individual differences in CI may improve autistic children and adolescents' engagement with psychological therapy for co-occurring mental health difficulties.

1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterised by social communication difficulties and restricted and repetitive behaviours and sensory anomalies (American Psychiatric Association, 2013) that affects 1 in 54 children (Centers for Disease Control and Prevention, 2019). In both population derived sample estimates and meta-analysis that have examined psychiatric co-occurring conditions amongst autistic individuals, 70% of autistic[1] children and adolescents have at least one co-occurring condition (Simonoff et al., 2008), between 20-41% experience internalising conditions including anxiety and mood disorders, and between 12-30% experience externalising conditions such as oppositional defiant and conduct disorder (Lai et al., 2019; Simonoff et al., 2008).

Given that co-occurring psychiatric conditions negatively impact the quality of life for autistic children and adolescents (van Steensel et al., 2012), identifying possible vulnerability factors can inform clinical assessment, formulation and intervention. Recent systematic reviews have highlighted that individual differences in executive function (EF) amongst autistic individuals may pose a significant risk factor for the development and maintenance of psychopathology (Demetriou et al., 2018; Uddin, 2021). The unitary (i.e., different components within EF may correlate with each other to suggest a common underlying process) and diversity (i.e., different EF processes also show separability when assessed using performance-based vs rater-report measures, and may load onto different latent constructs) (Friedman & Miyake, 2017) highlights that it may be possible to adopt a dimensional approach to better understand the unique impact of individual EF processes above and beyond the common EF factor contributing to the behavioural differences observed across autistic individuals (Demetriou et al., 2018). Furthermore, the degree of heterogeneity in performance across different EF domains is more significant in young people from neurodiverse backgrounds compared to their neurotypical peers. Reasons accounting for widespread heterogeneity may be related to a number of factors including method of EF assessment, age range of participants, and level of individual functioning, further suggesting a common EF factor may not be able to inform different subtypes of EF difficulties amongst autistic young people (Demetriou et al., 2019).

[1] This study uses both identity-first and person-first language when referring to autism, as studies in recent years have shown that the semantic choice of language when referring to autism is often debated without a general consensus being reached (Bury et al., 2020; Kenny et al., 2016; Vivanti, 2020).

Adopting a dimensional approach by focusing on a single executive function domain can also support the establishment and critical evaluation of evidence-base to explore whether the identified construct may be suitable for intervention as an explicit treatment target. Such knowledge is crucial for supporting clinicians to make informed decisions when adapting clinical interventions to treat psychopathology for autistic children and young people (Demetriou et al., 2018; Kenworthy et al., 2014; Morris & Mansell, 2018; Uddin, 2021). One important executive function domain under recent scrutiny in autism research is cognitive flexibility, especially when considered from a developmental perspective across adolescence (Uddin, 2021). Cognitive flexibility enables one to develop a well-organised response in an efficient manner and act in a goal-directed way, and increased cognitive flexibility is associated with being better able to adapt to novel situations and generalise problem solving skills across a variety of settings (Kenworthy et al., 2014). For autistic young people, cognitive flexibility plays an important buffering role against increasing development demands during adolescence from biological (changes in hormones, neural reorganisation in the adolescent brain), psychological (increased peer-sensitivity including reward and rejection), and social (changes in peer relationships and increasing independence from family) perspectives (Uddin, 2021). One recent study found that different aspects of cognitive and social flexibility reported by parents accounted for individual differences in social adaptive functioning and communication skills in autistic youths aged 7-17 years, such that greater flexibility supported the ability for young people to function independently when transitioning to young adulthood (Bertollo et al., 2020), and is a protective factor against maladjustment through puberty.

Reduced cognitive flexibility, or cognitive inflexibility (CI), can also be a risk factor in development for autistic young people (Uddin, 2021). Compared to adolescents with ADHD and neurotypical peers, autistic adolescents and their parents report greater cognitive inflexibility (CI) and reduced emotional control and reduced self-monitoring (Kenworthy et al., 2022). Parent-report of CI in autistic children and adolescents (aged 5-18 years) directly predicted externalising symptoms and indirectly predicted internalising symptoms via intolerance of uncertainty (Ozsivadjian et al., 2021). Another recent study using a range of neuropsychological tasks to measure CI demonstrated associations with internalising symptoms across both adolescence and early adulthood, with inflexibility accounting for the stability of symptoms across timepoints (Hollocks et al., 2022). This suggests that CI may be one mechanism through which emotional difficulties are maintained longitudinally.

The definition of CI and its assessment shows variance across empirical literature (Ionescu, 2012). At the behavioural level, cognitive flexibility has been assessed by observing one's ability to switch between different sets of rules and instructions (or set-shifting), finding alternative solutions, and even multitasking (Cragg & Chevalier, 2012; Geurts et al., 2009). At the conceptual level, flexibility is less clearly defined, and has been related to cognitive control that falls under executive function, shifting between and generating alternative strategies when problem solving in light of conflicting evidence (Bennett & Müller, 2010; Garcia-Garcia et al., 2010), engaging in adaptive behaviours in a goal-oriented manner based on environmental changes (Deák, 2003), and even divergent thinking and creativity (Cretenet & Dru, 2009; Dietrich & Kanso, 2010). Cognitive mechanisms interact with environmental factors such as task demands, contextual cues, and sensorimotor aspects, and continues to mature over one's lifetime as cognitive flexibility (Ionescu, 2012). Given the complexity in the definition of cognitive flexibility and the number of cognitive, sensorimotor, and environmental factors that need to be considered during its assessment, empirical research has used a wide range of experimental tasks, neurocognitive tasks, and self- and observer questionnaire reports to capture cognitive flexibility at the behavioural and cognitive level across contexts (Ionescu, 2012). Examining differences in cognitive flexibility therefore also requires consideration and comparison across different assessment methods, given that different experimental and neurocognitive tasks and questionnaires may draw on different mechanisms underlying cognitive flexibility in different contexts.

Previous systematic and literature reviews on the topic of CI have evaluated the psychometric properties of standardised measures, including their discriminability (Leung & Zakzanis, 2014) and ecological validity when completed by autistic individuals (Geurts et al., 2009). No review to date has explored how CI may be associated with internalising and externalising symptoms in autistic children and adolescents. The current systematic review and meta-analysis has two objectives:

Aim 1: What is the relationship between CI and internalising symptoms (INT; e.g., anxiety and mood symptoms/disorders?) in autistic children and adolescents?

Aim 2: What is the relationship between CI and externalising symptoms (EXT; e.g., aggression, rule-breaking) in autistic children and adolescents?

Exploratory Aim: To explore whether any significant relationships observed in Aim 1 and/or 2 may be moderated by participants' mean age, gender (proportion of male participants), mean full-scale IQ, study quality, and modality of assessment.

We hope that a close examination of the empirical literature can aid clinical practice through generating hypotheses about the potential benefits of directly targeting CI to boost therapeutic engagement and outcomes in this clinical population when working with psychiatric co-occurring conditions.

2. Methods

2.1 Search strategy

This review followed the PRISMA 2020 Checklist (Page et al., 2021), see Prospero (CRD42021277294) for study protocol. Peer-reviewed journal articles published in English until 11th April 2022 were retrieved from PubMed, EMBASE, MEDLINE, PsycINFO and Web of Science. The earliest relevant article identified using the search terms was published in 1964. Synonyms of the following key words were used in identifying relevant articles across each database: autism, children/adolescent, CI, INT (Aim 1) and EXT (Aim 2) (Appendix 1 for full search strategy). Search terms were kept broad to explore which internalising and externalising conditions have been researched in relation to CI in adolescents with ASD. Literature only using ADHD as an outcome measure were excluded given the changes in classification and the predominant construct overlap between ADHD and neurodevelopmental conditions (Rietz et al., 2021). After collating results using EndNote library, duplicates were first removed before screening titles, abstracts and full-text articles based on the inclusion/exclusion criteria. Reference lists of included studies were screened to identify relevant articles.

2.2 Study selection

The inclusion/exclusion criteria described followed the PECO (Participant, Exposure, Comparison, Outcome) (Table 1) outlined by COSMOS-E (Conducting Systematic Reviews and Meta-Analyses of observational Studies of Etiology) (Dekkers et al., 2019). Both cross-sectional and longitudinal quantitative studies published in English and in peer-reviewed journals were included in the review. Qualitative studies, systematic review/meta-analyses, opinion articles, grey literature and non-English publications were excluded.

Table 1.

Summary of inclusion and exclusion criteria as per Participant Exposure Comparison Outcome (PECO).

Inclusion Criteria	Exclusion Criteria
Participant	
• Sample includes young people aged 0-24 years (WHO definition for young people) • Participants have a clinical diagnosis of autism spectrum disorder or equivalent (e.g., Childhood autism (ICD-10)/Autistic Disorder (DSM-IV), Asperger's Syndrome, Pervasive Developmental Disorder - Not Otherwise Specified). Clinical diagnosis should be provided by a qualified healthcare and/or education professional via clinical assessment measures.	• Sample does not include young people aged 0-24 years. • Sample does not include participants with a clinical diagnosis of ASD or equivalent.
Exposure	
• Study must include at least one instrument to measure cognitive flexibility, including, but not limited to the tests and measures identified by a systematic review by (Miles et al., 2020) (See Appendix 3 for detailed list of cognitive flexibility measures).	• Study does not include any measures of cognitive flexibility.
Comparison	
• **Optional:** Studies may include age-matched sample of neurotypical children and/or adolescents with or without anxiety as a comparison group.	• If the study meets the requirement under Participant and Exposure of the PECO criteria, absence of a comparison group *will not* lead to the exclusion of the study in the systematic review, as a comparison group is optional and not required to address the stated research questions.
Outcome	
• For Aim 1: Study must meet the inclusion criteria and include at least one measure of internalising symptoms. A diagnosis of any conditions associated with internalising symptoms (e.g., mood or anxiety) is not necessary to be included in the review. • For Aim 2: Study must meet the inclusion criteria and include at least one measure of externalising symptoms. A diagnosis of any condition associated with externalising symptoms (e.g., conduct disorder, oppositional defiant disorder) is not necessary to be included in the review.	• Study does not include any measures of internalising/externalising symptoms; study only measures attention deficit hyperactivity disorder symptoms without any other measure of internalising/externalising symptoms.

2.3 Quality appraisal

Quality appraisal was completed by using The Standard Quality Assessment Criteria for Evaluating Primary Research papers from a Variety of Fields (Kmet et al., 2004) (Appendix 2 for description). The cut-off for inclusion ranges from being liberal (0.55) to conservative (0.75), with the current study adopting a moderately conservative threshold of 0.60 for study inclusion (Kmet et al., 2004). All studies were assessed independently by two assessors, who met to discuss and review any discrepancies in scoring, with final discussion outcomes being reflected by the quality appraisal scores provided in Tables 3 and 4. The interclass correlation coefficient between the two assessors showed moderate agreement ($\kappa = 0.73$) with a 95% confidence interval of (0.64 – 0.81).

2.4 Data extraction

Table 3 (INT) and Table 4 (EXT) show information extracted from studies included in the systematic review: 1) author, year and country of publication, 2) ASD diagnosis criteria and measure, 3) sample size and gender, 4) mean and standard deviation of age and full scale IQ (where available), 5) CI measure, 6) INT or EXT measure, 7) main findings of CI, INT/EXT, and the association between CI and INT/EXT, 8) quality appraisal score.

2.5 Data analysis

For each meta-analysis, Pearson's correlation coefficient (r) was chosen as a commonly reported effect size measure in observational studies. The first/last authors of studies that did not report Pearson's correlation (n = 19) were contacted via email on two occasions to request the relevant association. Six authors could not be reached or no longer had access to the raw dataset, and four authors responded with the relevant correlation coefficients that were included in the respective meta-analyses, and nine authors did not respond. When two or more symptom measures are used, specific scales for INT or EXT are used rather than total problem score.

Meta-analyses were conducted using RStudio (Core Team, 2019) and the *metafor* package in R (Viechtbauer, 2019). Due to possible variations in study outcomes because of differences in participant characteristics such as age, gender, IQ etc., a random-effects meta-analysis model was used. The effect size for each study was first converted to Fisher's Z, which was subsequently converted back to a summary correlation. To interpret the magnitude of effect sizes, Cohen's guidelines (Cohen, 1988) for small (r = 0.10), moderate (r

= 0.30) and large (r = 0.50) effects were applied. To assess the degree of heterogeneity across studies, Cochran's Q test and the Higgin's and Thompson's I^2 tests were used. Heterogeneity is indicated by either a statistically significant result from Q test ($p < .05$), or higher I^2 value (75% = substantial heterogeneity, 50% = moderate heterogeneity, 25% = low heterogeneity) (Higgins et al., 2003). Funnel plots were generated to inspect possible asymmetry that may indicate risk of publication bias, as indicated by a significant Egger's test statistic ($p < .05$) (Egger et al., 1997). Several study characteristics were explored using independent meta-regressions as potential moderators: 1) mean age, 2) gender (proportion of male participants), 3) mean FSIQ, 4) study quality. Finally, to explore whether the overall effect sizes from each meta-analysis are influenced by 1) CI measurement; 2) co-occurring ADHD-diagnosis, separate post-hoc sensitivity analyses were completed for studies using parent report measures of CI only, and for studies where adolescents did not have a reported co-occurring ADHD diagnosis.

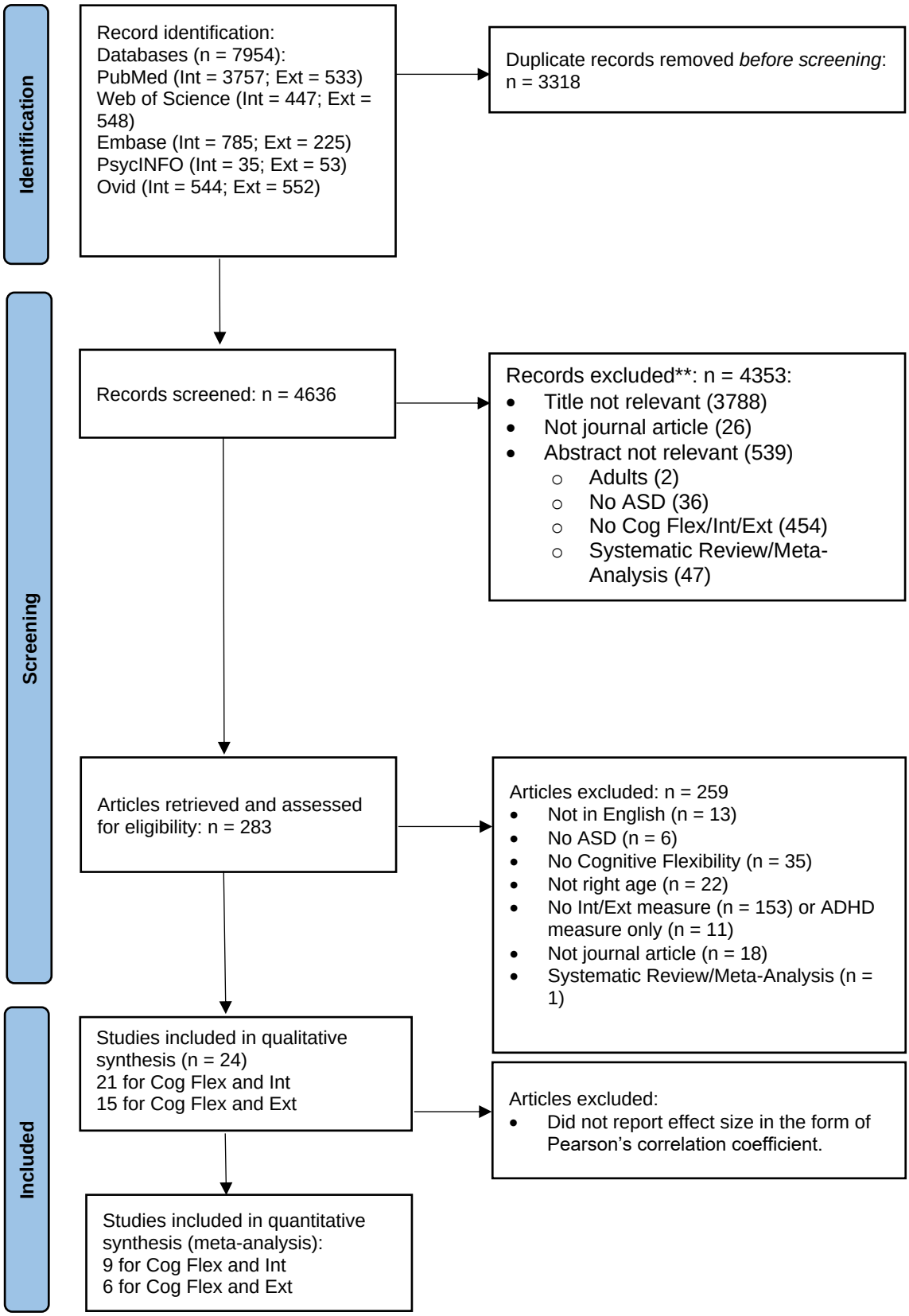
3. Results

3.1 Search results

The PRISMA diagram (Figure 1) summarises the literature search process (Moher et al., 2009). The first author performed the initial literature search across all databases on 3rd September 2021 and an updated literature search on 11th April 2022, removed study duplicates, and completed title, abstract and full-text screening. A second coder independently screened ~10% of abstracts (n = 83; Kappa coefficient = 0.96), and ~10% of full-text articles (n = 27; Kappa coefficient = 0.96) with high inter-rater reliability. 24 articles were selected for quality assessment. 21 studies measured CI and INT (Aim 1), including nine Pearson's correlations for meta-analysis. 15 studies measured CI and EXT (Aim 2), including six Pearson's correlation coefficients for meta-analysis.

Figure 1.

PRISMA Diagram.



Note: ASD = Autism Spectrum Disorder; Cog Flex = Cognitive Flexibility; Int = Internalising; Ext = Externalising.

3.2 Study characteristics

Tables 2 summarises the characteristics for the 24 included studies. Of the 21 studies included for Aim 1, six studies reported family socioeconomic status (SES), three included largely low to middle income families (Carter Leno et al., 2022; Dieckhaus et al., 2021; Yerys et al., 2009), and three used either parental (Berenguer et al., 2018) or maternal education (Andersen et al., 2015; Gardiner & Iarocci, 2018) as an estimate of family SES (on average achieved secondary education completion). Of the 15 studies included for Aim 2, five studies reported SES, two included families from low to middle SES (Carter Leno et al., 2022; Yerys et al., 2009), and three included families where mothers or parents completed secondary school education on average (Andersen et al., 2015; Berenguer et al., 2018; Gardiner & Iarocci, 2018).

Table 2.

Study characteristics of included 24 full-text articles.

	Aim 1 (21 studies) – CI & INT (n = 1608)		**Aim 2 (15 studies) – CI & EXT (n = 1115)**	
	M (SD)	**Range**	**M (SD)**	**Range**
Sample size	76.57 (75.48)	11 – 321	74.33 (62.06)	20 – 242
% Male	82.51 (17.06)	19 – 100	83.60 (19.46)	19 – 100
Age (Years)	11.14 (2.45)	7.77 – 16.67	10.75 (2.19)	7.77 – 15.4
FSIQ	(20 studies)		(15 studies)	
	97.68 (10.37)	69.49 – 114.75	99.51 (8.61)	83.5 – 114.75
Ethnicity	(% - 6 studies)		(% - 3 studies)	
Caucasian	69.44 (16.61)	42.86 – 86.61	72.98 (7.73)	65.31 – 80.77
Mixed/Other ethnicity	23.07 (12.87)	8.66 – 42.86	21.84 (5.63)	15.93 – 27.14
Black	6.27 (5.76)	1.59 – 14.29	7.1 (1.5)	6.04 – 8.16
Asian	2.72 (3.78)	0 – 7.94	2.86 (1.72)	1.65 – 4.08
Study quality	0.83 (0.08)	0.64 - 1	0.82 (0.08)	0.64 – 0.91
Recruitment	(n = studies)		(n = studies)	
Clinical sites (including hospitals / university clinic)	9		7	
Community settings	7		5	
School	1		1	
Longitudinal datasets	4		2	
Comorbidities	(n = participants; 6 studies)		(n = participants; 4 studies)	
ADHD	153		153	
ODD/CD	25		25	
PTEN mutation	38		-	
Macroencephaly	25		-	
CI Measure	(n = studies)		(n = studies)	
Parent report	13		10	
Teacher report	1		1	
Neurocognitive/Task measure	9		6	

Note. CI = Cognitive Inflexibility; INT = Internalising; EXT = Externalising; FSIQ = Full Scale IQ; ADHD = Attention Deficit Hyperactivity Disorder; ODD = Oppositional Defiant Disorder; CD = Conduct Disorder.

3.3 Measurement of CI

Across the 24 studies included in this systematic review, 15 studies used a parent report measure to examine CI in children and adolescents with ASD. 13 of those 15 studies used the shift scale or behavioural regulation index of the Behaviour Rating Inventory of Executive Function (BRIEF; Gioia et al., 2000), one study used The Flexibility Scale-Revised (FS-R; Strang et al., 2017), and one study also used the Sameness subscale from the Repetitive Behaviour Scale-Revised (Maddox et al., 2018). Only one study used the teacher report version of the BRIEF (Berenguer et al., 2018). Using parent and teacher reports, autistic children and adolescents with co-occurring ADHD were found to have greater CI compared to adolescents with ASD only (Berenguer et al., 2018; Yerys et al., 2009), who in turn had greater CI compared to adolescents with ADHD only (Dieckhaus et al., 2021; Lawson et al., 2015), with neurotypical adolescents being rated with lowest CI (Andersen et al., 2015; Berenguer et al., 2018; Gardiner & Iarocci, 2018; Yerys et al., 2009). Only one study found there to be no significant differences in parent-rated CI when comparing adolescents with ASD and ADHD to adolescents with ADHD only, with ADHD and Oppositional Defiant Disorder/Conduct Disorder (ODD/CD), or with ASD, ADHD and ODD/CD (Sesso et al., 2020). Parents also reported that autistic adolescents with microencephaly experienced greater CI compared to adolescents with *PTEN* mutation and without ASD, but did not differ from autistic adolescents with *PTEN* mutation, suggesting that CI may be uniquely associated with ASD above and beyond the effect of *PTEN* mutation (Uljarević et al., 2022).

Ten studies used a task-based measure to examine CI in adolescents with ASD, including the NEuroPSYchological Assessment (NEPSY-II; Trimarco et al., 2020), a probabilistic reversal learning paradigm (Crawley et al., 2020), Block Design[2] (Hollocks et al., 2022), the Opposite Words task (Hollocks et al., 2022), Trail Making (Hollocks et al., 2022), Colour Word Interference Task (CW-4; Andersen et al., 2015), Wisconsin Card Sorting Task (WCST; Hollocks et al., 2014, 2022; Tachibana et al., 2013; Teunisse et al., 2012), and the Cambridge Neuropsychological Test Automated battery Intra/Extra dimensional set shift task (CANTAB ID/ED; Happé et al., 2006; Rogers et al., 2006; Teunisse et al., 2012). Compared to neurotypical peers,

[2] Block design is included as a proxy for cognitive flexibility as it is a task that requires non-verbal problem solving and loads significantly onto the latent construct measuring cognitive inflexibility, such as following through a well-organised response in an efficient, flexible, and goal-directed manner. Block design has previously been used as a clinical outcome measure of the latent construct of cognitive inflexibility in a clinical trial on "Unstuck and on Target" – an intervention aimed to target cognitive inflexibility in autistic children by Kenworthy et al. (2014).

adolescents with ASD showed reduced task accuracy and greater perseverative errors (Crawley et al., 2020), and poorer performance on fluency based tasks involving generation of novel responses (Trimarco et al., 2020) or tasks requiring inhibiting interference from incorrect responses (Andersen et al., 2015). On switching tasks which assesses a range of executive functions including using environmental stimuli to modulate one's behaviour in a goal-directed manner and inhibiting interfering stimuli, one study found that adolescents with ASD performed similarly to neurotypical adolescents (Trimarco et al., 2020). Another found that performance on switching task improved by achieving a greater number of categories with fewer perseverative errors on the WCST after adolescents with ASD read aloud for 30 minutes five times a day for five weeks (Tachibana et al., 2013).

3.4 CI and INT

Table 3 shows a summary of results from the 21 studies that explored the association between INT and CI. Overall, many studies found that the parent / teacher reported CI significantly correlated with greater symptoms of anxiety (Dieckhaus et al., 2021; Lawson et al., 2015; Uljarević et al., 2022; Vogan et al., 2018), depression (Gardiner & Iarocci, 2018; Lawson et al., 2015; Lieb & Bohnert, 2017) and general emotional problems (Hollocks et al., 2022) in adolescents with ASD. Sesso et al. (2020) found that items from the shift subscale of BRIEF and internalising subscale of CBCL loaded onto the same factor in a group of autistic adolescents, suggesting construct overlap in the two measurements. Ozsivadjian et al. (2021) also found that parent rated CI measured by FS-R was not directly associated with INT, but rather was directly associated with greater intolerance of uncertainty, which in turn increased level of parent reported anxiety symptoms in adolescents with autism. Similarly, studies using neurocognitive assessment or experimental tasks to assess CI in adolescents with ASD also found that greater CI was associated with greater behavioural difficulties (Teunisse et al., 2012) including INT (Andersen et al., 2015), anxiety and depression (Crawley et al., 2020; Hollocks et al., 2014), and socioemotional problems (Dajani et al., 2016).

Two studies used a longitudinal study design and explored CI as a mediator of changes in INT severity over adolescence (Hollocks et al., 2022), and as a moderator between family stressful life events (F-SLE) and future INT during childhood (Carter Leno et al., 2022). Greater CI at age 16 was found to be a predictor of greater anxiety and depression at age 23 amongst autistic adolescents, and also partially mediated changes in symptom severity of anxiety, depression and emotional problems between the ages of 16 and 23 (Hollocks et

al., 2022). Amongst autistic children, CI only moderated the relationship between F-SLE and future INT between the ages of 7 and 11 amongst those with atypical shifting abilities measured at age 8 as reported by parents, and not those with typical shifting abilities (Carter Leno et al., 2022).

Table 3.

Summary of studies examining the relationship between cognitive inflexibility (CI) in children and adolescents with ASD and internalising symptoms (n = 21).

Author (Year); Country	ASD Diagnosis (Criteria; Measure)	N (male)	Age (Years; M, SD); IQ (M, SD)	Cognitive Flexibility (CF) Measure	Internalising (INT) Symptom Measure	Main Findings	Quality Score
Carter Leno et al. (2022); Canada	DSM-IV-TR; ADOS; ADI-R	ASD: 242 (204) Typical shifting: 144 Atypical shifting: 98	Age: T1: 3.46 T5: 7.77 T6: 8.73 T7: 9.71 T8: 10.77 FSIQ (T6): Typical shifting: 86.55 (18.96) Atypical shifting: 82.70 (19.21)	BRIEF-Shift (Parent)	CBCL – Internalising (Teacher)	*Confounding variables controlled for:* family income and autism symptom severity. *CI (Cognitive Inflexibility) & INT:* Atypical Shifting vs. Typical Shifting: Greater CI significantly moderated the relationship between family-stressful life events (F-SLE) and future internalising problems only in the group with atypical shifting abilities.	0.79
Dieckhaus et al. (2021); USA	DSM-5; ASD: ADOS-2; ADHD: MINI-Kid.	ASD: 35 (35) ADHD: 83 (63)	Age: ASD: 9.85 (0.88) ADHD: 9.56 (0.87) FSIQ: ASD: 101.63 (13.88) ADHD: 97.54 (15.02)	BRIEF-Shift (Parent)	CBCL – Anxiety (Parent)	*Confounding variables controlled for:* gender and ethnoracial identity *CI:* 54% of ASD and 46% of ADHD group showed clinically elevated scores on Shift subscale (greater CI). *INT:* 51% of ASD and 36% of ADHD group showed clinically elevated anxiety problems on CBCL. *CI & INT:* In both ASD and ADHD groups – greater CI associated with greater anxiety scores (ASD: Spearman's rho = 0.61, $p < .001$; ADHD: Spearman's rho = 0.60, $p < .001$).	0.82
Hollocks et al. (2022); UK	ICD-10; ADOS-2, ADI-R	ASD: 81 (74)	Age: Wave 2: 15.4 (0.45) Wave 3: 23.2 (0.79) FSIQ (Wave 2): 83.5 (17.8)	WASI – Block Design Opposite Words Trail Making WCST (Performance-based)	SDQ – Emotional Problems (Parent – Wave 2) BAI (Parent – Wave 3) BDI (Parent – Wave 3)	*Confounding variables controlled for:* verbal IQ, restricted and repetitive behaviours *CI & INT (Age 16):* CI significantly associated with increased emotional problems *CI & INT (Age 23):* greater CI at age 16 predicted greater anxiety and depression at age 23. CI partially mediated the relationship between anxiety, depression and emotional problems between age 16 and 23.	0.83

*Ozsivadjian et al. (2021); UK	DSM-5; DAWBA	ASD: 95 (71)	Age: 11 (3.2) FSIQ: (n = 59) 98.5 (2.3)	FS-R (Parent)	RCADS - Total (Parent) SDQ – Emotional Problems (Parent)	*Confounding variable controlled for:* autism symptom severity *CI & INT:* CI positively associated with RCADS total (r = .39) and SDQ-E ***(r = .34).*** CI did not significantly predict internalising symptoms. CI significantly predicted higher intolerance of uncertainty (β =.73, SE = 0.09; p ⩽ .01).	0.91
Uljarevic et al. (2021); Australia	DSM-5; ADI-R; ADOS-2.	PTEN-ASD: 38 (30) Macro-ASD: 25 (21) PTEN no ASD: 23 (15)	Age: PTEN-ASD: 8.93 (4.75) Macro-ASD: 11.99 (5.15) PTEN-no ASD: 8.94 (4.85) FSIQ: PTEN-ASD: 66.32 (13.71) Macro-ASD: 74.30 (24.50) PTEN-no ASD: 99.14 (17.40)	BRIEF – Shift (Parent)	CBCL 1.5-5/6-18 – Anxiety (Parent)	*Confounding variable controlled for:* FSIQ *CIs:* Macro-ASD group > PTEN-no ASD group. *CI & INT:* Over the whole sample: there is a significant positive correlation between CI and anxiety (r = .53, p <.01).	0.86
*Crawley et al. (2020); UK	ADI-R; ADOS.	ASD: 321 (232) NT: 251 (171)	Age: ASD: 16.67 (5.92) NT: 16.93 (6.02) FSIQ: ASD: 103.6 (15.28) NT: 108.95 (12.82)	Probabilistic reversal learning (PRL) (Performance-based)	BAI (Parent for Children; Self for Adolescents); BYI-II – Anxiety (Parent for Children; Self for Adolescents)	*Confounding variable controlled for:* IQ, restricted and repetitive behaviour *CI:* ASD < NT on task accuracy; ASD > NT on number of perseverative errors (greater CI). *CI & INT:* in ASD children, perseverative errors positively correlated with anxiety ***(r = .34)***.	1
*Sesso et al. (2020); Italy	DSM-5; K-SADS-PL; ADI-R; ADOS.	ADHD: 64 (56) ADHD+ASD: 19 (18) ADHD+ODD/CD: 43 (39) ADHD + ASD+ODD/CD: 25 (24)	Age: ADHD: 10.02 (2.49) ADHD+ASD: 9.58 (2.69) ADHD+ODD/CD: 9.37 (2.95) ADHD+ASD+ODD/CD: 8.4 (2.24) FSIQ: ADHD: 93 (14.98)	BRIEF-2 Shift (Parent)	CBCL 6-18 - Internalising Problems (Parent)	*Confounding variable controlled for:* none *CI:* no significant between-group differences. *CI & INT:* Items from the Shift (BRIEF) subscale and internalising symptoms (CBCL) loaded onto the same principal component factor. For ASD group, there was a positive correlation between CI and internalising problems (***r = .51***, *p* = .04).	0.91

			ADHD+ASD: 92.69 (17) ADHD+ODD/CD: 96.86 (16.05) ADHD+ASD+ODD/ CD: 98.94 (18.06)				
Trimarco et al. (2020); Italy	DSM-5; ADOS-2	ASD: 21 (4) PKU: 15 (8) Control: 14 (6)	Age: ASD: 9.83 (1.95) PKU: 10.26 (2.26) NT: 10.20 (1.99) FSIQ: ASD: 94.33 (18.94) PKU: 95.47 (12.50)	NEPSY-II: Switching, Response Set, Animal Sorting, Design Fluency (Performance-based)	CBCL 6-18 Internalising Problems (Parent)	*Confounding variable controlled for:* none *CI:* ASD < NT group on design fluency and response set. No differences on switching tasks across PKU, ASD and NT groups. *INT:* ASD > NT and PKU groups.	0.73
Dajani et al. (2019); USA	ASD: ADOS-G; ADOS-2; ADI-R; ADHD: DICA-IV; CPRS-R:L.	ASD: 24 (18) ADHD: 31 (22) NT: 44 (31)	Age: ASD: 10.30 (1.44) ADHD: 9.74 (1.24) NT: 10.47 (1.03) FSIQ: ASD: 102.48 (12.3) ADHD: 109.68 (12.64) NT: 119.66 (13.21)	BRIEF – Shift (Parent)	CBCL 6-18 Internalising Problems (Parent)	*Confounding variable controlled for:* head motion *CI:* weaker left SPL to right SPL connectivity is related to greater CI and worse emotional control in children.	0.82
Berenguer et al. (2018); Spain	DSM-5; ASD: SCQ; ADI-R ADHD: SDQ	ASD: 30 (27) ADHD: 35 (32) ASD + ADHD: 22 (21) NT: 37 (23)	Age: ASD: 8.39 (1.3) ADHD: 9.14 (1.4) ASD+ADHD: 8.86 (1.3) NT: 8.54 (1.2) FSIQ: ASD: 100.37 (12.4) ADHD: 99.03 (9.8) ASD+ADHD: 102.86 (13.0) NT: 102.11 (8.9)	BRIEF – BRI (Teacher)	SDQ Emotional Problems (Parents)	*Confounding variables controlled for:* sex, vocabulary and educational level of parents *CI:* ASD + ADHD > ASD, ADHD > NT. *INT:* ASD, ADHD, ASD + ADHD > NT	0.86
*Gardiner et al. (2018); Canada	DSM-IV-TR; ADI-R;	ASD: 59 (51) NT: 67 (33)	Age: ASD: 10.07 (2.09) NT: 9.44 (1.73)	BRIEF – Shift (Parent)	BASC-2 – Internalising	*Confounding variable controlled for:* IQ	0.91

	ADOS.		FSIQ: ASD: 107.47 (13.25) NT: 111.37 (12.78)		Behaviours (Parent)	*CI:* ASD > NT *INT:* ASD > NT on depression symptoms *CI & INT:* No significant association between CI and anxiety; For the ASD group - shift (β = .35, p = .02) and emotional control (β = .37, p = .03) scales emerged as unique significant contributors towards depression symptom severity. Greater CI also was associated with greater internalising symptoms ***(r = .54)***.	
*Vogan et al. (2018); Canada	ADOS/ ADOS-2	ASD: 39 (34) NT: 34 (20)	Age: ASD: 10.6 (1.8) NT: 11.2 (2.1) FSIQ: ASD: 103.3 (14.7) NT: 115.4 (11.7)	BRIEF – BRI (Parent)	CBCL – Anxious/Depressed (Parent)	*Confounding variable controlled for:* Age *CI & INT:* ASD group – Behavioural Regulation Index (BRI) from BRIEF showed significant correlation with anxiety/depression symptom severity (***r = 0.45,*** p < .01) rated two years later. Regression analyses showed that more BRI problems at T1 predicted later symptoms of anxiety/depression (p < .01) at T2 (18% of variance).	0.82
*Lieb et al. (2017); USA	DSM-IV-TR	ASD: 127 (103)	Age: 13.95 (1.6)	BRIEF - Shift (Parent)	CBCL – Depression (Parent) YSR-Depression (Self)	*Confounding variables controlled for:* age, gender, mode of participation *CI & INT:* CI positively associated with CBCL-D (***r = .46***, p < .01) and YSR-D (r = .34, p < .01).	0.86
Dajani et al. (2016); USA	ASD: ADOS-G; ADOS-2; ADI-R; ADHD: DICA-IV; CPRS-R:L.	ASD: 30 (23) ADHD: 93 (72) ASD + ADHD: 66 (55) NT: 128 (98)	Age: ASD: 9.76 (1.36) ADHD: 9.79 (1.21) ASD+ADHD: 10.45 (1.40) NT: 10.03 (1.18) FSIQ: ASD: 106.10 (14.88) ADHD: 107.31 (11.67) ASD+ADHD: 99.99 (15.98) NT: 115.76 (12.23)	BRIEF (Parent) NEPSY-II Statue subtest WISC-IV Backward Digit Span (Performance-based)	CBCL 6-18 – Anxiety/Depression (Parent)	*Confounding variable controlled for:* Diagnosis *CI:* ASD primarily in the "impaired" class for executive function (78%) (including 47% of children with ASD only, and 92% of children with both ASD and ADHD), with 20% in the "average" class. *CI & INT:* Socioemotional problems (i.e., including highest level of anxiety and depression) based on EF profile: “impaired” EF > “average” EF > “above average” EF	0.86
*Andersen et al. (2015); Norway	K-SADS-PL	ASD: 34 (28) NT: 45 (29)	Age: ASD: 11.6 (2.0) NT: 11.4 (1.5) FSIQ: ASD: 99.9 (17.4)	CW4 (Performance-based)	CBCL – Internalising Problems (Parent)	*Confounding variable controlled for:* Age *CI:* ASD > NT group, both showed similar rates of improvement over time.	0.77

			NT: 104.5 (13.1)			*INT:* ASD > NT on depression symptoms. ASD group showed improvement over time. *CI & INT:* Neither group showed any significant correlation between changes in flexibility and changes in depression. At baseline, greater internalising symptoms was associated with greater CI (***r = 0.47***).	
Lawson et al. (2015); USA	DSM-IV-TR; ASD: ADI-R; ADOS; ADHD: ADHD Rating Scale-IV	ASD: 70 (63) ADHD: 55 (39)	Age: ASD: 10.07 (1.77) ADHD: 8.93 (2.69) FSIQ: ASD: 107.01 (19) ADHD: 111.53 (16.85)	BRIEF – Shift (Parent)	CBCL – Anxiety/Depression (Parent)	*Confounding variables controlled for:* age, gender *CI:* ASD > ADHD group. *CI & INT:* Across the whole sample, CI is positively associated with Anxious/Depressed (r = .39, p < .001) scale. Greater CI is also associated with higher anxious/depressed symptoms in the ASD group (B = 0.288, p < .001).	0.91
*Hollocks et al. (2014); UK	ICD-10; ADI-R; ADOS; SCQ.	ASD: 90 (82)	Age: 15.5. (0.47) FSIQ: 84.5 (17.2)	Card Sorting Task - adapted from WCST (Performance-based)	SDQ - Emotional Symptoms (Parent)	*Confounding variable controlled for:* age *CI & INT:* Poorer card sorting task performance was associated with greater anxiety ***(r = -.24***, p < .05) and greater depression (r = -.23, p < .05).	0.91
Tachibana et al. (2013); Japan	DSM-IV-TR	ASD: 11 (8) [Intervention group: 6 (4) Control group: 5 (4)]	Age: ASD: 9.24 (0.82) [Intervention: 8.93 (0.71); Control: 9.62 (0.84)] FSIQ: ASD: 93.36 (13.20) [Intervention: 92.67 (15.66); Control: 94.20 (11.30)]	WCST (Performance-based)	CBCL – Anxiety/Depression (Parent)	*Confounding variable controlled for:* none *CI:* intervention group showed significant improvement in number of "perseverative errors" and "categories achieved" on WCST compared to control group. *INT:* Intervention group showed significant improvement on depression/anxiety symptom severity compared to controls.	0.67
Teunisse et al. (2012); The Netherlands	DSM-IV	ASD: 20 (20)	Age: 13.7 (1) FSIQ: 105.5 (13)	WCST-S, CANTAB ID/ED (Performance-based); BFRS-R (Parent); BRIEF – Shift (Parent)	CBCL/4-18 Total Problems (Parent)	*Confounding variable controlled for:* none *CI:* CANTAB ID/ED and WCST-S are positively associated (r = .46, p < .05). Both parent-based flexibility rating scales are positively associated with each other (r = .65, p < .01). *CI & Total Problems:* Both parent-based flexibility scales (BFRS-R, r = .51, p <.05; BRIEF Shift Score, r = .54, p < .05) significantly correlated with total problem score on CBCL. Neuropsychological tests did not significantly correlate with CBCL.	0.64

*Yerys et al. (2009); USA	DSM-IV; ADI/ADI-R; ADOS; ADHD: Inattentive Type on the DSM-IV ADHD parent rating scale	ASD: 28 (20) ASD + ADHD: 21 (18) NT: 21 (13)	Age: ASD: 9.7 (2.12) ASD+ADHD: 9.65 (1.62) NT:10.3 (1.76) FSIQ: ASD: 117.39 (18.68) ASD+ADHD: 111.24 (13.56) NT: 116.24 (11.53)	BRIEF-Shift (Parent)	BASC – Internalising Problems (Parent)	*Confounding variable controlled for:* none *CI:* ASD+ADHD > ASD and NT, ASD group > NT *INT:* ASD and ASD+ADHD groups > NT group. *CI & INT:* ASD and ASD+ADHD groups combined - CI positively associated with internalising symptoms ***(r = .46).***	0.82
Happé et al. (2006); UK	DSM-IV	ASD: 32 (32) ADHD: 30 (30) NT: 32 (32)	Age: ASD: 10.9 (2.4) ADHD: 11.6 (1.7) NT: 11.2 (2.0) FSIQ: ASD: 99.7 (18.7) ADHD: 99.1 (17.7) NT: 106.8 (13.4)	Verbal Fluency; Design Fluency; CANTAB ID/ED (Performance-based)	SDQ Emotional Problems (Parent)	*Confounding variables controlled for:* age and FSIQ *CI:* ASD group: age positively associated with performance on Categories and Design fluency, and ID/ED. *CI & INT:* Within the ADHD group, partialling out age revealed a significant correlation between Flexibility and SDQ Emotional symptoms (r = -.56, p = .001). There were no associations between SDQ scores and flexibility in ASD or NT group.	0.82

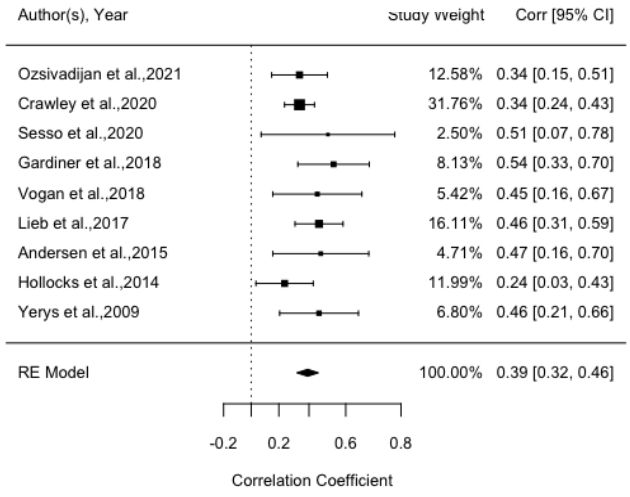
Note. ADHD = Attention Deficit Hyperactivity Disorder; ADI-(R) = Autism Diagnostic Interview (Revised); ADOS = Autism Diagnostic Observation Schedule; ASD = Autism Spectrum Disorder; BAI = Beck Anxiety Inventory; BASC = Behvaior Assessment System for Children; BFRS-R = Behaviour Flexibility Rating Scale-Revised; BRIEF-(S) = Behavior Rating Inventory of Executive Function (Shift subscale); BRI = Behavioural Regulation Index; BYI-II = Beck Youth Inventories: Second edition; CANTAB ID/ED = Cambridge Neuropsychological Test Automated Battery Intra/Extra dimensional set shift; CBCL = Child Behaviour Checklist; CD = Conduct Disorder; CF= Cognitive Flexibility; CI = Cognitive inflexibility; CPRS = Conner's Parent Rating Scale; CW-4 = Colour-Word Interference Test Condition 4; DAWBA = Development and Wellbeing Assessment; DICA=IV = Diagnostic Interview for Children and Adolescents IV; DSM = Diagnostic Statistical Manual; FS-R = The Flexibility Scale-Revised; IFSIQ = Full Scale IQ; ICD = International Classification of Disease; INT = Internalising symptoms; K-SADS-PL = Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime version; NEPSY-II = A Developmental NEuroPSYchological assessment; NT = Neurotypical; ODD = Oppositional Defiant Disorder; MINI Kid = Mini international neuropsychiatric interview for children and adolescents: ADHD module; PKU = Phenylketonuria; RCADS = Revised Child Anxiety and Depression Scale; SCQ = Social Communication Questionnaire; SDQ = Strength and Difficulties Questionnaire; SPL = superior parietal lobule; WCST = Wisconsin Card Sorting Task; WISC = Wechsler Intelligence Scale for Children. *Indicates studies included in meta-analysis. Statistics in italics and bold are correlations used for meta-analysis.

3.4.1 Meta-analyses of CI and INT

The meta-analysis examining the association between CI and INT ranged from 0.24 and 0.54 across a total of nine studies (n = 833 children and adolescents with ASD) in five countries (Figure 2). Two studies included adolescents with both ASD and ADHD (n = 40) (Sesso et al., 2020; Yerys et al., 2009). A forest plot of the reported correlation coefficient between CI and INT estimates with 95% confidence interval for all the included studies is shown in Figure 2. The meta-analysis showed a significant, moderate effect size, r = .39, p < .001, 95% CI [0.32, 0.46], indicating that higher CI was associated with higher levels of INT. Heterogeneity was low: Q(8) = 7.93, p = .44, I^2 = 13.17%. There was a non-significant moderator effect of participants' age (Q(1) = 3.38, p = .07), proportion of autistic male participants (Q(1) = 0.23, p = .63), mean FSIQ (Q(1) = 2.51, p = .11), and study quality (Q(1) = 2.51, p = .11). Funnel plot did not show significant study asymmetry, and neither Egger's regression test (p = .13) nor Rank Correlation Test (p = 0.61) suggested evidence for publication bias. Post-hoc sensitivity analyses (Appendix 3a) found that a significant moderate effect size was maintained with only studies using parent-report measures of CI (6 studies; r = .48, p < .001, 95% CI [0.36, 0.52]), with only studies using performance-based measures of CI (3 studies; r = .34, p < .001, 95% CI [0.25, 0.44], and when excluding studies with autistic adolescents and co-occurring ADHD (7 studies; r = .38, p < .001, 95% CI [0.31, 0.45]).

Figure 2.

Forest plot of correlation between measures of cognitive flexibility and internalising behaviours amongst autistic children and adolescents, and 95% Confidence Interval for Random Effects (RE) Model.



Note. Corr = Correlation. A positive correlation shows that greater difficulties with cognitive flexibility is associated with greater internalising symptoms.

3.5 CI and EXT

Table 4 shows a summary of results from the 15 studies that explored the association between EXT and CI. The majority of studies used the BRIEF-Shift scale parent measure of CI and found that greater CI in adolescents with ASD was associated with greater EXT (Gardiner & Iarocci, 2018; Lawson et al., 2015; Ozsivadjian et al., 2021; Vogan et al., 2018; Yerys et al., 2009). However, one study found increased EXT only correlated with greater CI as measured by the RBS-R Sameness scale, but not by BRIEF-Shift scale (Maddox et al., 2018). Only one study which included a sample of adolescents with ASD and ADHD found no association between CI and EXT (Sesso et al., 2020). Results from studies using neurocognitive assessment measures and cognitive tasks showed more mixed findings. One study which used a combination of CI measures from the NEPSY-II and WISC-IV showed that adolescents with ASD were more likely to show impaired executive function compared to adolescents with ADHD or neurotypical peers, and greater executive function impairment was associated with higher socioemotional difficulties including aggression (Dajani et al., 2016). In contrast, one study which used the CANTAB ID/ED found CI was not associated with levels of callous-unemotional traits that may contribute towards greater EXT (Rogers et al., 2006), and another which used the colour-word interference task also found that CI was not significantly associated with EXT (Andersen et al., 2015). Another study which used a range of tasks (block design, trail making, opposite words task and WCST) also found that CI showed a moderate (non-significant) association with increased behavioural problems amongst autistic adolescents (Hollocks et al., 2022).

Two studies used a longitudinal study design and explored CI as a mediator of changes in EXT severity over adolescence (Hollocks et al., 2022), and as a moderator between family stressful life events (F-SLE) and future EXT during childhood (Carter Leno et al., 2022). Greater CI at age 16 was found to be a predictor of greater behavioural problems at age 23 amongst autistic adolescents (Hollocks et al., 2022). Amongst autistic children, although CI did not significantly moderate the relationship between F-SLE and future EXT between the ages of 7 and 11, a near-significant trend was observed amongst those with atypical shifting abilities measured at age 8 as reported by parents compared to those with typical shifting abilities (Carter Leno et al., 2022).

Table 4.

Summary of studies examining the relationship between cognitive inflexibility (CI) in children and adolescents with ASD and externalising symptoms (n = 15).

Author (Year); Country	ASD Diagnosis (Criteria; Measure)	N (male)	Age (Years; M, SD); IQ (M, SD)	Cognitive Flexibility (CF) Measure	Externalising Symptom (EXT) Measure	Main Findings	Quality Score
Carter Leno et al. (2022); Canada	DSM-IV-TR; ADOS; ADI-R	ASD: 242 (204) Typical shifting: 144 Atypical shifting: 98	Age: T1: 3.46 T5: 7.77 T6: 8.73 T7: 9.71 T8: 10.77 FSIQ (T6): Typical shifting: 86.55 (18.96) Atypical shifting: 82.70 (19.21)	BRIEF-Shift (Parent)	CBCL – Externalising (Teacher)	*Confounding variables controlled for:* family income and autism symptom severity. *CI (Cognitive inflexibility) & EXT:* Atypical Shifting vs. Typical Shifting: Atypical Shifting vs. Typical Shifting: Greater CI moderated (though did not reach statistical significance) the relationship between family-stressful life events (F-SLE) and future externalising problems only in the group with atypical shifting abilities.	0.79
Hollocks et al. (2022); UK	ICD-10; ADOS-2, ADI-R	ASD: 81 (74)	Age: Wave 2: 15.4 (0.45) Wave 3: 23.2 (0.79) FSIQ (Wave 2): 83.5 (17.8)	WASI – Block Design Opposite Words Trail Making WCST (Performance-based)	SDQ – Conduct Problems (Parent, Wave 2 and 3)	*Confounding variables controlled for:* verbal IQ, restricted and repetitive behaviours *CI & EXT (Age 16):* CI showed moderate (though non-significant) association with increased EXT *CI & EXT (Age 23):* greater CI at age 16 predicted greater EXT at age 23	0.83
*Ozsivadjian et al. (2021); UK	DSM-5; DAWBA	ASD: 95 (71)	Age: 11 (3.2) FSIQ: (n = 59) 98.5 (2.3)	FS-R (Parent)	RCADS – Total Score (Parent) SDQ – Conduct problems (Parent)	*Confounding variable controlled for:* autism symptom severity *CI & EXT:* CI positively associated with RCADS total (r = .39); and SDQ-B (***r = .51***). CI significantly predicted higher externalising symptoms (β = .57, SE = 0.13; p ⩽ .01).	0.91
*Sesso et al. (2020); Italy	DSM-5; K-SADS-PL; ADI-R;	ADHD: 64 (56) ADHD+ASD: 19 (18)	Age: ADHD: 10.02 (2.49) ADHD+ASD: 9.58 (2.69)	BRIEF-2 Shift (Parent)	CBCL 6-18 Externalising Problems (Parent)	*Confounding variable controlled for:* none *CI:* no significant between- group differences in CF.	0.91

	ADOS.	ADHD+ODD/CD: 43 (39) ADHD + ASD+ODD/CD: 25 (24)	ADHD+ODD/CD: 9.37 (2.95) ADHD+ASD+ODD/CD: 8.4 (2.24) FSIQ: ADHD: 93 (14.98) ADHD+ASD: 92.69 (17) ADHD+ODD/CD: 96.86 (16.05) ADHD+ASD+ODD/CD: 98.94 (18.06)			*EXT:* ADHD+ASD+ODD/CD > ADHD+ASD on externalising problems. *CI & EXT:* For ASD group, there was no significant correlation between CI and externalising problems (***r* = .32,** p = .22).	
Trimarco et al. (2020); Italy	DSM-5; ADOS-2	ASD: 21 (4) PKU: 15 (8) Control: 14 (6)	Age: ASD: 9.83 (1.95) PKU: 10.26 (2.26) Control: 10.20 (1.99) FSIQ: ASD: 94.33 (18.94) PKU: 95.47 (12.50)	NEPSY-II: Switching, Response Set, Animal Sorting, Design Fluency (Performance-based)	CBCL 6-18 Externalising Problems (Parent)	*Confounding variable controlled for:* none *CI:* ASD < PKU/Control groups on design fluency and response set. No group differences on switching tasks. *EXT:* ASD > NT on externalising problems.	0.73
Berenguer et al. (2018); Spain	DSM-5; SDQ; SCQ; ADI-R.	ASD: 30 (27) ADHD: 35 (32) ASD + ADHD: 22 (21) NT: 37 (23)	Age: ASD: 8.39 (1.3) ADHD: 9.14 (1.4) ASD+ADHD: 8.86 (1.3) NT: 8.54 (1.2) FSIQ: ASD: 100.37 (12.4) ADHD: 99.03 (9.8) ASD+ADHD: 102.86 (13.0) NT: 102.11 (8.9)	BRIEF – BRI (Teacher)	SDQ – Behavioural Problems (Parent)	*Confounding variables controlled for:* sex, vocabulary and educational level of parents *CI:* ASD + ADHD > ASD or ADHD > NTs groups *EXT:* ASD + ADHD, ADHD > ASD > NT on externalising problems.	0.86
*Gardiner et al. (2018); Canada	DSM-IV-TR; ADI-R; ADOS.	ASD: 59 (51) NT: 67 (33)	Age: ASD: 10.07 (2.09) NT: 9.44 (1.73) FSIQ: ASD: 107.47 (13.25) NT: 111.37 (12.78)	BRIEF-Shift (Parent)	BASC-2 – Externalising Behaviour (Parent)	*Confounding variable controlled for:* IQ *CI:* ASD > NT *CI & EXT:* Greater CI significantly associated with greater externalising symptoms ***(r = .59)***.	0.91

Maddox et al. (2018); USA	DSM-IV-TR; ADOS-2	ASD: 182 (172)	Age: 9.32 (2.25) IQ: 104.26 (18.67)	BRIEF – Shift (Parent); RBS-R Sameness (Parent)	BASC-2 Aggression (Parent)	*Confounding variables controlled for:* age, IQ, recruitment site *CI & EXT:* Greater CI significantly associated with more challenging behaviours when measured using RBS-R sameness scale (B = 0.171, p < .05), but not BRIEF Shift scale (B = .085, p > .05).	0.82
*Vogan et al. (2018); Canada	ADOS/ADOS-2.	ASD: 39 (34) NT: 34 (20)	Age: ASD: 10.6 (1.8) NT: 11.2 (2.1) FSIQ: ASD: 103.3 (14.7) NT: 115.4 (11.7)	BRIEF – BRI (Parent)	CBCL – Aggressiveness (Parent)	*Confounding variable controlled for*: age *CI & EXT:* In ASD group, BRI (BRIEF) showed significant correlation with CBCL Aggressiveness scale (***r = .61,*** p < .001) rated two years later. Regression analyses showed that more executive function difficulties at T1 predicted later aggressive behaviour.	0.82
Dajani et al. (2016); USA	ASD: ADOS-G; ADOS-2; ADI-R; ADHD: DICA-IV; CPRS-R:L.	ASD: 30 (23) ADHD: 93 (72) ASD + ADHD: 66 (55) NT: 128 (98)	Age: ASD: 9.76 (1.36) ADHD: 9.79 (1.21) ASD+ADHD: 10.45 (1.40) NT: 10.03 (1.18) FSIQ: ASD: 106.10 (14.88) ADHD: 107.31 (11.67) ASD+ADHD: 99.99 (15.98) NT: 115.76 (12.23)	BRIEF (Parent); NEPSY-II: Statue subtest; WISC-IV: Backward Digit Span (Performance-based)	CBCL 6-18 – Aggression (Parent)	*Confounding variable controlled for:* diagnosis *CI difficulties:* ASD primarily in the "impaired" class for executive function (78%) (including 47% of children with ASD only, and 92% of children with both ASD and ADHD), with 20% in the "average" class. *CI & EXT:* Socioemotional problems (i.e., including highest level of aggression) based on EF profile: "impaired" EF > "average" EF > "above average" EF	0.86
*Andersen et al. (2015); Norway	K-SADS-PL	ASD: 34 (28) NT: 45 (29)	Age: ASD: 11.6 (2.0) NT: 11.4 (1.5) FSIQ: ASD: 99.9 (17.4) NT: 104.5 (13.1)	CW4 (Performance-based)	CBCL – Externalising Problems (Parent)	*Confounding variable controlled for:* age *CI:* ASD > NT group, and both groups showed similar rates of improvement in flexibility over time. *CI & EXT:* At baseline, greater externalising symptoms did not show significant association with greater CI (***r = 0.24***).	0.77
Lawson et al. (2015); USA	DSM-IV-TR; ASD: ADI-R; ADOS; ADHD: ADHD	ASD: 70 (63) ADHD: 55 (39)	Age: ASD: 10.07 (1.77) ADHD: 8.93 (2.69) FSIQ: ASD: 107.01 (19) ADHD: 111.53 (16.85)	BRIEF – Shift (Parent)	CBCL – Aggression (Parent)	*Confounding variables controlled for:* age, gender *CI:* ASD diagnosis associated with greater CI. *CI & EXT:* Across the whole sample, CI was positively associated with CBCL Aggressive Behaviour (r = .30, p	0.91

	Rating Scale-IV.					= .001) scale. For ASD group, greater CI was associated with higher EXT (B = 0.23, p < .001).	
Teunisse et al. (2012); The Netherlands	DSM-IV	ASD: 20 (20)	Age: 13.7 (1) FSIQ: 105.5 (13)	WCST-S; CANTAB ID/ED (Performance-based); BFRS-R (Parent); BRIEF - Shift (Parent)	CBCL/4-18 Total Problems (Parent)	*Confounding variable controlled for:* none *CI:* There is a positive correlation between performance on CANTAB ID/ED and WCST-S (r = .46, p < .05) and between both parent-based flexibility rating scales (r = .65, p < .01). *CI & Total Problems:* Both parent-based flexibility scales (BFRS-R, r = .51, p <.05; BRIEF Shift Score, r = .54, p < .05) significantly correlated with total problem score on CBCL. Neuropsychological tests did not significantly correlate with CBCL.	0.64
*Yerys et al. (2009); USA	DSM-IV; ADI/ADI-R; ADOS; ADHD: Inattentive Type on the DSM-IV ADHD parent rating scale	ASD: 28 (20) ASD + ADHD: 21 (18) NT: 21 (13)	Age: ASD: 9.7 (2.12) ASD+ADHD: 9.65 (1.62) NT:10.3 (1.76) FSIQ: ASD: 117.39 (18.68) ASD+ADHD: 111.24 (13.56) NT: 116.24 (11.53)	BRIEF – Shift (Parent)	BASC – Externalising Problems (Parent)	*Confounding variable controlled for:* none *CI:* ASD+ADHD > ASD > NT groups. *EXT:* ASD and ASD + ADHD > NT *CI & EXT:* ASD and ASD+ADHD groups combined – CI positively associated with externalising symptoms ***(r = .38).***	0.82
Rogers et al. (2006); UK	DSM-IV	ASD low CU: 18 (18) ASD high CU: 10 (10)	Age: ASD Low CU: 14.51 (2.34) ASD High CU: 14.60 (2.58) FSIQ: ASD Low CU: 92.1 (22.2) ASD High CU: 85.0 (13.5)	CANTAB ID/ED (Performance-based)	APSD (Teacher)	*Confounding variable controlled for:* none *CI:* Both CU-high and CU-low children performed poorly on ID/ED task, no group differences on errors.	0.68

Note. ADHD = Attention Deficit Hyperactivity Disorder; ADI-(R) = Autism Diagnostic Interview (Revised); ADOS = Autism Diagnostic Observation Schedule; APSD = Antisocial Process Screening Device; ASD = Autism Spectrum Disorder; BASC = Behavior Assessment System for Children; BFRS-R = Behaviour Flexibility Rating Scale-Revised; BRIEF-(S) = Behavior Rating Inventory of Executive Function (Shift subscale); CANTAB ID/ED = Cambridge Neuropsychological Test Automated Battery Intra/Extra dimensional set shift; CBCL = Child Behaviour Checklist; CD = Conduct Disorder; CF= Cognitive Flexibility; CI = Cognitive inflexibility; CPRS = Conner's Parent Rating Scale; CU = Callous Unemotional; CW4 = Colour Word Interference task – condition 4; DAWBA = Development and Wellbeing Assessment; DICA=IV = Diagnostic Interview for Children and Adolescents IV; DSM = Diagnostic Statistical Manual; EXT = Externalising; FS-R = The Flexibility Scale-Revised; FSIQ = Full Scale IQ; ICD = International Classification of

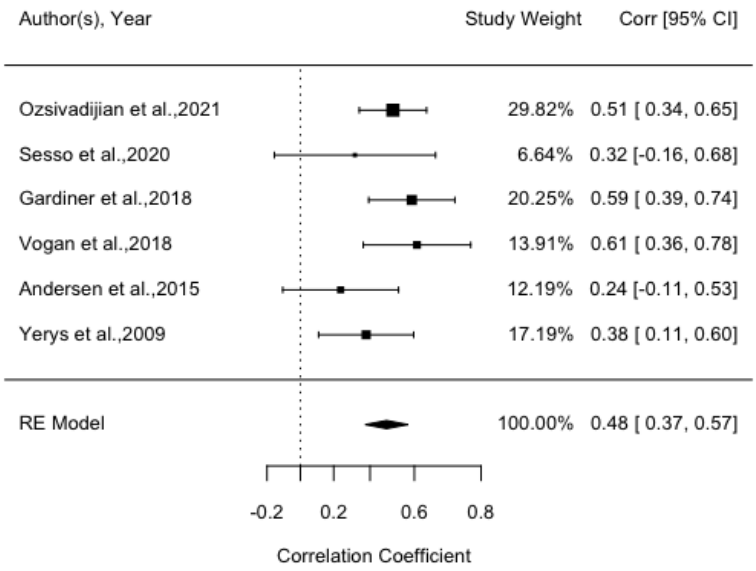
Disease; K-SADS-PL = Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children – Present and Lifetime version; NEPSY-II = A Developmental NEuroPSYchological assessment; NT = Neurotypical; ODD = Oppositional Defiant Disorder; PACS = Parental Account of Childhood Symptoms; PKU = Phenylketonuria; RBS-R = Repetitive Behaviour Scale – Revised; RCADS = Revised Child Anxiety and Depression Scale; SDQ = Strength and Difficulties Questionnaire; WCST = Wisconsin Card Sorting Task; WISC = Wechsler Intelligence Scale for Children. *Indicates studies included in meta-analysis. Statistics in italics and bold are correlations used for meta-analysis.

3.5.1 Meta-analyses of CI and EXT

The meta-analysis examining the association between CI and EXT ranged from 0.24 and 0.61 across a total of six studies (n = 295 children and adolescents with ASD) in five countries (Figure 3). Five of the six studies used a parent report measure to assess CI in adolescents with ASD. A forest plot of the reported correlation coefficient between CI and EXT estimates with 95% confidence intervals for all the included studies are shown in Figure 3. The meta-analysis showed a significant, large effect size, $r = .48$, $p < .001$, 95% CI [0.38, 0.58], indicating that higher CI was associated with higher levels of EXT. Heterogeneity was low: $Q(5) = 6.40$, $p = .27$, $I^2 = 14.63\%$. There was a non-significant moderator effect of participants' age ($Q(1) = 0.08$, $p = .78$), proportion of autistic male participants ($Q(1) = 0.03$, $p = .87$), mean FSIQ ($Q(1) = 0.06$, $p = .80$), and study quality ($Q(1) = 0.06$, $p = .80$). Funnel plot did not show significant study asymmetry, and neither Egger's regression test ($p = .27$) nor Rank Correlation Test ($p = .47$) suggested evidence for publication bias. Post-hoc sensitivity analyses (Appendix 3b) showed a significant large effect size was maintained with only studies using parent-report measures of CI (5 studies; $r = .51$, $p < .001$, 95% CI [0.41, 0.60]), and when excluding studies with autistic adolescents and co-occurring ADHD (4 studies; $r = .52$, $p < .001$, 95% CI [0.40, 0.62]).

Figure 3.

Forest plot of correlation between measures of cognitive inflexibility and externalising behaviours amongst autistic children and adolescents, and 95% Confidence Interval for Random Effects (RE) Model.



Note. Corr = Correlation. A positive correlation shows that greater difficulties with cognitive flexibility is associated with greater externalising symptoms.

4. Discussion

4.1 CI, internalising, and externalising symptoms

The current systematic review and meta-analysis found a significant and moderate to large effect size between CI and greater internalising and externalising symptoms in adolescents with ASD. Findings are robust given the low degree of heterogeneity across studies included in the meta-analyses, and results withstood sensitivity analysis when only including parent-report of CI or performance-based measures of CI (for internalising symptoms only) and excluding autistic adolescents with co-occurring ADHD diagnosis. CI may be a transdiagnostic factor that can increase one's vulnerability to experiencing rigid or perseverative patterns of unhelpful cognition (e.g., rumination) and behaviours (e.g., avoidance, reduced activity, aggression) (Hollocks et al., 2022), resulting in maladaptive emotion regulation strategies that are less effective in the moment (Cai et al., 2018).

The current study found that the effect size of the association between CI and internalising symptoms was greater when CI was measured using parent-report measures (r = .48) compared to performance-based task measures (r = .34). It is important to note that a major caveat is that only three studies used a performance-based task measure and therefore the generalisability of this finding may be somewhat limited. However, this finding is significant when considering literature has highlighted issues around convergence of measurement between more ecologically valid reporter-based measures (e.g., BRIEF) that assess how CI may affect daily functioning activities, compared to performance-based measures of CI that assess more specific cognitive constructs in a lab-based setting (e.g., WCST) (Uddin, 2021).

The convergence of effect sizes in the current meta-analysis is significant to suggest that there is some shared unitary construct underlying CI, as the association between internalising symptoms and CI remains when accounting for measurement differences. The stronger association with parent-rated measures may be a combination of shared method variance, and that behavioural implications of CI can be more easily observed across different settings in daily lives by parents/carers. The latter is particularly important when considering how individual differences in cognitive flexibility may be either a risk factor or protective factor in the context of biopsychosocial changes during adolescence, and therefore the impact of CI on daily adaptive functioning and behaviour in relation to psychopathology is more important for clinicians to assess and incorporate into formulation and treatment when working with autistic young people.

Although the current meta-analysis did not explicitly examine the reciprocal impact of co-occurring internalising/externalising symptoms on autistic adolescents' CI, it is possible that increased symptomatology can negatively impact autistic adolescents' flexible problem solving ability as reflected by frequent "stuck-in-set perseveration" errors during cognitive flexibility tasks (Crawley et al., 2020; Tachibana et al., 2013). For example, rumination over negative thoughts in depression can perpetuate over time, resulting in greater inactive and less flexible ways of thinking, rather than actively engaging with the environment and problem solving (Kashdan, 2010). Over time, pervasive negative cognitive style can also reduce behavioural flexibility and result in more rigid coping behaviours, further affecting one's emotional and social functioning (Kashdan, 2010). Individuals with heightened anxiety may also engage in experiential avoidance to reduce psychological distress, and deploy more rigid patterns of behavioural responses and experience persistent worries regardless of situational context (Borkovec, 1994).

However, the direction of causation between CI and behavioural symptoms remains ambiguous, as only three studies employed a longitudinal research design to provide insight from a developmental perspective (Andersen et al., 2015; Carter Leno et al., 2022; Hollocks et al., 2022). This is especially important as one meta-analysis exploring changes in CI from childhood (<12 years) to adulthood (>18 years) found that adolescence (between 12-18 years) marked a period of significant heterogeneity for CI measured across studies (Demetriou et al., 2018). One study found that increased rigidity in thinking and rumination may be a predisposing and perpetuating factor that results in prolonged experience of distress from family stressful life events for autistic children aged 7-11 years, increasing their vulnerability to developing and maintaining internalising symptoms across childhood (Carter Leno et al., 2022). However, it is unclear whether greater CI may have a direct effect on the development of externalising symptoms before puberty (Carter Leno et al., 2022).

During adolescence, although improvements in CI were noted amongst children and adolescents with ASD aged 9-16 years, performance was still poorer compared to their neurotypical peers, and adolescents with ASD maintained greater levels of depression symptoms (Andersen et al., 2015). The relatively protracted maturation of cognitive flexibility for adolescents with ASD compared to neurotypical peers might mean less adaptable ways of coping with the challenges that arise during adolescence, and increase one's vulnerability to developing internalising symptoms later in adulthood (Andersen et al., 2015).

When transitioning from adolescence to young adulthood, Hollocks et al. (2021) found that CI measured at the age of 16 continued to be associated with symptoms of anxiety and depression and at the age of 23, suggesting that it is an important cognitive mechanism that may influence the development and maintenance of internalising symptoms over time. The same study also found that when controlling for restricted and repetitive behaviours (RRBs), CI measured at age 16 was significantly associated with externalising symptoms at the ages of 16 and 23, suggesting that the continued impact of CI on emotion regulation is maintained across adolescent development, independent of RRBs considered to be core to ASD symptomatology.

The overlap between emotion regulation difficulties and CI in autism has been supported by neuroimaging studies where reduced connectivity between frontal and limbic regions of the brain may be associated with ineffective top-down emotion regulation in response to negative emotions (Samson et al., 2015). Reduced top-down emotion regulation may be especially evident during adolescence where the development of frontal lobes and executive functions matures at a slower rate compared to limbic brain regions for emotion processing (Blakemore & Robbins, 2012). Autistic adolescents may be even more vulnerable compared to neurotypical peers to feel overwhelmed by difficult emotions when unable to switch between maladaptive and adaptive emotion regulation strategies due to greater CI.

4.2 Measurement of CI

Most studies in the current review relied on parent-report to assess CI, especially the shift scale of BRIEF. Both parent measures and cognitive tasks largely indicate greater CI amongst adolescents with ASD compared to neurotypical peers or peers with other neurodevelopmental conditions, though greater variation in performance were noted when using task-performance based ratings. This may be due to experimental and neurocognitive tasks requiring a range of cognitive processes beyond cognitive flexibility to be employed for successful performance, and therefore it is difficult to unpick the extent to which CI may have contributed towards performance variance across individuals, without controlling for cognitive processes other than CI (Geurts et al., 2009).

Only one study explored the concordance between parent report of CI and adolescents' performance on neurocognitive tasks (Teunisse et al., 2012). Shared method variance was observed within parental measures and performance measures, though not between these measures of CI. Compared to task-based measures,

parental report of CI showed lower specificity as they also positively correlated with general behavioural problems, IQ and ASD symptomatology. The "Halo Effect"[3] on the association between CI and behavioural measures rated by parents may be due to questions about executive function often including a component of emotional control (e.g., items on shift subscale of BRIEF uses words such as "resists", "becomes upset", "is disturbed by"). Parents reporting CI may take into consideration internalising and externalising symptoms and result in greater construct overlap. Therefore, it is important to be cautious when interpreting the positive associations identified in this meta-analysis which is largely based on parent measures of CI.

4.3 Limitations

The current systematic review/meta-analysis has several limitations. First, the majority of studies relied on parent reports of CI and emotional/behavioural difficulties, and therefore may result in inflated correlation across the measures due to shared methods variance (Podsakoff et al., 2003; Yorke et al., 2018). One recent study found parents perceived the magnitude of CI to be much greater compared to adolescents' self-reports, and parents focused on observable behaviours at home/community compared to adolescents reporting on their inner experiences across multiple contexts including school (Kenworthy et al., 2022). Future studies should aim to assess CI by drawing on a range of perspectives including parents, teachers, self-report, and objective assessment (e.g., cognitive assessment). Furthermore, the few studies that used task-based measures showed greater individual variances in autistic adolescents' CI compared to parent reports, which may suggest greater heterogeneity in construct specificity across different tasks. Future studies may wish to use multiple tasks to extrapolate a latent construct of CI that may be more directly comparable across different studies.

Second, generalisability of findings is limited as study samples mostly failed to include autistic adolescents with intellectual disability. It is unclear for studies that did not report co-occurring conditions amongst autistic adolescents whether this was not assessed/recorded or whether no co-occurring conditions were found within the sample, the latter being unlikely given the high rates of psychiatric co-occurring conditions found in this population (Simonoff et al., 2008). It may be possible that between-subject differences in CI may be attributed to unreported co-occurring conditions (such as ADHD) rather than ASD per se. Future

[3] The Halo Effect refers to the concept that a reporter rating on someone else's behaviour may fail to distinguish between distinct and independent aspects of the behaviours observed, resulting in inflated inflation of correlation between the different types of behaviours observed (Saal et al., 1980).

studies can therefore benefit from more robustly assessing and explicitly reporting co-occurring conditions in autistic adolescents.

Finally, the current study samples were largely boys. Sex differences in CI in autism have remained largely unexplored, with only one study including autistic children and adolescents aged 7-14 years suggesting that girls had poorer performance in WCST with greater perseverative errors and completing fewer categories compared to boys (Memari et al., 2013). Future studies can include more autistic females to further explore whether there are sex-based differences in CI observed in autism, in relation to internalising and externalising symptoms over the course of development.

4.4 Clinical implications

The current meta-analysis explored the association between CI and internalising and externalising symptoms in autistic children and adolescents, with the hope to highlight how this domain may be a possible treatment target that will enhance therapeutic outcomes when explicitly addressed in clinical interventions for psychopathology when working with this clinical group. Our findings suggest that CI does have associations with internalising and externalising symptoms in autistic children and adolescents, and evidence does support that clinicians should assess for and incorporate individual differences in CI into person-centred formulation, and adapt clinical interventions to either explicitly target CI, or account for how CI may interfere with treatment efficacy and reception perceived by the young person. Accounting for individual differences in CI is especially important given many evidence-based psychological treatments for mental health problems aim to bring about cognitive and behavioural change and thus are reliant on flexibility in both cognition and behaviour.

As cognitive flexibility can support individuals to flexibly adapt to different situational demands (Kashdan, 2010), clinicians should more consistently evaluate individual differences in CI to guide assessment and personalisation of treatment approach when working with autistic adolescents. Current adaptations to evidence-based treatment for autistic adolescents with mental health conditions often focus on changing the format of communication and session structure, such as by having more frequent sessions and adopting more visual aids to make session material more concrete (Rodgers & South, 2021). However, such adaptations do not directly address constructs such as CI (Scarpa et al., 2021), which might affect engagement and response to therapeutic approaches that aim to increase awareness of alternative patterns of thinking and behaviour (e.g., Cognitive Behavioural Therapy) (Rodgers & South, 2021), and reduce intervention effectiveness.

One approach that explicitly targets CI and executive functions such as planning and organisation is called "*Unstuck and On Target!"* (Cannon et al., 2011), developed for educators to deliver in classroom settings for autistic students aged 8-11 years without intellectual disability, to support students in learning and utilising their skills to increase flexibility in real-life (Kenworthy et al., 2014). To increase children's perceived sense of control over flexible decision making in a non-threatening way, the use of gamified digital platforms that have clear visual cues may help children more easily access, engage with, and adhere to new intervention approaches (Blackwell et al., 2021). Supporting autistic adolescents to internalise flexible thinking can shape their resilience and potentially buffer against adversity, such as family stressful life events, and support them to navigate more complex situations by better balancing self-regulation and goal-oriented behaviours (Scarpa et al., 2021).

5. Supplementary Materials

Appendix 1

Full Electronic Database Search Terms and history of preliminary scoping search results.

Planned search terms (See Appendix A for more information on preliminary scoping searches):

Main search terms include the following search constructs used for both aims:

Autism: ((Autis*) OR (Asperg*) OR (ASD) OR (ASC) OR (PDD)) AND

Children/adolescent: ((adolescen*) OR (young person) OR (young people) OR (youth*) OR (child*) OR (infant*) OR (toddler*)) AND

Cognitive flexibility †: ((cognitive flexib*) OR (cognitive inflexib*) OR (cognitive rigid*) OR (rigid*) OR (mental flexib*) OR (set shift*) OR (WCST) OR (Wisconsin Card Sorting Task) OR (Trail Making) OR (Brixton) OR (Haptic illusion) OR (Catbat) OR (Delis-Kaplan Executive Function System) OR (Behavior Rating Inventory*) OR (Cognitive Flexibility Scale*))

Aim 1 - ***Internalising symptoms:*** (Anxiety) OR (internali*) OR (OCD) OR (intrus*) OR (mood) OR (depress*) OR (affect*) OR (suicid*) OR (self-harm*) OR (somati*) OR (PTSD) OR (Trauma*) OR (Phobia)

Aim 2 - ***Externalising symptoms:*** (aggress*) OR (antisocial*) OR (externali*) OR (delinquen*) OR (disrupt*) OR (conduct*) OR (anger*) OR (defiant) OR (hyperactiv*) OR (challenging behav*) OR (ADHD) OR (ODD) OR (oppositional*)

Preliminary Scoping Search Results:

1. **Main Search Terms:** A preliminary scoping search using the main search terms on PubMed on 12th July 2021 generated 4,093 results. Many of the search terms for cognitive flexibility were extracted from a published systematic review exploring cognitive flexibility in patients with Anorexia Nervosa (Miles et al., 2020).

2. **Main Search Terms & Aim 1:** A preliminary scoping search using the main search terms and search terms unique to Aim 1 in PubMed on 12th July 2021 generated 1,012 results.

3. **Main Search Terms & Aim 2:** A preliminary scoping search using the main search terms and search terms unique to Aim 2 in PubMed on 12th July 2021 generated 1,097 results.

†Summary of main measures of cognitive flexibility as reported in (Miles et al., 2020)

1. Neurocognitive Assessment measures and Cognitive Tasks:

Wisconsin Cart Sorting Task (WCST)

Trail Making Test (TMT)

Berg's Card Sorting Task

Brixton Spatial Anticipation Test

CANTAB Intra-and Extra-Dimensional Task (ID/ED)

CatBat

Controlled Oral Word Association Test

Delis-Kaplan Executive Function System (D-KEFS) – in particular the colour-word interference task, TMT and verbal fluency task

Haptic Illusions Task

Hayling Sentence Completion Task

2. Self-report measures:

Cognitive Flexibility Scale (CFS)

Shift subscale of Behaviour Rating Inventory of Executive Functioning

Detail and Flexibility questionnaire

Appendix 2

Description of the Quality Appraisal Tool (Kmet et al., 2004):

This 14-item tool has a detailed scoring protocol for examining 1) description of study objectives, 2) appropriateness of study design for addressing research question, 3) method of participant selection, 4) quality of participant information reported, 5) random allocation to treatment group (if applicable), 6) intervention blinding of investigators (if applicable), 7) intervention blinding of participants (if applicable), 8) description of outcome variables, 9) appropriateness of sample size, 10) appropriateness of statistical analysis, 11) estimate of variance for main results, 12) control for confounding variables, 13) sufficient detail in reporting of results, 14) whether results support conclusions drawn. Each item is rated on a scale of yes (2 points), partial (1 point), no (0 point) and not applicable (N/A). The summary score (between 0-1) is calculated in three steps: 1) calculate the total sum score = (number of "yes" *2 points) + (number of "partials" *1 point), 2) calculate the total possible sum = 28 – (total number of "N/A" * 2 points); 3) create summary score (range 0-1) = total sum/total possible sum. This tools has been successfully used in the past for systematic reviews examining quantitative research in older adults with autism (Tse et al., 2021).

Appendix 3

a) Sensitivity analyses for cognitive inflexibility and internalising symptoms

To explore whether the effect size observed above between internalising symptoms and cognitive flexibility remains when accounting for differences in method of measurement (i.e., parent report versus task-based measure), a post-hoc sensitivity analysis was completed including only studies that used a parent report measure of cognitive flexibility (n = 6). The sensitivity analysis showed a significant, moderate effect size, r = .48, p < .001, 95% CI [0.36, 0.52], indicating that higher cognitive inflexibility was associated with higher levels of internalising symptoms. There was no substantial degree of heterogeneity, Q(5) = 2.48, p = .78, I^2 = 0%. Funnel plot did not show significant study asymmetry, and neither Egger's regression test (p = .56) nor Rank Correlation Test (p = 1.00) suggested evidence for publication bias.

A separate post-hoc sensitivity analysis was completed including only studies that used performance-based measures of cognitive flexibility (n = 3). The sensitivity analysis showed a significant, moderate effect size, r = .34, p < .001, 95% CI [0.25, 0.44], indicating that higher cognitive inflexibility was associated with higher levels of internalising symptoms. There was no substantial degree of heterogeneity, Q(2) = 1.74, p = .41, I^2 = 0.01%. Funnel plot did not show significant study asymmetry, and neither Egger's regression test (p = .66) nor Rank Correlation Test (p = 1.00) suggested evidence for publication bias.

To explore the extent to which the effect size observed between internalising symptoms and cognitive flexibility is affected by co-occurring ADHD, a post-hoc sensitivity analysis was completed by excluding the two studies with young people with ASD and ADHD (Sesso et al., 2020; Yerys et al., 2009), leaving a total of seven studies in this analysis. The sensitivity analysis showed a significant, moderate effect size, r = .38, p < .001, 95% CI [0.31, 0.45], indicating that higher cognitive inflexibility was associated with higher levels of internalising symptoms. There was no substantial degree of heterogeneity, Q(6) = 7.09, p = .31, I^2 = 16.99%. Funnel plot did not show significant study asymmetry, and neither Egger's regression test (p = .26) nor Rank Correlation Test (p = 0.56) suggested evidence for publication bias.

b) Sensitivity analyses for cognitive inflexibility and externalising symptoms

To explore whether the effect size observed above between externalising symptoms and cognitive flexibility remains when accounting for differences in method of measurement (i.e., parent report versus task-based measure), a post-hoc sensitivity analysis was completed including only studies that used a parent report measure of cognitive flexibility (n = 5). The sensitivity analysis showed a significant, a significant, large effect size, r = .51, p < .001, 95% CI [0.41, 0.60], indicating that higher cognitive inflexibility was associated with higher levels of externalising symptoms. There was no substantial degree of heterogeneity, Q(4) = 3.58, p = .47, I^2 = 0%.). Funnel plot did not show significant study asymmetry, and neither Egger's regression test (p = .54) nor Rank Correlation Test (p = .82) suggested evidence for publication bias. Given only one study used behavioural task to measure cognitive flexibility, a sensitivity analysis could not be conducted.

To explore the whether the effect size observed between externalising symptoms and cognitive flexibility remains when accounting for co-occurring ADHD, a post-hoc sensitivity analysis was completed by excluding the two studies with young people with ASD and ADHD (Sesso et al., 2020; Yerys et al., 2009), leaving a total of four studies in the analysis. The sensitivity analysis showed a significant, large effect size, r = .52, p < .001, 95% CI [0.40, 0.62], indicating that higher cognitive inflexibility was associated with higher levels of externalising symptoms. There was no substantial degree of heterogeneity, Q(3) = 4.63, p = .20, I^2 = 17.96%. Funnel plot did not show significant study asymmetry, and neither Egger's regression test (p = .56) nor Rank Correlation Test (p = .75) suggested evidence for publication bias.

6. References

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM-5®)*. American Psychiatric Pub.

Andersen, P. N., Skogli, E. W., Hovik, K. T., Egeland, J., & Øie, M. (2015). Associations Among Symptoms of Autism, Symptoms of Depression and Executive Functions in Children with High-Functioning Autism: A 2 Year Follow-Up Study. *Journal of Autism and Developmental Disorders*, *45*(8), 2497–2507. https://doi.org/10.1007/s10803-015-2415-8

Bennett, J., & Müller, U. (2010). The Development of Flexibility and Abstraction in Preschool Children. *Merrill-Palmer Quarterly*, *56*(4), 455–473.

Berenguer, C., Roselló, B., Colomer, C., Baixauli, I., & Miranda, A. (2018). Children with autism and attention deficit hyperactivity disorder. Relationships between symptoms and executive function, theory of mind, and behavioral problems. *Research in Developmental Disabilities*, *83*, 260–269. https://doi.org/10.1016/j.ridd.2018.10.001

Bertollo, J. R., Strang, J. F., Anthony, L. G., Kenworthy, L., Wallace, G. L., & Yerys, B. E. (2020). Adaptive Behavior in Youth with Autism Spectrum Disorder: The Role of Flexibility. *Journal of Autism and Developmental Disorders*, *50*(1), 42–50. https://doi.org/10.1007/s10803-019-04220-9

Blackwell, S., Zylberberg, A., Scerif, G., Miller, S., & Woodcock, K. A. (2021). Understanding the psycho-social context for a new early intervention for resistance to change that aims to strike a beneficial balance between structure and flexibility. *BMC Psychiatry*, *21*(1), 621. https://doi.org/10.1186/s12888-021-03519-1

Blakemore, S.-J., & Robbins, T. W. (2012). Decision-making in the adolescent brain. *Nature Neuroscience*, *15*(9), 1184–1191. https://doi.org/10.1038/nn.3177

Borkovec, T. D. (1994). The nature, functions, and origins of worry. In G. Davey & F. Tallis (Eds.), *Worrying: Perspectives on theory, assessment, and treatment* (pp. 5–33). Wiley & Sons.

Bury, S. M., Jellett, R., Spoor, J. R., & Hedley, D. (2020). "It Defines Who I Am" or "It's Something I Have": What Language Do [Autistic] Australian Adults [on the Autism Spectrum] Prefer? *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-020-04425-3

Cai, R. Y., Richdale, A. L., Uljarević, M., Dissanayake, C., & Samson, A. C. (2018). Emotion regulation in autism spectrum disorder: Where we are and where we need to go. *Autism Research*, *11*(7), 962–978. https://doi.org/10.1002/aur.1968

Cannon, L., Kenworthy, L., Alexander, K. C., Werner, M. A., & Anthony, L. (2011). Unstuck and on Target! An Executive Function Curriculum to Improve Flexibility for Children with Autism Spectrum Disorders. Research Edition. In *Brookes Publishing Company*. Brookes Publishing Company.

Carter Leno, V., Wright, N., Pickles, A., Bedford, R., Zaidman-Zait, A., Kerns, C., Mirenda, P., Zwaigenbaum, L., Duku, E., Bennett, T., Georgiades, S., Smith, I., Vaillancourt, T., Szatmari, P., & Elsabbagh, M. (2022). Exposure to family stressful life events in autistic children: Longitudinal associations with mental health and the moderating role of cognitive flexibility: *Autism*. https://doi.org/10.1177/13623613211061932

Centers for Disease Control and Prevention. (2019, April 5). *Data and Statistics on Autism Spectrum Disorder | CDC*. Centers for Disease Control and Prevention. https://www.cdc.gov/ncbddd/autism/data.html

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge.

Core Team, R. (2019). *R: a language and environment for statistical computing.* R Foundation for Statistical Computing.

Cragg, L., & Chevalier, N. (2012). The processes underlying flexibility in childhood. *Quarterly Journal of Experimental Psychology*, *65*(2), 209–232. https://doi.org/10.1080/17470210903204618

Crawley, D., Zhang, L., Jones, E. J. H., Ahmad, J., Oakley, B., Cáceres, A. S. J., Charman, T., Buitelaar, J. K., Murphy, D. G. M., Chatham, C., Ouden, H. den, Loth, E., & Group, the E.-A. L. (2020). Modeling flexible behavior in childhood to adulthood shows age-dependent learning mechanisms and less optimal learning in autism in each age group. *PLOS Biology*, *18*(10), e3000908. https://doi.org/10.1371/journal.pbio.3000908

Cretenet, J., & Dru, V. (2009). Influence of peripheral and motivational cues on rigid-flexible functioning: Perceptual, behavioral, and cognitive aspects. *Journal of Experimental Psychology. General*, *138*(2), 201–217. https://doi.org/10.1037/a0015379

Dajani, D. R., Llabre, M. M., Nebel, M. B., Mostofsky, S. H., & Uddin, L. Q. (2016). Heterogeneity of executive functions among comorbid neurodevelopmental disorders. *Scientific Reports*, *6*, 36566. https://doi.org/10.1038/srep36566

Deák, G. O. (2003). The Development of Cognitive Flexibility and Language Abilities. In *Advances in child development and behavior, Vol. 31* (pp. 271–327). Academic Press.

Dekkers, O. M., Vandenbroucke, J. P., Cevallos, M., Renehan, A. G., Altman, D. G., & Egger, M. (2019). COSMOS-E: Guidance on conducting systematic reviews and meta-analyses of observational studies of etiology. *PLoS Medicine*, *16*(2). https://doi.org/10.1371/journal.pmed.1002742

Demetriou, E. A., DeMayo, M. M., & Guastella, A. J. (2019). Executive Function in Autism Spectrum Disorder: History, Theoretical Models, Empirical Findings, and Potential as an Endophenotype. *Frontiers in Psychiatry*, *10*. https://doi.org/10.3389/fpsyt.2019.00753

Demetriou, E. A., Lampit, A., Quintana, D. S., Naismith, S. L., Song, Y. J. C., Pye, J. E., Hickie, I., & Guastella, A. J. (2018). Autism spectrum disorders: A meta-analysis of executive function. *Molecular Psychiatry*, *23*(5), 1198–1204. https://doi.org/10.1038/mp.2017.75

Dieckhaus, M. F. S., Hardy, K. K., Gutermuth Anthony, L., Verbalis, A., Kenworthy, L., & Pugliese, C. E. (2021). Anxiety relates to classroom executive function problems in students with ASD, but not ADHD. *Research in Autism Spectrum Disorders*, *82*, 101739. https://doi.org/10.1016/j.rasd.2021.101739

Dietrich, A., & Kanso, R. (2010). A review of EEG, ERP, and neuroimaging studies of creativity and insight. *Psychological Bulletin*, *136*(5), 822–848. https://doi.org/10.1037/a0019749

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ*, *315*(7109), 629–634. https://doi.org/10.1136/bmj.315.7109.629

Friedman, N. P., & Miyake, A. (2017). Unity and diversity of executive functions: Individual differences as a window on cognitive structure. *Cortex*, *86*, 186–204. https://doi.org/10.1016/j.cortex.2016.04.023

Garcia-Garcia, M., Barceló, F., Clemente, I. C., & Escera, C. (2010). The role of the dopamine transporter DAT1 genotype on the neural correlates of cognitive flexibility. *The European Journal of Neuroscience*, *31*(4), 754–760. https://doi.org/10.1111/j.1460-9568.2010.07102.x

Gardiner, E., & Iarocci, G. (2018). Everyday executive function predicts adaptive and internalizing behavior among children with and without autism spectrum disorder. *Autism Research: Official Journal of the International Society for Autism Research*, *11*(2), 284–295. https://doi.org/10.1002/aur.1877

Geurts, H. M., Corbett, B., & Solomon, M. (2009). The paradox of cognitive flexibility in autism. *Trends in Cognitive Sciences*, *13*(2), 74–82. https://doi.org/10.1016/j.tics.2008.11.006

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). TEST REVIEW Behavior Rating Inventory of Executive Function. *Child Neuropsychology*, *6*(3), 235–238. https://doi.org/10.1076/chin.6.3.235.3152

Happé, F., Booth, R., Charlton, R., & Hughes, C. (2006). Executive function deficits in autism spectrum disorders and attention-deficit/hyperactivity disorder: Examining profiles across domains and ages. *Brain and Cognition*, *61*(1), 25–39. https://doi.org/10.1016/j.bandc.2006.03.004

Higgins, J. P. T., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *BMJ*, *327*(7414), 557–560. https://doi.org/10.1136/bmj.327.7414.557

Hollocks, M. J., Charman, T., Baird, G., Lord, C., Pickles, A., & Simonoff, E. (2021). Exploring the impact of adolescent cognitive inflexibility on emotional and behavioural problems experienced by autistic adults. *Autism*, 13623613211046160. https://doi.org/10.1177/13623613211046160

Hollocks, M. J., Jones, C. R. G., Pickles, A., Baird, G., Happé, F., Charman, T., & Simonoff, E. (2014). The association between social cognition and executive functioning and symptoms of anxiety and depression in adolescents with autism spectrum disorders. *Autism Research: Official Journal of the International Society for Autism Research*, *7*(2), 216–228. https://doi.org/10.1002/aur.1361

Ionescu, T. (2012). Exploring the nature of cognitive flexibility. *New Ideas in Psychology*, *30*(2), 190–200. https://doi.org/10.1016/j.newideapsych.2011.11.001

Kashdan, T. B. (2010). Psychological Flexibility as a Fundamental Aspect of Health. *Clinical Psychology Review*, *30*(7), 865–878. https://doi.org/10.1016/j.cpr.2010.03.001

Kenny, L., Hattersley, C., Molins, B., Buckley, C., Povey, C., & Pellicano, E. (2016). Which terms should be used to describe autism? Perspectives from the UK autism community. *Autism*, *20*(4), 442–462. https://doi.org/10.1177/1362361315588200

Kenworthy, L., Anthony, L. G., Naiman, D. Q., Cannon, L., Wills, M. C., Luong-Tran, C., Werner, M. A., Alexander, K. C., Strang, J., Bal, E., Sokoloff, J. L., & Wallace, G. L. (2014). Randomized Controlled Effectiveness Trial of Executive Function Invention for Children on the Autism Spectrum. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *55*(4), 374–383. https://doi.org/10.1111/jcpp.12161

Kenworthy, L., Verbalis, A., Bascom, J., daVanport, S., Strang, J. F., Pugliese, C., Freeman, A., Jeppsen, C., Armour, A. C., Jost, G., Hardy, K., & Wallace, G. L. (2022). Adding the missing voice: How self-report of autistic youth self-report on an executive functioning rating scale compares to parent report and that of youth with attention deficit hyperactivity disorder or neurotypical development. *Autism*, *26*(2), 422–433. https://doi.org/10.1177/13623613211029117

Kmet, L., Lee, R. C., Cook, L. S., Lorenzetti, D., Godlovitch, G., & Einsiedel, E. (2004). *Standard quality assessment cirteria for evaluating primary research papers from a variety of fields.* Alberta Heritage Foundatoin for Medical Research.

Lai, M.-C., Kassee, C., Besney, R., Bonato, S., Hull, L., Mandy, W., Szatmari, P., & Ameis, S. H. (2019). Prevalence of co-occurring mental health diagnoses in the autism population: A systematic review and meta-analysis. *The Lancet Psychiatry*, *6*(10), 819–829. https://doi.org/10.1016/S2215-0366(19)30289-5

Lawson, R. A., Papadakis, A. A., Higginson, C. I., Barnett, J. E., Wills, M. C., Strang, J. F., Wallace, G. L., & Kenworthy, L. (2015). Everyday executive function impairments predict comorbid psychopathology in autism spectrum and attention deficit hyperactivity disorders. *Neuropsychology*, *29*(3), 445–453. https://doi.org/10.1037/neu0000145

Leung, R. C., & Zakzanis, K. K. (2014). Brief Report: Cognitive Flexibility in Autism Spectrum Disorders: A Quantitative Review. *Journal of Autism and Developmental Disorders*, *44*(10), 2628–2645. https://doi.org/10.1007/s10803-014-2136-4

Lieb, R. W., & Bohnert, A. M. (2017). Relations Between Executive Functions, Social Impairment, and Friendship Quality on Adjustment Among High Functioning Youth with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *47*(9), 2861–2872. https://doi.org/10.1007/s10803-017-3205-2

Maddox, B. B., Cleary, P., Kuschner, E. S., Miller, J. S., Armour, A. C., Guy, L., Kenworthy, L., Schultz, R. T., & Yerys, B. E. (2018). Lagging skills contribute to challenging behaviors in children with autism spectrum disorder without intellectual disability. *Autism: The International Journal of Research and Practice*, *22*(8), 898–906. https://doi.org/10.1177/1362361317712651

Memari, A. H., Ziaee, V., Shayestehfar, M., Ghanouni, P., Mansournia, M. A., & Moshayedi, P. (2013). Cognitive flexibility impairments in children with autism spectrum disorders: Links to age, gender and child outcomes. *Research in Developmental Disabilities*, *34*(10), 3218–3225. https://doi.org/10.1016/j.ridd.2013.06.033

Miles, S., Gnatt, I., Phillipou, A., & Nedeljkovic, M. (2020). Cognitive flexibility in acute anorexia nervosa and after recovery: A systematic review. *Clinical Psychology Review*, *81*, 101905. https://doi.org/10.1016/j.cpr.2020.101905

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ*, *339*, b2535. https://doi.org/10.1136/bmj.b2535

Morris, L., & Mansell, W. (2018). A systematic review of the relationship between rigidity/flexibility and transdiagnostic cognitive and behavioral processes that maintain psychopathology. *Journal of Experimental Psychopathology*, *9*(3), 2043808718779431. https://doi.org/10.1177/2043808718779431

Ozsivadjian, A., Hollocks, M. J., Magiati, I., Happé, F., Baird, G., & Absoud, M. (2021). Is cognitive inflexibility a missing link? The role of cognitive inflexibility, alexithymia and intolerance of uncertainty in externalising and internalising behaviours in young people with autism spectrum disorder. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *62*(6), 715–724. https://doi.org/10.1111/jcpp.13295

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *The Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Rietz, E. D., Pettersson, E., Brikell, I., Ghirardi, L., Chen, Q., Hartman, C., Lichtenstein, P., Larsson, H., & Kuja-Halkola, R. (2021). Overlap between attention-deficit hyperactivity disorder and neurodevelopmental, externalising and internalising disorders: Separating unique from general psychopathology effects. *The British Journal of Psychiatry*, *218*(1), 35–42. https://doi.org/10.1192/bjp.2020.152

Rodgers, J., & South, M. (2021). Commentary: Thinking flexibly about mental health and autism - a commentary on Ozsivadjian et al. (2020). *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *62*(6), 725–727. https://doi.org/10.1111/jcpp.13340

Rogers, J., Viding, E., Blair, R. J., Frith, U., & Happé, F. (2006). Autism spectrum disorder and psychopathy: Shared cognitive underpinnings or double hit? *Psychological Medicine*, *36*(12), 1789–1798. https://doi.org/10.1017/S0033291706008853

Saal, F. E., Downey, R. G., & Lahey, M. A. (1980). Rating the ratings: Assessing the psychometric quality of rating data. *Psychological Bulletin*, *88*(2), 413–428. https://doi.org/10.1037/0033-2909.88.2.413

Samson, A. C., Hardan, A. Y., Lee, I. A., Phillips, J. M., & Gross, J. J. (2015). Maladaptive Behavior in Autism Spectrum Disorder: The Role of Emotion Experience and Emotion Regulation. *Journal of Autism and Developmental Disorders*, *45*(11), 3424–3432. https://doi.org/10.1007/s10803-015-2388-7

Scarpa, A., Swain, D. M., Factor, R. S., Dahiya, A. V., & Bertollo, J. R. (2021). Enhancing Flexibility: A Biosocial Model for Resilience to Adversity in Youth With Autism. *SAGE Open*, *11*(3), 21582440211037996. https://doi.org/10.1177/21582440211037997

Sesso, G., Cristofani, C., Berloffa, S., Cristofani, P., Fantozzi, P., Inguaggiato, E., Narzisi, A., Pfanner, C., Ricci, F., Tacchi, A., Valente, E., Viglione, V., Milone, A., & Masi, G. (2020). Autism Spectrum Disorder and Disruptive Behavior Disorders Comorbidities Delineate Clinical Phenotypes in Attention-Deficit Hyperactivity Disorder: Novel Insights from the Assessment of Psychopathological

and Neuropsychological Profiles. *Journal of Clinical Medicine*, *9*(12), E3839. https://doi.org/10.3390/jcm9123839

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric Disorders in Children With Autism Spectrum Disorders: Prevalence, Comorbidity, and Associated Factors in a Population-Derived Sample. *Journal of the American Academy of Child & Adolescent Psychiatry*, *47*(8), 921–929. https://doi.org/10.1097/CHI.0b013e318179964f

Strang, J. F., Anthony, L. G., Yerys, B. E., Hardy, K. K., Wallace, G. L., Armour, A. C., Dudley, K., & Kenworthy, L. (2017). The Flexibility Scale: Development and Preliminary Validation of a Cognitive Flexibility Measure in Children with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, *47*(8), 2502–2518. https://doi.org/10.1007/s10803-017-3152-y

Tachibana, Y., Hwang, Y., Abe, Y., Goto, S., Sugai, K., & Kawashima, R. (2013). Reading aloud improves executive function of children with autism spectrum disorder: A pilot randomized controlled trial. *International Journal on Disability and Human Development*, *12*(1), 91–101. https://doi.org/10.1515/ijdhd-2012-0128

Teunisse, J.-P., Roelofs, R. L., Verhoeven, E. W. M., Cuppen, L., Mol, J., & Berger, H. J. C. (2012). Flexibility in children with autism spectrum disorders (ASD): Inconsistency between neuropsychological tests and parent-based rating scales. *Journal of Clinical and Experimental Neuropsychology*, *34*(7), 714–723. https://doi.org/10.1080/13803395.2012.670209

Trimarco, B., Manti, F., Nardecchia, F., Melogno, S., Testa, M., Meledandri, G., Carducci, C., Penge, R., & Leuzzi, V. (2020). Executive functioning, adaptive skills, emotional and behavioral profile: A comparison between autism spectrum disorder and phenylketonuria. *Molecular Genetics and Metabolism Reports*, *23*, 100577. https://doi.org/10.1016/j.ymgmr.2020.100577

Tse, V. W. S., Lei, J., Crabtree, J., Mandy, W., & Stott, J. (2021). Characteristics of Older Autistic Adults: A Systematic Review of Literature. *Review Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s40489-021-00238-x

Uddin, L. Q. (2021). Brain Mechanisms Supporting Flexible Cognition and Behavior in Adolescents With Autism Spectrum Disorder. *Biological Psychiatry*, *89*(2), 172–183. https://doi.org/10.1016/j.biopsych.2020.05.010

Uljarević, M., Frazier, T. W., Rached, G., Busch, R. M., Klaas, P., Srivastava, S., Martinez-Agosto, J. A., Sahin, M., Eng, C., Hardan, A. Y., & Developmental Synaptopathies Consortium. (2022). Brief Report: Role of Parent-Reported Executive Functioning and Anxiety in Insistence on Sameness in Individuals with Germline PTEN Mutations. *Journal of Autism and Developmental Disorders*, *52*(1), 414–422. https://doi.org/10.1007/s10803-021-04881-5

van Steensel, F. J. A., Bögels, S. M., & Dirksen, C. D. (2012). Anxiety and quality of life: Clinically anxious children with and without autism spectrum disorders compared. *Journal of Clinical Child and Adolescent Psychology: The Official Journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53*, *41*(6), 731–738. https://doi.org/10.1080/15374416.2012.698725

Viechtbauer, W. (2019). *Meta-analysis package for R*. CRAN.

Vivanti, G. (2020). Ask the Editor: What is the Most Appropriate Way to Talk About Individuals with a Diagnosis of Autism? *Journal of Autism and Developmental Disorders*, *50*(2), 691–693. https://doi.org/10.1007/s10803-019-04280-x

Vogan, V. M., Leung, R. C., Safar, K., Martinussen, R., Smith, M. L., & Taylor, M. J. (2018). Longitudinal Examination of Everyday Executive Functioning in Children With ASD: Relations With Social, Emotional, and Behavioral Functioning Over Time. *Frontiers in Psychology*, *9*. https://www.frontiersin.org/article/10.3389/fpsyg.2018.01774

Yerys, B. E., Wallace, G. L., Sokoloff, J. L., Shook, D. A., James, J. D., & Kenworthy, L. (2009). Attention deficit/hyperactivity disorder symptoms moderate cognition and behavior in children with autism spectrum disorders. *Autism Research: Official Journal of the International Society for Autism Research*, *2*(6), 322–333. https://doi.org/10.1002/aur.103

Yorke, I., White, P., Weston, A., Rafla, M., Charman, T., & Simonoff, E. (2018). The Association Between Emotional and Behavioral Problems in Children with Autism Spectrum Disorder and Psychological Distress in Their Parents: A Systematic Review and Meta-analysis. *Journal of Autism and Developmental Disorders*, *48*(10), 3393–3415. https://doi.org/10.1007/s10803-018-3605-y

7. Appendices

7.1 Standard Quality Assessment Criteria for Evaluating Primary Research Papers (Kmet et al. 2004)

Appendix A: Manual for Quality Scoring of Quantitative Studies

Definitions and Instructions for Quality Assessment Scoring

How to calculate the summary score

- **Total sum** = (number of "yes" * 2) + (number of "partials" * 1)
- **Total possible sum** = 28 – (number of "N/A" * 2)
- **Summary score:** total sum / total possible sum

Quality assessment

1. *Question or objective sufficiently described?*

   Yes: Is easily identified in the introductory section (or first paragraph of methods section). Specifies (where applicable, depending on study design) *all* of the following: purpose, subjects/target population, and the *specific* intervention(s) /association(s)/descriptive parameter(s) under investigation. A study purpose that only becomes apparent after studying other parts of the paper is *not* considered sufficiently described.

   Partial: Vaguely/incompletely reported (e.g. "describe the effect of" or "examine the role of" or "assess opinion on many issues" or "explore the general attitudes"...); *or* some information has to be gathered from parts of the paper other than the introduction/background/objective section.

   No: Question or objective is not reported, or is incomprehensible.

   N/A: Should not be checked for this question.

2. *Design evident and appropriate to answer study question?*

   (If the study question is not given, infer from the conclusions).

   Yes: Design is easily identified and is appropriate to address the study question / objective.

   Partial: Design and /or study question not clearly identified, but gross inappropriateness is not evident; *or* design is easily identified but only partially addresses the study question.

   No: Design used does not answer study question (e.g., a comparison group is required to answer the study question, but none was used); *or* design cannot be identified.

   N/A: Should not be checked for this question.

3. *Method of subject selection (and comparison group selection, if applicable) or source of information/input variables (e.g., for decision analysis) is described and appropriate.*

   Yes: Described and appropriate. Selection strategy *designed* (i.e., consider sampling frame and strategy) to obtain an unbiased sample of the relevant target population or the entire target population of interest (e.g., consecutive patients for clinical trials, population-based random sample for case-control studies or surveys). Where applicable, inclusion/exclusion criteria are described and defined (e.g., "cancer" -- ICD code or equivalent should be provided). *Studies of volunteers:* methods and setting of recruitment reported. *Surveys:* sampling frame/ strategy clearly described and appropriate.

   Partial: Selection methods (and inclusion/exclusion criteria, where applicable) are not completely described, but no obvious inappropriateness. Or selection strategy is not ideal (i.e., likely introduced bias) but did not likely seriously distort the results (e.g., telephone survey sampled from listed phone numbers only; hospital based case-control study identified all cases admitted during the study period, but recruited controls admitted during the day/evening only). Any study describing participants only as "volunteers" or "healthy volunteers". *Surveys:* target population mentioned but sampling strategy unclear.

   No: No information provided. *Or* obviously inappropriate selection procedures (e.g., inappropriate comparison group if intervention in women is compared to intervention in men). *Or* presence of selection bias which likely seriously distorted the results (e.g., obvious selection on "exposure" in a case-control study).

   N/A: Descriptive case series/reports.

4. *Subject (and comparison group, if applicable) characteristics or input variables/information (e.g., for decision analyses) sufficiently described?*

   Yes: Sufficient relevant baseline/demographic information clearly characterizing the participants is provided (or reference to previously published baseline data is provided). Where applicable, reproducible criteria used to describe/categorize the participants are clearly defined (e.g., ever-smokers, depression scores, systolic blood pressure > 140). **If** "healthy volunteers" are used, age and sex must be reported (at minimum). *Decision analyses:* baseline estimates for input variables are clearly specified.

   Partial: Poorly defined criteria (e.g. "hypertension", "healthy volunteers", "smoking"). *Or* incomplete relevant baseline / demographic information (e.g., information on likely confounders not reported). *Decision analyses:* incomplete reporting of baseline estimates for input variables.

   No: No baseline / demographic information provided.
   Decision analyses: baseline estimates of input variables not given.

   N/A: Should not be checked for this question.

5. *If random allocation to treatment group was possible, is it described?*

   Yes: True randomization done - requires a description of the method used (e.g., use of random numbers).

   Partial: Randomization mentioned, but method is not (i.e. it may have been possible that randomization was not true).

   No: Random allocation not mentioned although it would have been feasible and appropriate (and was possibly done).

   N/A: Observational analytic studies. Uncontrolled experimental studies. Surveys. Descriptive case series / reports. Decision analyses.

6. *If interventional and blinding of investigators to intervention was possible, is it reported?*

   Yes: Blinding reported.

   Partial: Blinding reported but it is not clear who was blinded.

   No: Blinding would have been possible (and was possibly done) but is not reported.

   N/A: Observational analytic studies. Uncontrolled experimental studies. Surveys. Descriptive case series / reports. Decision analyses.

7. *If interventional and blinding of subjects to intervention was possible, is it reported?*

   Yes: Blinding reported.

   Partial: Blinding reported but it is not clear who was blinded.

   No: Blinding would have been possible (and was possibly done) but is not reported.

   N/A: Observational studies. Uncontrolled experimental studies. Surveys. Descriptive case series / reports.

8. *Outcome and (if applicable) exposure measure(s) well defined and robust to measurement / misclassification bias? Means of assessment reported?*

   Yes: Defined (or reference to complete definitions is provided) and measured according to reproducible, "objective" criteria (e.g., death, test completion – yes/no, clinical scores). Little or minimal potential for measurement / misclassification errors. *Surveys:* clear description (or reference to clear description) of questionnaire/interview content and response options. *Decision analyses:* sources of uncertainty are defined for all input variables.

   Partial: Definition of measures leaves room for subjectivity, *or* not sure (i.e., not reported in detail, but probably acceptable). *Or* precise definition(s) are missing, but no evidence or problems in the paper that would lead one to assume major problems. *Or* instrument/mode of assessment(s) not reported. Or misclassification errors may have occurred, but they did not likely seriously distort the results (e.g., slight difficulty with recall of long-ago events; exposure is measured only at baseline in a long cohort study). *Surveys:* description of

questionnaire/interview content incomplete; response options unclear. *Decision analyses:* sources of uncertainty are defined only for some input variables.

No: Measures not defined, or are inconsistent throughout the paper. *Or* measures employ only ill-defined, subjective assessments, e.g. "anxiety" or "pain." *Or* obvious misclassification errors/measurement bias likely seriously distorted the results (e.g., a prospective cohort relies on self-reported outcomes among the "unexposed" but requires clinical assessment of the "exposed"). *Surveys:* no description of questionnaire/interview content or response options. *Decision analyses:* sources of uncertainty are not defined for input variables.

N/A: Descriptive case series / reports.

9. *Sample size appropriate?*

Yes: Seems reasonable with respect to the outcome under study and the study design. When statistically significant results are achieved for major outcomes, appropriate sample size can usually be assumed, unless large standard errors (SE > ½ effect size) and/or problems with multiple testing are evident. *Decision analyses:* size of modeled cohort / number of iterations specified and justified.

Partial: Insufficient data to assess sample size (e.g., sample seems "small" and there is no mention of power/sample size/effect size of interest and/or variance estimates aren't provided). *Or* some statistically significant results with standard errors > ½ effect size (i.e., imprecise results). *Or* some statistically significant results in the absence of variance estimates. *Decision analyses:* incomplete description or justification of size of modeled cohort / number of iterations.

No: Obviously inadequate (e.g., statistically non-significant results and standard errors > ½ effect size; or standard deviations > _ of effect size; or statistically non-significant results with no variance estimates and obviously inadequate sample size). *Decision analyses:* size of modeled cohort / number of iterations not specified.

N/A: Most surveys (except surveys comparing responses between groups or change over time). Descriptive case series / reports.

10. *Analysis described and appropriate?*

Yes: Analytic methods are described (e.g. "chi square"/ "t-tests"/"Kaplan-Meier with log rank tests", etc.) and appropriate.

Partial: Analytic methods are not reported and have to be guessed at, but are probably appropriate. *Or* minor flaws or some tests appropriate, some not (e.g., parametric tests used, but unsure whether appropriate; control group exists but is not used for statistical analysis). *Or* multiple testing problems not addressed.

No: Analysis methods not described and cannot be determined. *Or* obviously inappropriate analysis methods (e.g., chi-square tests for continuous data, SE given where normality is highly unlikely, etc.). *Or* a study with a descriptive goal / objective is over-analyzed.

N/A: Descriptive case series / reports.

11. *Some estimate of variance (e.g., confidence intervals, standard errors) is reported for the main results/outcomes (i.e., those directly addressing the study question/ objective upon which the conclusions are based)?*

Yes: Appropriate variances estimate(s) is/are provided (e.g., range, distribution, confidence intervals, etc.). *Decision analyses:* sensitivity analysis includes all variables in the model.

Partial: Undefined "+/-" expressions. *Or* no specific data given, but insufficient power acknowledged as a problem. *Or* variance estimates not provided for all main results/outcomes. *Or* inappropriate variance estimates (e.g., a study examining change over time provides a variance around the parameter of interest at "time 1" or "time 2", but does not provide an estimate of the variance around the difference). *Decision analyses:* sensitivity analysis is limited, including only some variables in the model.

No: No information regarding uncertainty of the estimates. *Decision analyses:* No sensitivity analysis.

N/A: Descriptive case series / reports. Descriptive surveys collecting information using open-ended questions.

12. *Controlled for confounding?*

Yes: Randomized study, with comparability of baseline characteristics reported (or non-comparability controlled for in the analysis). *Or* appropriate control at the design or analysis stage (e.g., matching, subgroup analysis, multivariate models, etc). *Decision analyses:* dependencies between variables fully accounted for (e.g., joint variables are considered).

Partial: Incomplete control of confounding. *Or* control of confounding reportedly done but not completely described. *Or* randomized study without report of comparability of baseline characteristics. *Or* confounding not considered, but not likely to have seriously distorted the results. *Decision analyses:* incomplete consideration of dependencies between variables.

No: Confounding not considered, and may have seriously distorted the results. *Decision analyses:* dependencies between variables not considered.

N/A: Cross-sectional surveys of a single group (i.e., surveys examining change over time or surveys comparing different groups should address the potential for confounding). Descriptive studies. Studies explicitly stating the analysis is strictly descriptive/exploratory in nature.

13. *Results reported in sufficient detail?*

Yes: Results include major outcomes and all mentioned secondary outcomes.

Partial: Quantitative results reported only for some outcomes. *Or* difficult to assess as study question/objective not fully described (and is not made clear in the methods section), but results seem appropriate.

No: Quantitative results are reported for a subsample only, or "n" changes continually across the denominator (e.g., reported proportions do not account for the entire study sample, but are reported only for those with complete data -- i.e., the category of "unknown" is not used where needed). *Or* results for some major or mentioned secondary outcomes are only qualitatively reported when quantitative reporting would have been possible (e.g., results include vague comments such as "more likely" without quantitative report of actual numbers).

N/A: Should not be checked for this question.

14. *Do the results support the conclusions?*

Yes: All the conclusions are supported by the data (even if analysis was inappropriate). Conclusions are based on all results relevant to the study question, negative as well as positive ones (e.g., they aren't based on the sole significant finding while ignoring the negative results). Part of the conclusions may expand beyond the results, if made *in addition to* rather than instead of those strictly supported by data, and if including indicators of their interpretative nature (e.g., "suggesting," "possibly").

Partial: Some of the major conclusions are supported by the data, some are not. *Or* speculative interpretations are not indicated as such. *Or* low (or unreported) response rates call into question the validity of generalizing the results to the target population of interest (i.e., the population defined by the sampling frame/strategy).

No: None or a very small minority of the major conclusions are supported by the data. *Or* negative findings clearly due to low power are reported as definitive evidence against the alternate hypothesis. *Or* conclusions are missing. *Or* extremely low response rates invalidate generalizing the results to the target population of interest (i.e., the population defined by the sampling frame/strategy).

N/A: Should not be checked for this question.

7.2 Quality Appraisal Ratings for Included Papers (n = 24)

Author (year); Country	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Total	QualSyst Score
Anderson et al. (2015); Norway	2	2	1	2	N/A	N/A	N/A	1	1	2	1	1	2	2	17	0.77
Berenguer et al. (2018); Spain	2	2	1	2	N/A	N/A	N/A	2	1	2	2	2	2	1	19	0.86
Carter Leno et al. (2022); Canada	2	2	1	2	N/A	N/A	N/A	2	1	2	2	2	2	1	19	0.79
Crawley et al. (2020); UK	2	2	2	2	N/A	N/A	N/A	2	2	2	2	2	2	2	22	1
Dajani et al. (2016); USA	2	2	0	2	N/A	N/A	N/A	2	1	2	2	2	2	2	19	0.86
Dajani et al. (2019); USA	2	2	0	2	N/A	N/A	N/A	2	1	2	2	1	2	2	18	0.82
Dieckhaus et al. (2021); USA	2	2	1	2	N/A	N/A	N/A	2	1	2	2	1	2	1	18	0.82
Gardiner et al. (2018); Canada	2	2	1	2	N/A	N/A	N/A	2	1	2	2	2	2	2	20	0.91
Happé et al. (2006); UK	2	2	1	2	N/A	N/A	N/A	2	1	0	2	2	2	2	18	0.82
Hollocks et al. (2014); UK	2	2	1	2	N/A	N/A	N/A	2	1	2	2	2	2	2	20	0.91
Hollocks et al. (2022); UK	2	2	1	2	N/A	N/A	N/A	2	1	2	2	2	2	2	20	0.83
Lawson et al. (2015); USA	2	2	1	2	N/A	N/A	N/A	2	2	2	1	2	2	2	20	0.91

Lieb et al. (2017); USA	2	2	1	1	N/A	N/A	N/A	2	2	2	1	2	2	2	19	0.86
Maddox et al. (2018); USA	2	1	1	1	N/A	N/A	N/A	1	2	2	2	2	2	2	18	0.82
Ozsivadjian et al. (2021); UK	2	2	1	2	N/A	N/A	N/A	2	1	2	2	2	2	2	20	0.91
Rogers et al. (2006); UK	2	2	1	1	N/A	N/A	N/A	2	1	2	1	0	2	1	15	0.68
Sesso et al. (2020); Italy	2	2	1	2	N/A	N/A	N/A	2	1	2	2	2	2	2	20	0.91
Tachibana et al. (2013); Japan	1	1	1	1	2	N/A	N/A	2	1	2	1	1	2	1	16	0.67
Teunisse et al. (2012); The Netherlands	1	2	0	1	N/A	N/A	N/A	1	1	2	2	0	2	2	14	0.64
Trimarco et al. (2020); Italy	2	2	1	2	N/A	N/A	N/A	2	1	1	1	1	2	1	16	0.73
Uljarevic et al. (2021); Australia	2	2	1	2	N/A	N/A	N/A	1	1	2	2	2	2	2	19	0.86
Visser et al. (2015); The Netherlands	2	2	1	2	N/A	N/A	N/A	1	1	2	1	2	2	2	18	0.82
Vogan et al. (2018); Canada	1	2	1	2	N/A	N/A	N/A	2	1	2	1	2	2	2	18	0.82
Yerys et al. (2009); USA	2	2	1	2	N/A	N/A	N/A	2	1	2	1	2	2	1	18	0.82

7.3 Publication of systematic review and meta-analysis in Autism Research

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RESEARCH ARTICLE

Examining the relationship between cognitive inflexibility and internalizing and externalizing symptoms in autistic children and adolescents: A systematic review and meta-analysis

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Abstract

Compared to neurotypical peers, autistic adolescents show greater cognitive inflexibility (CI) which manifests at the behavioral and cognitive level and potentially increases vulnerability for the development of internalizing (INT) and externalizing (EXT) symptoms. This systematic review and meta-analysis explored the association between CI and INT/EXT in autistic adolescents. PubMed, EMBASE, MEDLINE, PsycINFO and Web of Science databases were searched to identify relevant studies until April 2022 (PROSPERO protocol: CRD42021277294). Systematic review included 21 studies ($n = 1608$) of CI and INT, and 15 studies ($n = 1115$) of CI and EXT. A pooled effect size using Pearson's correlation between CI and INT/EXT was calculated and the moderating effects of age, sex, IQ and study quality were investigated using meta-regressions. Sensitivity analyses were completed to investigate the impact of measure variance for CI and co-occurring ADHD on the overall effects. Greater CI is associated with increased INT (nine studies; $n = 833$; $r = 0.39$ (moderate effect), 95% confidence interval [0.32, 0.46]) and EXT (six studies; $n = 295$; $r = 0.48$ (large effect), 95% confidence interval [0.38, 0.58]). Results withheld when only using parental reports of CI and excluding autistic adolescents with co-occurring ADHD. Increased CI may be a transdiagnostic vulnerability factor that can increase autistic adolescents' rigid or perseverative patterns of unhelpful cognition and behaviors and reduce their ability to access psychological interventions. Addressing CI may improve autistic children and adolescents' engagement with psychological therapy for co-occurring mental health difficulties.

Lay Summary

This systematic review and meta-analysis explored the relationship between cognitive inflexibility (CI) and symptoms of anxiety, depression and behavioral difficulties in autistic children and adolescents. CI refers to increased rigidity and perseveration in thinking and behavior and was found to be associated with increased mental health symptoms in autistic adolescents. Addressing and targeting individual differences in CI may improve autistic children and adolescents' engagement with psychological therapy for co-occurring mental health difficulties.

KEYWORDS

autism spectrum disorder, cognitive inflexibility, cognitive flexibility, externalizing, internalizing, meta-analysis, systematic review

INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterized by social communication difficulties and restricted and repetitive behaviors and sensory anomalies (American Psychiatric Association, 2013) that affects 1 in 54 children (Centers for Disease Control and Prevention, 2019). In both population derived sample estimates and meta-analysis that have examined psychiatric co-occurring conditions amongst autistic individuals, 70% of autistic[1] children and adolescents have at least one co-occurring condition (Simonoff et al., 2008), between 20% and 41% experience internalizing conditions including anxiety and mood disorders, and between 12% and 30% experience externalizing conditions such as oppositional defiant and conduct disorder (Lai et al., 2019; Simonoff et al., 2008).

Given that co-occurring psychiatric conditions negatively impact the quality of life for autistic children and adolescents (van Steensel et al., 2012), identifying possible vulnerability factors can inform clinical assessment, formulation and intervention. Recent systematic reviews have highlighted that individual differences in executive function (EF) amongst autistic individuals may pose a significant risk factor for the development and maintenance of psychopathology (Demetriou et al., 2018; Uddin, 2021). The unitary (i.e., different components within EF may correlate with each other to suggest a common underlying process) and diversity (i.e., different EF processes also show separability when assessed using performance-based vs rater-report measures, and may load onto different latent constructs) (Friedman & Miyake, 2017) highlights that it may be possible to adopt a dimensional approach to better understand the unique impact of individual EF processes above and beyond the common EF factor contributing to the behavioral differences observed across autistic individuals (Demetriou et al., 2018). Furthermore, the degree of heterogeneity in performance across different EF domains is more significant in young people from neurodiverse backgrounds compared to their neurotypical peers. Reasons accounting for widespread heterogeneity may be related to a number of factors including method of EF assessment, age range of participants, and level of individual functioning, further suggesting a common EF factor may not be able to inform different subtypes of EF difficulties amongst autistic young people (Demetriou et al., 2019).

Adopting a dimensional approach by focusing on a single executive function domain can also support the establishment and critical evaluation of evidence-base to explore whether the identified construct may be suitable for intervention as an explicit treatment target. Such knowledge is crucial for supporting clinicians to make informed decisions when adapting clinical interventions to treat psychopathology for autistic children and young people (Demetriou et al., 2018; Kenworthy et al., 2014; Morris & Mansell, 2018; Uddin, 2021). One important executive function domain under recent scrutiny in autism research is cognitive flexibility, especially when considered from a developmental perspective across adolescence (Uddin, 2021). Cognitive flexibility enables one to develop a well-organized response in an efficient manner and act in a goal-directed way, and increased cognitive flexibility is associated with being better able to adapt to novel situations and generalize problem-solving skills across a variety of settings (Kenworthy et al., 2014). For autistic young people, cognitive flexibility plays an important buffering role against increasing development demands during adolescence from biological (changes in hormones, neural reorganization in the adolescent brain), psychological (increased peer-sensitivity including reward and rejection), and social (changes in peer relationships and increasing independence from family) perspectives (Uddin, 2021). One recent study found that different aspects of cognitive and social flexibility reported by parents accounted for individual differences in social adaptive functioning and communication skills in autistic youths aged 7–17 years, such that greater flexibility supported the ability for young people to function independently when transitioning to young adulthood (Bertollo et al., 2020), and is a protective factor against maladjustment through puberty.

Reduced cognitive flexibility, or cognitive inflexibility (CI), can also be a risk factor in development for autistic young people (Uddin, 2021). Compared to adolescents with ADHD and neurotypical peers, autistic adolescents and their parents report greater CI and reduced emotional control and reduced self-monitoring (Kenworthy et al., 2022). Parent-report of CI in autistic children and adolescents (aged 5–18 years) directly predicted externalizing symptoms and indirectly predicted internalizing symptoms via intolerance of uncertainty (Ozsivadjian et al., 2021). Another recent study using a range of neuropsychological tasks to measure CI demonstrated associations with internalizing symptoms across both adolescence and early adulthood, with inflexibility accounting for the stability of symptoms across timepoints (Hollocks et al., 2022). This suggests that CI may be one mechanism through which emotional difficulties are maintained longitudinally.

The definition of CI and its assessment shows variance across empirical literature (Ionescu, 2012). At the behavioral level, cognitive flexibility has been assessed by observing one's ability to switch between different sets of rules and instructions (or set-shifting), finding alternative solutions, and even multitasking (Cragg & Chevalier, 2012; Geurts et al., 2009). At the conceptual level, flexibility is less clearly defined, and has been related to cognitive control that falls under executive function, shifting between and generating alternative strategies when problem solving in light of conflicting

[1]This study uses both identity-first and person-first language when referring to autism, as studies in recent years have shown that the semantic choice of language when referring to autism is often debated without a general consensus being reached (Bury et al., 2020; Kenny et al., 2016; Vivanti, 2020).

evidence (Bennett & Müller, 2010; Garcia-Garcia et al., 2010), engaging in adaptive behaviors in a goal-oriented manner based on environmental changes (Deák, 2003), and even divergent thinking and creativity (Cretenet & Dru, 2009; Dietrich & Kanso, 2010). Cognitive mechanisms interact with environmental factors such as task demands, contextual cues, and sensorimotor aspects, and continues to mature over one's lifetime as cognitive flexibility (Ionescu, 2012). Given the complexity in the definition of cognitive flexibility and the number of cognitive, sensorimotor, and environmental factors that need to be considered during its assessment, empirical research has used a wide range of experimental tasks, neurocognitive tasks, and self- and observer questionnaire reports to capture cognitive flexibility at the behavioral and cognitive level across contexts (Ionescu, 2012). Examining differences in cognitive flexibility therefore also requires consideration and comparison across different assessment methods, given that different experimental and neurocognitive tasks and questionnaires may draw on different mechanisms underlying cognitive flexibility in different contexts.

Previous systematic and literature reviews on the topic of CI have evaluated the psychometric properties of standardized measures, including their discriminability (Leung & Zakzanis, 2014) and ecological validity when completed by autistic individuals (Geurts et al., 2009). No review to date has explored how CI may be associated with internalizing and externalizing symptoms in autistic children and adolescents. The current systematic review and meta-analysis has two objectives:

1. Aim 1: What is the relationship between CI and internalizing symptoms (INT; e.g., anxiety and mood symptoms/disorders?) in autistic children and adolescents?
2. Aim 2: What is the relationship between CI and externalizing symptoms (EXT; e.g., aggression, rule-breaking) in autistic children and adolescents?

Exploratory Aim: To explore whether any significant relationships observed in Aim 1 and/or 2 may be moderated by participants' mean age, gender (proportion of male participants), mean full-scale IQ, study quality, and modality of assessment.

We hope that a close examination of the empirical literature can aid clinical practice through generating hypotheses about the potential benefits of directly targeting CI to boost therapeutic engagement and outcomes in this clinical population when working with psychiatric co-occurring conditions.

METHODS

Search strategy

This review followed the PRISMA 2020 Checklist (Page et al., 2021), see Prospero (CRD42021277294) for study

TABLE 1 Summary of inclusion and exclusion criteria as per Participant Exposure Comparison Outcome

Inclusion criteria	Exclusion criteria
Participant	
• Sample includes young people aged 0–24 years (WHO definition for young people) • Participants have a clinical diagnosis of autism spectrum disorder or equivalent (e.g., Childhood autism (ICD-10)/Autistic Disorder (DSM-IV), Asperger's Syndrome, Pervasive Developmental Disorder - Not Otherwise Specified). Clinical diagnosis should be provided by a qualified healthcare and/or education professional via clinical assessment measures	• Sample does not include young people aged 0–24 years • Sample does not include participants with a clinical diagnosis of ASD or equivalent
Exposure	
• Study must include at least one instrument to measure cognitive flexibility, including, but not limited to the tests and measures identified by a systematic review by (Miles et al., 2020) (See Appendix C for detailed list of cognitive flexibility measures)	• Study does not include any measures of cognitive flexibility
Comparison	
• Optional: Studies may include age-matched sample of neurotypical children and/or adolescents with or without anxiety as a comparison group	• If the study meets the requirement under Participant and Exposure of the PECO criteria, absence of a comparison group *will not* lead to the exclusion of the study in the systematic review, as a comparison group is optional and not required to address the stated research questions
Outcome	
• For Aim 1: Study must meet the inclusion criteria and include at least one measure of internalizing symptoms. A diagnosis of any conditions associated with internalizing symptoms (e.g., mood or anxiety) is not necessary to be included in the review • For Aim 2: Study must meet the inclusion criteria and include at least one measure of externalizing symptoms. A diagnosis of any condition associated with externalizing symptoms (e.g., conduct disorder, oppositional	• Study does not include any measures of internalizing/externalizing symptoms; study only measures attention deficit hyperactivity disorder symptoms without any other measure of internalizing/externalizing symptoms

(Continues)

TABLE 1 (Continued)

Inclusion criteria	Exclusion criteria
defiant disorder) is not necessary to be included in the review	

protocol. Peer-reviewed journal articles published in English until April 11, 2022 were retrieved from PubMed, EMBASE, MEDLINE, PsycINFO and Web of Science. The earliest relevant article identified using the search terms was published in 1964. Synonyms of the following key words were used in identifying relevant articles across each database: autism, children/adolescent, CI, INT (Aim 1) and EXT (Aim 2) (Appendix A for full search strategy). Search terms were kept broad to explore which internalizing and externalizing conditions have been researched in relation to CI in adolescents with ASD. Literature only using ADHD as an outcome measure were excluded given the changes in classification and the predominant construct overlap between ADHD and neurodevelopmental conditions (Rietz et al., 2021). After collating results using EndNote library, duplicates were first removed before screening titles, abstracts and full-text articles based on the inclusion/exclusion criteria. Reference lists of included studies were screened to identify relevant articles.

Study selection

The inclusion/exclusion criteria described followed the participant, exposure, comparison, outcome (Table 1) outlined by conducting systematic reviews and meta-analyses of observational studies of etiology (Dekkers et al., 2019). Both cross-sectional and longitudinal quantitative studies published in English and in peer-reviewed journals were included in the review. Qualitative studies, systematic review/meta-analyses, opinion articles, gray literature and non-English publications were excluded.

Quality appraisal

Quality appraisal was completed by using The Standard Quality Assessment Criteria for Evaluating Primary Research papers from a Variety of Fields (Kmet et al., 2004) (Appendix B for description). The cut-off for inclusion ranges from being liberal (0.55) to conservative (0.75), with the current study adopting a moderately conservative threshold of 0.60 for study inclusion (Kmet et al., 2004). All studies were assessed independently by two assessors, who met to discuss and review any discrepancies in scoring, with final discussion outcomes being reflected by the quality appraisal scores provided in Tables 3 and 4. The interclass correlation coefficient between the two assessors showed moderate agreement ($\kappa = 0.73$) with a 95% confidence interval of (0.64–0.81).

Data extraction

Table 3 (INT) and Table 4 (EXT) show information extracted from studies included in the systematic review: (1) author, year and country of publication, (2) ASD diagnosis criteria and measure, (3) sample size and gender, (4) mean and standard deviation of age and full scale IQ (where available), (5) CI measure, (6) INT or EXT measure, (7) main findings of CI, INT/EXT, and the association between CI and INT/EXT, (8) quality appraisal score.

Data analysis

For each meta-analysis, Pearson's correlation coefficient (r) was chosen as a commonly reported effect size measure in observational studies. The first/last authors of studies that did not report Pearson's correlation ($n = 19$) were contacted via email on two occasions to request the relevant association. Six authors could not be reached or no longer had access to the raw dataset, and four authors responded with the relevant correlation coefficients that were included in the respective meta-analyses, and nine authors did not respond. When two or more symptom measures are used, specific scales for INT or EXT are used rather than total problem score.

Meta-analyses were conducted using RStudio (Core Team, 2019) and the *metafor* package in R (Viechtbauer, 2019). Due to possible variations in study outcomes because of differences in participant characteristics such as age, gender, IQ, and so forth, a random-effects meta-analysis model was used. The effect size for each study was first converted to Fisher's Z, which was subsequently converted back to a summary correlation. To interpret the magnitude of effect sizes, Cohen's guidelines (Cohen, 1988) for small (r = 0.10), moderate (r = 0.30) and large (r = 0.50) effects were applied. To assess the degree of heterogeneity across studies, Cochran's Q test and the Higgin's and Thompson's I^2 tests were used. Heterogeneity is indicated by either a statistically significant result from Q test ($p < 0.05$), or higher I^2 value (75% = substantial heterogeneity, 50% = moderate heterogeneity, 25% = low heterogeneity) (Higgins et al., 2003). Funnel plots were generated to inspect possible asymmetry that may indicate risk of publication bias, as indicated by a significant Egger's test statistic ($p < 0.05$) (Egger et al., 1997). Several study characteristics were explored using independent meta-regressions as potential

moderators: (1) mean age, (2) gender (proportion of male participants), (3) mean FSIQ, (4) study quality. Finally, to explore whether the overall effect sizes from each meta-analysis are influenced by (1) CI measurement; (2) co-occurring ADHD-diagnosis, separate post hoc sensitivity analyses were completed for studies using parent report measures of CI only, and for studies where adolescents did not have a reported co-occurring ADHD diagnosis.

RESULTS

Search results

The PRISMA diagram (Figure 1) summarizes the literature search process (Moher et al., 2009). The first author performed the initial literature search across all databases on 3rd September 2021 and an updated literature search on 11th April 2022, removed study duplicates, and

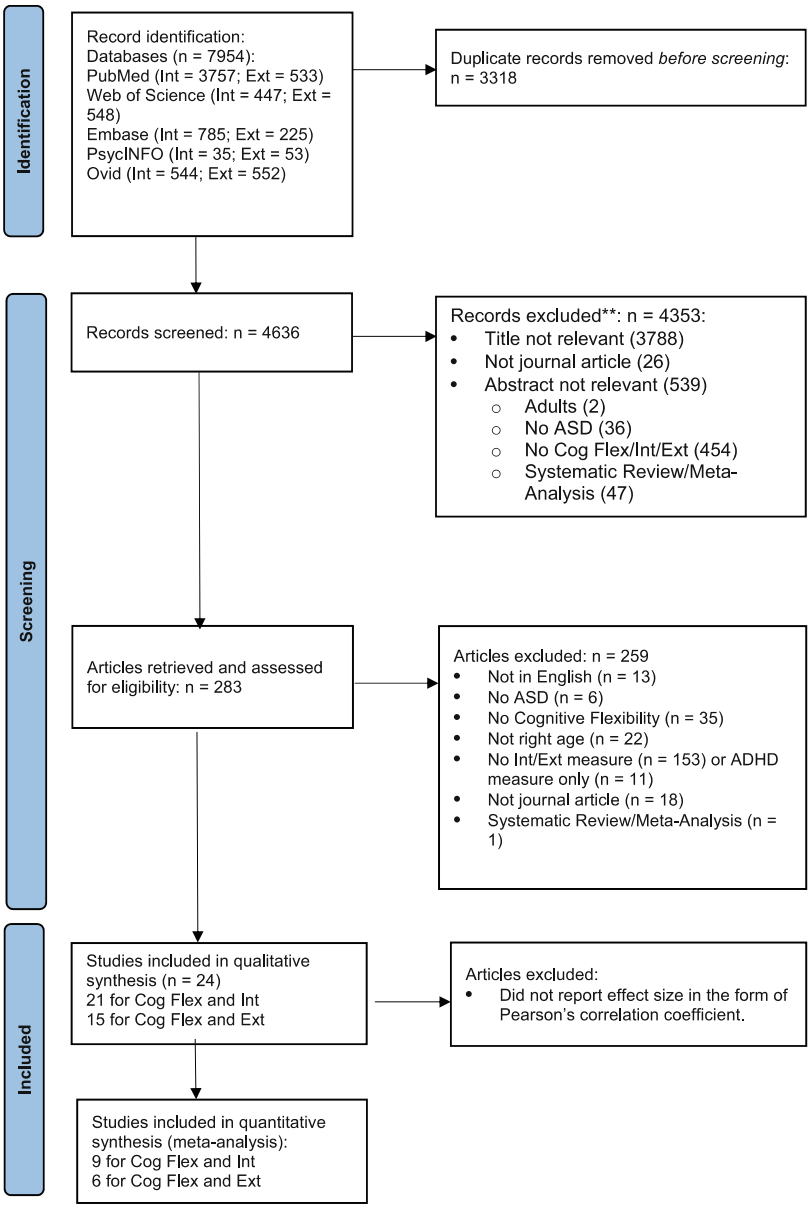

FIGURE 1 PRISMA diagram

completed title, abstract and full-text screening. A second coder independently screened ~10% of abstracts ($n = 83$; Kappa coefficient = 0.96), and ~ 10% of full-text articles ($n = 27$; Kappa coefficient = 0.96) with high inter-rater reliability. The 24 articles were selected for quality assessment. The 21 studies measured CI and INT (Aim 1), including nine Pearson's correlations for meta-analysis. The 15 studies measured CI and EXT (Aim 2), including six Pearson's correlation coefficients for meta-analysis.

Study characteristics

Tables 2 summarizes the characteristics for the 24 included studies. Of the 21 studies included for Aim 1, six studies reported family socioeconomic status (SES), three included largely low to middle income families (Carter Leno et al., 2022; Dieckhaus et al., 2021; Yerys et al., 2009), and three used either parental (Berenguer et al., 2018) or maternal education (Andersen et al., 2015; Gardiner & Iarocci, 2018) as an estimate of family SES (on average achieved secondary education completion). Of the 15 studies included for Aim 2, five studies reported SES, two included families from low to middle SES (Carter Leno et al., 2022; Yerys et al., 2009), and three included families where mothers or parents completed secondary school education on average (Andersen et al., 2015; Berenguer et al., 2018; Gardiner & Iarocci, 2018).

Measurement of CI

Across the 24 studies included in this systematic review, 15 studies used a parent report measure to examine CI in children and adolescents with ASD. The 13 of those 15 studies used the shift scale or behavioral regulation index of the Behavior Rating Inventory of Executive Function (BRIEF; Gioia et al., 2000), one study used The Flexibility Scale-Revised (FS-R; Strang et al., 2017), and one study also used the Sameness subscale from the Repetitive Behavior Scale-Revised (Maddox et al., 2018).

TABLE 2 Study characteristics of included 24 full-text articles

	Aim 1 (21 studies)–CI and INT ($n = 1608$)		Aim 2 (15 studies)–CI and EXT ($n = 1115$)	
	M (SD)	**Range**	**M (SD)**	**Range**
Sample size	76.57 (75.48)	11–321	74.33 (62.06)	20–242
% male	82.51 (17.06)	19–100	83.60 (19.46)	19–100
Age (years)	11.14 (2.45)	7.77–16.67	10.75 (2.19)	7.77–15.4
FSIQ	(20 studies)		(15 studies)	
	97.68 (10.37)	69.49–114.75	99.51 (8.61)	83.5–114.75
Ethnicity	(% - six studies)		(% - three studies)	
Caucasian	69.44 (16.61)	42.86–86.61	72.98 (7.73)	65.31–80.77
Mixed/other ethnicity	23.07 (12.87)	8.66–42.86	21.84 (5.63)	15.93–27.14
Black	6.27 (5.76)	1.59–14.29	7.1 (1.5)	6.04–8.16
Asian	2.72 (3.78)	0–7.94	2.86 (1.72)	1.65–4.08
Study quality	0.83 (0.08)	0.64–1	0.82 (0.08)	0.64–0.91
Recruitment	(n = studies)		(n = studies)	
Clinical sites (including hospitals/university clinic)	9		7	
Community settings	7		5	
School	1		1	
Longitudinal datasets	4		2	
Comorbidities	(n = participants; six studies)		(n = participants; four studies)	
ADHD	153		153	
ODD/CD	25		25	
PTEN mutation	38		—	
Macroencephaly	25		—	
CI measure	(n = studies)		(n = studies)	
Parent report	13		10	
Teacher report	1		1	
Neurocognitive/task measure	9		6	

Abbreviations: ADHD, attention deficit hyperactivity disorder; CD, conduct disorder; CI, cognitive inflexibility; EXT, externalizing; FSIQ, full scale IQ; INT, internalizing; ODD, oppositional defiant disorder.

Only one study used the teacher report version of the BRIEF (Berenguer et al., 2018). Using parent and teacher reports, autistic children and adolescents with co-occurring ADHD were found to have greater CI compared to adolescents with ASD only (Berenguer et al., 2018; Yerys et al., 2009), who in turn had great CI compared to adolescents with ADHD only (Dieckhaus et al., 2021; Lawson et al., 2015), with neurotypical adolescents being rated with lowest CI (Andersen et al., 2015; Berenguer et al., 2018; Gardiner & Iarocci, 2018; Yerys et al., 2009). Only one study found there to be no significant differences in parent-rated CI when comparing adolescents with ASD and ADHD to adolescents with ADHD only, with ADHD and Oppositional Defiant Disorder/Conduct Disorder (ODD/CD), or with ASD, ADHD and ODD/CD (Sesso et al., 2020). Parents also reported that autistic adolescents with microencephaly experienced greater CI compared to adolescents with *PTEN* mutation and without ASD, but did not differ from autistic adolescents with *PTEN* mutation, suggesting that CI may be uniquely associated with ASD above and beyond the effect of *PTEN* mutation (Uljarević et al., 2022).

Ten studies used a task-based measure to examine CI in adolescents with ASD, including the NEuroPSYchological Assessment (NEPSY-II; Trimarco et al., 2020), a probabilistic reversal learning paradigm (Crawley et al., 2020), Block Design[2] (Hollocks et al., 2022), the Opposite Words task (Hollocks et al., 2022), Trail Making (Hollocks et al., 2022), Color Word Interference Task (CW-4; Andersen et al., 2015), Wisconsin Card Sorting Task (WCST; Hollocks et al., 2014, 2022; Tachibana et al., 2013; Teunisse et al., 2012), and the Cambridge Neuropsychological Test Automated battery Intra/Extra dimensional set shift task (CANTAB ID/ED; Happé et al., 2006; Rogers et al., 2006; Teunisse et al., 2012). Compared to neurotypical peers, adolescents with ASD showed reduced task accuracy and greater perseverative errors (Crawley et al., 2020), and poorer performance on fluency based tasks involving generation of novel responses (Trimarco et al., 2020) or tasks requiring inhibiting interference from incorrect responses (Andersen et al., 2015). On switching tasks which assesses a range of executive functions including using environmental stimuli to modulate one's behavior in a goal-directed manner and inhibiting interfering stimuli, one study found that adolescents with ASD performed similarly to neurotypical adolescents (Trimarco et al., 2020). Another found that performance on switching task improved by achieving a greater number of categories with fewer perseverative errors on the WCST after adolescents with ASD read aloud for 30 min five times a day for 5 weeks (Tachibana et al., 2013).

[2]Block design is included as a proxy for cognitive flexibility as it is a task that requires non-verbal problem solving and loads significantly onto the latent construct measuring cognitive inflexibility, such as following through a well-organized response in an efficient, flexible, and goal-directed manner. Block design has previously been used as a clinical outcome measure of the latent construct of cognitive inflexibility in a clinical trial on "Unstuck and on Target" – an intervention aimed to target cognitive inflexibility in autistic children by Kenworthy et al. (2014).

CI and INT

Table 3 shows a summary of results from the 21 studies that explored the association between INT and CI. Overall, many studies found that the parent/teacher reported CI significantly correlated with greater symptoms of anxiety (Dieckhaus et al., 2021; Lawson et al., 2015; Uljarević et al., 2022; Vogan et al., 2018), depression (Gardiner & Iarocci, 2018; Lawson et al., 2015; Lieb & Bohnert, 2017) and general emotional problems (Hollocks et al., 2022) in adolescents with ASD. Sesso et al. (2020) found that items from the shift subscale of BRIEF and internalizing subscale of CBCL loaded onto the same factor in a group of autistic adolescents, suggesting construct overlap in the two measurements. Ozsivadjian et al. (2021) also found that parent rated CI measured by FS-R was not directly associated with INT, but rather was directly associated with greater intolerance of uncertainty, which in turn increased level of parent reported anxiety symptoms in adolescents with autism. Similarly, studies using neurocognitive assessment or experimental tasks to assess CI in adolescents with ASD also found that greater CI was associated with greater behavioral difficulties (Teunisse et al., 2012) including INT (Andersen et al., 2015), anxiety and depression (Crawley et al., 2020; Hollocks et al., 2014), and socioemotional problems (Dajani et al., 2016).

Two studies used a longitudinal study design and explored CI as a mediator of changes in INT severity over adolescence (Hollocks et al., 2022), and as a moderator between family stressful life events (F-SLE) and future INT during childhood (Carter Leno et al., 2022). Greater CI at age 16 was found to be a predictor of greater anxiety and depression at age 23 amongst autistic adolescents, and also partially mediated changes in symptom severity of anxiety, depression and emotional problems between the ages of 16 and 23 (Hollocks et al., 2022). Amongst autistic children, CI only moderated the relationship between F-SLE and future INT between the ages of 7 and 11 amongst those with atypical shifting abilities measured at age 8 as reported by parents, and not those with typical shifting abilities (Carter Leno et al., 2022).

Meta-analyses of CI and INT

The meta-analysis examining the association between CI and INT ranged from 0.24 and 0.54 across a total of nine studies (n = 833 children and adolescents with ASD) in five countries (Figure 2). Two studies included adolescents with both ASD and ADHD (n = 40) (Sesso et al., 2020; Yerys et al., 2009). A forest plot of the

TABLE 3 Summary of studies examining the relationship between cognitive inflexibility (CI) in children and adolescents with ASD and internalizing symptoms ($n = 21$)

Author (year); country	ASD diagnosis (criteria; measure)	*N* (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Internalizing (INT) symptom measure	Main findings	Quality score
Carter Leno et al. (2022); Canada	DSM-IV-TR; ADOS; ADI-R	ASD: 242 (204) Typical shifting: 144 Atypical shifting: 98	Age: T1: 3.46 T5: 7.77 T6: 8.73 T7: 9.71 T8: 10.77 FSIQ (T6): Typical shifting: 86.55 (18.96) Atypical shifting: 82.70 (19.21)	BRIEF-Shift (parent)	CBCL–internalizing (teacher)	*Confounding variables controlled for*: family income and autism symptom severity *Cognitive Inflexibility and INT*: Atypical Shifting vs. Typical Shifting: Greater CI significantly moderated the relationship between family-stressful life events (F-SLE) and future internalizing problems only in the group with atypical shifting abilities	0.79
Dieckhaus et al. (2021); USA	DSM-5; ASD: ADOS-2; ADHD: MINI-Kid.	ASD: 35 (35) ADHD: 83 (63)	Age: ASD: 9.85 (0.88) ADHD: 9.56 (0.87) FSIQ: ASD: 101.63 (13.88) ADHD: 97.54 (15.02)	BRIEF-Shift (Parent)	CBCL – Anxiety (Parent)	*Confounding variables controlled for*: gender and ethnoracial identity *CI*: 54% of ASD and 46% of ADHD group showed clinically elevated scores on Shift subscale (greater CI) *INT*: 51% of ASD and 36% of ADHD group showed clinically elevated anxiety problems on CBCL *CI and INT*: In both ASD and ADHD groups – greater CI associated with greater anxiety scores (ASD: Spearman's rho = 0.61, $p < 0.001$; ADHD: Spearman's rho = 0.60, $p < 0.001$)	0.82

(Continues)

TABLE 3 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	*N* (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Internalizing (INT) symptom measure	Main findings	Quality score
Hollocks et al. (2022); UK	ICD-10; ADOS-2, ADI-R	ASD: 81 (74)	Age: Wave 2: 15.4 (0.45) Wave 3: 23.2 (0.79) FSIQ (Wave 2): 83.5 (17.8)	WASI–Block Design Opposite Words Trail Making WCST (Performance-based)	SDQ–emotional problems (parent–wave 2) BAI (parent–wave 3) BDI (parent–wave 3)	*Confounding variables controlled for*: verbal IQ, restricted and repetitive behaviors *CI and INT (Age 16)*: CI significantly associated with increased emotional problems *CI and INT (Age 23)*: greater CI at age 16 predicted greater anxiety and depression at age 23. CI partially mediated the relationship between anxiety, depression and emotional problems between age 16 and 23	0.83
* Ozsivadjian et al. (2021); UK	DSM-5; DAWBA	ASD: 95 (71)	Age: 11 (3.2) FSIQ: (n = 59) 98.5 (2.3)	FS-R (Parent)	RCADS - Total (Parent) SDQ–emotional problems (parent)	*Confounding variable controlled for*: *autism symptom severity* *CI and INT*: CI positively associated with RCADS total (r = 0.39) and SDQ-E ***(r = 0.34)***. CI did not significantly predict internalizing symptoms. CI significantly predicted higher intolerance of uncertainty (β =0.73, SE = 0.09; $p \leq 0.01$)	0.91
Uljarevic et al. (2022); Australia	DSM-5; ADI-R; ADOS-2.	PTEN-ASD: 38 (30) Macro-ASD: 25 (21) PTEN no ASD: 23 (15)	Age: PTEN-ASD: 8.93 (4.75) Macro-ASD: 11.99 (5.15) PTEN-no ASD: 8.94 (4.85) FSIQ:	BRIEF–shift (parent)	CBCL 1.5–5/6–18–anxiety (parent)	*Confounding variable controlled for*: *FSIQ* *CIs*: Macro-ASD group > PTEN-no ASD group. *CI and INT*: Over the whole sample: there is a significant	0.86

(Continues)

TABLE 3 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	*N* (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Internalizing (INT) symptom measure	Main findings	Quality score
			PTEN-ASD: 66.32 (13.71) Macro-ASD: 74.30 (24.50) PTEN-no ASD: 99.14 (17.40)			positive correlation between CI and anxiety (r = 0.53, $p < 0.01$).	
*Crawley et al. (2020); UK	ADI-R; ADOS.	ASD: 321 (232) NT: 251 (171)	Age: ASD: 16.67 (5.92) NT: 16.93 (6.02) FSIQ: ASD: 103.6 (15.28) NT: 108.95 (12.82)	Probabilistic reversal learning (PRL) (Performance-based)	BAI (parent for children; self for adolescents); BYI-II–anxiety (parent for children; self for adolescents)	*Confounding variable controlled for*: ***IQ, restricted and repetitive behavior*** *CI*: ASD < NT on task accuracy; ASD > NT on number of perseverative errors (greater CI) *CI and INT*: in ASD children, perseverative errors positively correlated with anxiety ***(r = 0.34)***	1
* Sesso et al. (2020); Italy	DSM-5; K-SADS-PL; ADI-R; ADOS.	ADHD: 64 (56) ADHD + ASD: 19 (18) ADHD + ODD/CD: 43 (39) ADHD + ASD + ODD/CD: 25 (24)	Age: ADHD: 10.02 (2.49) ADHD + ASD: 9.58 (2.69) ADHD + ODD/CD: 9.37 (2.95) ADHD + ASD + ODD/CD: 8.4 (2.24) FSIQ: ADHD: 93 (14.98) ADHD + ASD: 92.69 (17) ADHD + ODD/CD: 96.86 (16.05) ADHD + ASD + ODD/CD: 98.94 (18.06)	BRIEF-2 shift (parent)	CBCL 6–18-internalizing problems (parent)	*Confounding variable controlled for*: *none* *CI*: no significant between-group differences *CI and INT*: Items from the Shift (BRIEF) subscale and internalizing symptoms (CBCL) loaded onto the same principal component factor. For ASD group, there was a positive correlation between CI and internalizing problems (***r = 0.51***, $p = 0.04$)	0.91
Trimarco et al. (2020); Italy	DSM-5; ADOS-2	ASD: 21 (4) PKU: 15 (8) Control: 14 (6)	Age: ASD: 9.83 (1.95) PKU: 10.26 (2.26) NT: 10.20 (1.99)	NEPSY-II: Switching, Response Set, Animal Sorting, Design Fluency	CBCL 6–18 internalizing problems (parent)	*Confounding variable controlled for*: *none* *CI*: ASD < NT group on design fluency and	0.73

(Continues)

TABLE 3 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	*N* (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Internalizing (INT) symptom measure	Main findings	Quality score
			FSIQ: ASD: 94.33 (18.94) PKU: 95.47 (12.50)	(Performance-based)		response set. No differences on switching tasks across PKU, ASD and NT groups *INT*: ASD > NT and PKU groups	
Dajani et al. (2016); USA	ASD: ADOS-G; ADOS-2; ADI-R; ADHD: DICA-IV; CPRS-R: L.	ASD: 24 (18) ADHD: 31 (22) NT: 44 (31)	Age: ASD: 10.30 (1.44) ADHD: 9.74 (1.24) NT: 10.47 (1.03) FSIQ: ASD: 102.48 (12.3) ADHD: 109.68 (12.64) NT: 119.66 (13.21)	BRIEF–shift (parent)	CBCL 6–18 internalizing problems (parent)	*Confounding variable controlled for*: *head motion* *CI*: weaker left SPL to right SPL connectivity is related to greater CI and worse emotional control in children	0.82
Berenguer et al. (2018); Spain	DSM-5; ASD: SCQ; ADI-R ADHD: SDQ	ASD: 30 (27) ADHD: 35 (32) ASD + ADHD: 22 (21) NT: 37 (23)	Age: ASD: 8.39 (1.3) ADHD: 9.14 (1.4) ASD + ADHD: 8.86 (1.3) NT: 8.54 (1.2) FSIQ: ASD: 100.37 (12.4) ADHD: 99.03 (9.8) ASD + ADHD: 102.86 (13.0) NT: 102.11 (8.9)	BRIEF–BRI (Teacher)	SDQ emotional problems (parents)	*Confounding variables controlled for*: *sex, vocabulary and educational level of parents* *CI*: ASD + ADHD > ASD, ADHD > NT *INT*: ASD, ADHD, ASD + ADHD > NT	0.86
*Gardiner et al. (2018); Canada	DSM-IV-TR; ADI-R; ADOS.	ASD: 59 (51) NT: 67 (33)	Age: ASD: 10.07 (2.09) NT: 9.44 (1.73) FSIQ: ASD: 107.47 (13.25) NT: 111.37 (12.78)	BRIEF–shift (parent)	BASC-2–internalizing behaviors (parent)	*Confounding variable controlled for*: *IQ* *CI*: ASD > NT *INT*: ASD > NT on depression symptoms *CI and INT*: No significant association between CI and anxiety; For the ASD group - shift ($\beta = 0.35$, $p = 0.02$) and emotional control ($\beta = 0.37$, $p = 0.03$) scales emerged as unique significant	0.91

(Continues)

TABLE 3 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	*N* (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Internalizing (INT) symptom measure	Main findings	Quality score
						contributors towards depression symptom severity. Greater CI also was associated with greater internalizing symptoms ***(r = 0.54)***	
* Vogan et al. (2018); Canada	ADOS/ ADOS-2	ASD: 39 (34) NT: 34 (20)	Age: ASD: 10.6 (1.8) NT: 11.2 (2.1) FSIQ: ASD: 103.3 (14.7) NT: 115.4 (11.7)	BRIEF–BRI (parent)	CBCL–anxious/ depressed (parent)	*Confounding variable controlled for*: age *CI and INT*: ASD group–Behavioral Regulation Index (BRI) from BRIEF showed significant correlation with anxiety/depression symptom severity (***r = 0.45***, $p < 0.01$) rated 2 years later. Regression analyses showed that more BRI problems at T1 predicted later symptoms of anxiety/ depression ($p < 0.01$) at T2 (18% of variance)	0.82
*Lieb et al. (2017); USA	DSM-IV-TR	ASD: 127 (103)	Age: 13.95 (1.6)	BRIEF–shift (parent)	CBCL–depression (parent) YSR-depression (self)	*Confounding variables controlled for*: *age, gender, mode of participation* *CI and INT*: CI positively associated with CBCL-D (***r = 0.46***, $p < 0.01$) and YSR-D ($r = 0.34$, $p < 0.01$)	0.86
Dajani et al. (2016); USA	ASD: ADOS-G; ADOS-2; ADI-R; ADHD: DICA-IV; CPRS-R: L.	ASD: 30 (23) ADHD: 93 (72) ASD + ADHD: 66 (55) NT: 128 (98)	Age: ASD: 9.76 (1.36) ADHD: 9.79 (1.21) ASD + ADHD: 10.45 (1.40) NT: 10.03 (1.18) FSIQ:	BRIEF (Parent) NEPSY-II Statue subtest WISC-IV Backward Digit Span (Performance-based)	CBCL 6–18–Anxiety/ Depression (Parent)	*Confounding variable controlled for*: *diagnosis* *CI*: ASD primarily in the "impaired" class for executive function (78%) (including 47%	0.86

(Continues)

TABLE 3 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	*N* (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Internalizing (INT) symptom measure	Main findings	Quality score
			ASD: 106.10 (14.88) ADHD: 107.31 (11.67) ASD + ADHD: 99.99 (15.98) NT: 115.76 (12.23)			of children with ASD only, and 92% of children with both ASD and ADHD), with 20% in the "average" class. *CI and INT*: Socioemotional problems (i.e., including highest level of anxiety and depression) based on EF profile: "impaired" EF > "average" EF > "above average" EF	
* Andersen et al. (2015); Norway	K-SADS-PL	ASD: 34 (28) NT: 45 (29)	Age: ASD: 11.6 (2.0) NT: 11.4 (1.5) FSIQ: ASD: 99.9 (17.4) NT: 104.5 (13.1)	CW4 (Performance-based)	CBCL–Internalizing Problems (Parent)	*Confounding variable controlled for*: age *CI*: ASD > NT group, both showed similar rates of improvement over time. *INT*: ASD > NT on depression symptoms. ASD group showed improvement over time. *CI and INT*: Neither group showed any significant correlation between changes in flexibility and changes in depression. At baseline, greater internalizing symptoms was associated with greater CI (***r* = *0.47***).	0.77
Lawson et al. (2015); USA	DSM-IV-TR; ASD: ADI-R; ADOS;	ASD: 70 (63) ADHD: 55 (39)	Age: ASD: 10.07 (1.77) ADHD: 8.93 (2.69)	BRIEF–Shift (Parent)	CBCL–Anxiety/ Depression (Parent)	*Confounding variables controlled for*: *age, gender*	0.91

(Continues)

TABLE 3 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	*N* (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Internalizing (INT) symptom measure	Main findings	Quality score
	ADHD: ADHD Rating Scale-IV		FSIQ: ASD: 107.01 (19) ADHD: 111.53 (16.85)			*CI*: ASD > ADHD group. *CI and INT*: Across the whole sample, CI is positively associated with Anxious/ Depressed (r = 0.39, $p < 0.001$) scale. Greater CI is also associated with higher anxious/ depressed symptoms in the ASD group (B = 0.288, $p < 0.001$)	
* Hollocks et al. (2014); UK	ICD-10; ADI-R; ADOS; SCQ.	ASD: 90 (82)	Age: 15.5. (0.47) FSIQ: 84.5 (17.2)	Card Sorting Task - adapted from WCST (Performance-based)	SDQ - Emotional Symptoms (Parent)	*Confounding variable controlled for*: age *CI and INT*: Poorer card sorting task performance was associated with greater anxiety (***r* = −0.24**, $p < 0.05$) and greater depression (r = −0.23, $p < 0.05$)	0.91
Tachibana et al. (2013); Japan	DSM-IV-TR	ASD: 11 (8) [Intervention group: 6 (4); Control group: 5 (4)]	Age: ASD: 9.24 (0.82) [Intervention: 8.93 (0.71); Control: 9.62 (0.84)] FSIQ: ASD: 93.36 (13.20) [Intervention: 92.67 (15.66); Control: 94.20 (11.30)]	WCST (Performance-based)	CBCL–Anxiety/ Depression (Parent)	*Confounding variable controlled for*: *none* *CI*: intervention group showed significant improvement in number of "perseverative errors" and "categories achieved" on WCST compared to control group *INT*: Intervention group showed significant improvement on depression/anxiety symptom severity compared to controls	0.67

(Continues)

TABLE 3 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	*N* (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Internalizing (INT) symptom measure	Main findings	Quality score
Teunisse et al. (2012); The Netherlands	DSM-IV	ASD: 20 (20)	Age: 13.7 (1) FSIQ: 105.5 (13)	WCST-S, CANTAB ID/ED (Performance-based); BFRS-R (Parent); BRIEF–shift (parent)	CBCL/4–18 total problems (parent)	*Confounding variable controlled for*: *none* *CI*: CANTAB ID/ED and WCST-S are positively associated ($r = 0.46$, $p < 0.05$). Both parent-based flexibility rating scales are positively associated with each other ($r = 0.65$, $p < 0.01$) *CI and Total Problems*: Both parent-based flexibility scales (BFRS-R, $r = 0.51$, $p < 0.05$; BRIEF Shift Score, $r = 0.54$, $p < 0.05$) significantly correlated with total problem score on CBCL. Neuropsychological tests did not significantly correlate with CBCL	0.64
* Yerys et al. (2009); USA	DSM-IV; ADI/ADI-R; ADOS; ADHD: Inattentive Type on the DSM-IV ADHD parent rating scale	ASD: 28 (20) ASD + ADHD: 21 (18) NT: 21 (13)	Age: ASD: 9.7 (2.12) ASD + ADHD: 9.65 (1.62) NT:10.3 (1.76) FSIQ: ASD: 117.39 (18.68) ASD + ADHD: 111.24 (13.56) NT: 116.24 (11.53)	BRIEF-Shift (Parent)	BASC–internalizing problems (parent)	*Confounding variable controlled for*: *none* *CI*: ASD + ADHD > ASD and NT, ASD group > NT *INT*: ASD and ASD + ADHD groups > NT group *CI and INT*: ASD and ASD + ADHD groups combined - CI positively associated with internalizing symptoms ***(r = 0.46)***	0.82

(Continues)

TABLE 3 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	*N* (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Internalizing (INT) symptom measure	Main findings	Quality score
Happé et al. (2006); UK	DSM-IV	ASD: 32 (32) ADHD: 30 (30) NT: 32 (32)	Age: ASD: 10.9 (2.4) ADHD: 11.6 (1.7) NT: 11.2 (2.0) FSIQ: ASD: 99.7 (18.7) ADHD: 99.1 (17.7) NT: 106.8 (13.4)	Verbal Fluency; Design Fluency; CANTAB ID/ED (Performance-based)	SDQ Emotional Problems (Parent)	*Confounding variables controlled for*: *age and FSIQ* *CI*: ASD group: age positively associated with performance on Categories and Design fluency, and ID/ED *CI and INT*: Within the ADHD group, partialling out age revealed a significant correlation between Flexibility and SDQ Emotional symptoms ($r = -0.56$, $p = 0.001$). There were no associations between SDQ scores and flexibility in ASD or NT group	0.82

Note: *Indicates studies included in meta-analysis. Statistics in italics and bold are correlations used for meta-analysis.

Abbreviations: ADHD, Attention Deficit Hyperactivity Disorder; ADI-(R), Autism Diagnostic Interview (Revised); ADOS, Autism Diagnostic Observation Schedule; APSD, Antisocial process Screening Device; ASD, Autism Spectrum Disorder; BASC, Behavior Assessment System for Children; BFRS-R, Behavior Flexibility Rating Scale-Revised; BRIEF-(S), Behavior Rating Inventory of Executive Function (Shift subscale); CANTAB ID/ED, Cambridge Neuropsychological Test Automated Battery Intra/Extra dimensional set shift; CBCL, Child Behavior Checklist; CD, Conduct Disorder; CF, Cognitive Flexibility; CI, Cognitive inflexibility; CPRS, Conner's Parent Rating Scale; CU, Callous Unemotional; CW4, Color Word Interference task–condition 4; DAWBA, Development and Wellbeing Assessment; DICA, IV, Diagnostic Interview for Children and Adolescents IV; DSM, Diagnostic Statistical Manual; EXT, Externalizing; FS-R, The Flexibility Scale-Revised; FSIQ, Full Scale IQ; ICD, International Classification of Disease; K-SADS-PL, Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children–Present and Lifetime version; NEPSY-II, A Developmental NEuroPSYchological assessment; NT, Neurotypical; ODD, Oppositional Defiant Disorder; PACS, Parental Account of Childhood Symptoms; PKU, Phenylketonuria; RBS-R, Repetitive Behavior Scale–Revised; RCADS, Revised Child Anxiety and Depression Scale; SDQ, Strength and Difficulties Questionnaire; WCST, Wisconsin Card Sorting Task; WISC, Wechsler Intelligence Scale for Children.

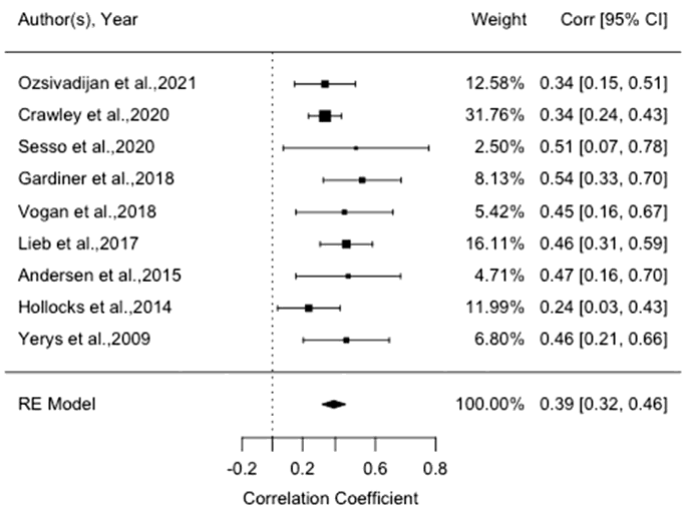

FIGURE 2 Forest plot of correlation between measures of cognitive flexibility and internalizing behaviors amongst autistic children and adolescents, and 95% confidence interval for random effects (RE) model

reported correlation coefficient between CI and INT estimates with 95% confidence interval for all the included studies is shown in Figure 2. The meta-analysis showed a significant, moderate effect size, $r = 0.39$, $p < 0.001$, 95% CI [0.32, 0.46], indicating that higher CI was associated with higher levels of INT. Heterogeneity was low: Q (8) = 7.93, $p = 0.44$, $I^2 = 13.17\%$. There was a nonsignificant moderator effect of participants' age (Q[1] = 3.38, $p = 0.07$), proportion of autistic male participants (Q [1] = 0.23, $p = 0.63$), mean FSIQ (Q[1] = 2.51, $p = 0.11$), and study quality (Q[1] = 2.51, $p = 0.11$). Funnel plot did not show significant study asymmetry, and neither Egger's regression test ($p = 0.13$) nor Rank Correlation Test ($p = 0.61$) suggested evidence for publication bias. Post hoc sensitivity analyses (Appendix C [a]) found that a significant moderate effect size was maintained with only studies using parent-report measures of CI (six studies; $r = 0.48$, $p < 0.001$, 95% CI [0.36, 0.52]), with only studies using performance-based measures of CI (three studies; $r = 0.34$, $p < 0.001$, 95% CI [0.25, 0.44]), and when excluding studies with autistic adolescents and co-occurring ADHD (seven studies; $r = 0.38$, $p < 0.001$, 95% CI [0.31, 0.45]).

CI and EXT

Table 4 shows a summary of results from the 15 studies that explored the association between EXT and CI. The majority of studies used the BRIEF-Shift scale parent measure of CI and found that greater CI in adolescents with ASD was associated with greater EXT (Gardiner & Iarocci, 2018; Lawson et al., 2015; Ozsivadjian et al., 2021; Vogan et al., 2018; Yerys et al., 2009). However, one study found increased EXT only correlated with greater CI as measured by the RBS-R Sameness scale, but not by BRIEF-Shift scale (Maddox et al., 2018). Only one study which included a sample of adolescents with ASD and ADHD found no association between CI and EXT (Sesso et al., 2020). Results from studies using neurocognitive assessment measures and cognitive tasks showed more mixed findings. One study which used a combination of CI measures from the NEPSY-II and WISC-IV showed that adolescents with ASD were more likely to show impaired executive function compared to adolescents with ADHD or neurotypical peers, and greater executive function impairment was associated with higher socioemotional difficulties including aggression (Dajani et al., 2016). In contrast, one study which used the CANTAB ID/ED found CI was not associated with levels of callous-unemotional traits that may contribute towards greater EXT (Rogers et al., 2006), and another which used the color-word interference task also found that CI was not significantly associated with EXT (Andersen et al., 2015). Another study which used a range of tasks (block design, trail making, opposite words task and WCST) also found that CI showed a moderate (nonsignificant) association with increased behavioral problems amongst autistic adolescents (Hollocks et al., 2022).

Two studies used a longitudinal study design and explored CI as a mediator of changes in EXT severity over adolescence (Hollocks et al., 2022), and as a moderator between family stressful life events (F-SLE) and future EXT during childhood (Carter Leno et al., 2022). Greater CI at age 16 was found to be a predictor of greater behavioral problems at age 23 amongst autistic adolescents (Hollocks et al., 2022). Amongst autistic children, although CI did not significantly moderate the relationship between F-SLE and future EXT between the

TABLE 4 Summary of studies examining the relationship between cognitive inflexibility (CI) in children and adolescents with ASD and externalizing symptoms ($n = 15$)

Author (year); country	ASD diagnosis (criteria; measure)	N (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Externalizing symptom (EXT) measure	Main findings	Quality score
Carter Leno et al. (2022); Canada	DSM-IV-TR; ADOS; ADI-R	ASD: 242 (204) Typical shifting: 144 Atypical shifting: 98	Age: T1: 3.46 T5: 7.77 T6: 8.73 T7: 9.71 T8: 10.77 FSIQ (T6): Typical shifting: 86.55 (18.96) Atypical shifting: 82.70 (19.21)	BRIEF-shift (parent)	CBCL–externalizing (teacher)	*Confounding variables controlled for*: family income and autism symptom severity. *Cognitive inflexibility and EXT*: Atypical shifting vs. Typical shifting: Atypical shifting vs. typical shifting: greater CI moderated (though did not reach statistical significance) the relationship between family-stressful life events (F-SLE) and future externalizing problems only in the group with atypical shifting abilities	0.79
Hollocks et al. (2022); UK	ICD-10; ADOS-2, ADI-R	ASD: 81 (74)	Age: Wave 2: 15.4 (0.45) Wave 3: 23.2 (0.79) FSIQ (Wave 2): 83.5 (17.8)	WASI–block design Opposite Words Trail making WCST (performance-based)	SDQ–conduct problems (parent, wave 2 and 3)	*Confounding variables controlled for*: verbal IQ, restricted and repetitive behaviors *CI and EXT (Age 16)*: CI showed moderate (though nonsignificant) association with increased EXT *CI and EXT (Age 23)*: greater CI at age 16 predicted greater EXT at age 23	0.83
* Ozsivadjian et al. (2021); UK	DSM-5; DAWBA	ASD: 95 (71)	Age: 11 (3.2) FSIQ: ($n = 59$) 98.5 (2.3)	FS-R (Parent)	RCADS–total score (parent) SDQ–conduct problems (Parent)	*Confounding variable controlled for*: *autism symptom severity* *CI and EXT*: CI positively associated with RCADS total	0.91

(Continues)

TABLE 4 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	N (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Externalizing symptom (EXT) measure	Main findings	Quality score
						(r = 0.39); and SDQ-B (***r = 0.51***). CI significantly predicted higher externalizing symptoms (β = 0.57, SE = 0.13; p ≤ 0.01).	
* Sesso et al. (2020); Italy	DSM-5; K-SADS-PL; ADI-R; ADOS	ADHD: 64 (56) ADHD+ASD: 19 (18) ADHD + ODD/CD: 43 (39) ADHD + ASD + ODD/CD: 25 (24)	Age: ADHD: 10.02 (2.49) ADHD+ASD: 9.58 (2.69) ADHD + ODD/CD: 9.37 (2.95) ADHD+ASD + ODD/CD: 8.4 (2.24) FSIQ: ADHD: 93 (14.98) ADHD+ASD: 92.69 (17) ADHD + ODD/CD: 96.86 (16.05) ADHD+ASD + ODD/CD: 98.94 (18.06)	BRIEF-2 Shift (Parent)	CBCL 6–18 Externalizing Problems (Parent)	*Confounding variable controlled for*: *none* *CI*: no significant between-group differences in CF. *EXT*: ADHD + ASD + ODD/CD > ADHD+ASD on externalizing problems *CI and EXT*: For ASD group, there was no significant correlation between CI and externalizing problems (***r = 0.32,*** *p* = 0.22)	0.91
Trimarco et al. (2020); Italy	DSM-5; ADOS-2	ASD: 21 (4) PKU: 15 (8) Control: 14 (6)	Age: ASD: 9.83 (1.95) PKU: 10.26 (2.26) Control: 10.20 (1.99) FSIQ: ASD: 94.33 (18.94) PKU: 95.47 (12.50)	NEPSY-II: switching, response set, animal sorting, design fluency (performance-based)	CBCL 6–18 externalizing problems (parent)	*Confounding variable controlled for*: *none* *CI*: ASD < PKU/Control groups on design fluency and response set. No group differences on switching tasks *EXT*: ASD > NT on externalizing problems	0.73
Berenguer et al. (2018); Spain	DSM-5; SDQ; SCQ; ADI-R.	ASD: 30 (27) ADHD: 35 (32) ASD + ADHD: 22 (21) NT: 37 (23)	Age: ASD: 8.39 (1.3) ADHD: 9.14 (1.4) ASD + ADHD: 8.86 (1.3) NT: 8.54 (1.2)	BRIEF–BRI (teacher)	SDQ–behavioral Problems (Parent)	*Confounding variables controlled for*: *sex, vocabulary and educational level of parents*	0.86

(Continues)

TABLE 4 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	N (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Externalizing symptom (EXT) measure	Main findings	Quality score
			FSIQ: ASD: 100.37 (12.4) ADHD: 99.03 (9.8) ASD + ADHD: 102.86 (13.0) NT: 102.11 (8.9)			*CI*: ASD + ADHD > ASD or ADHD > NTs groups *EXT*: ASD + ADHD, ADHD > ASD > NT on externalizing problems	
*Gardiner et al. (2018); Canada	DSM-IV-TR; ADI-R; ADOS	ASD: 59 (51) NT: 67 (33)	Age: ASD: 10.07 (2.09) NT: 9.44 (1.73) FSIQ: ASD: 107.47 (13.25) NT: 111.37 (12.78)	BRIEF-shift (parent)	BASC-2–externalizing behavior (parent)	*Confounding variable controlled for*: *IQ* *CI*: ASD > NT *CI and EXT*: Greater CI significantly associated with greater externalizing symptoms ***(r = 0.59)***	0.91
Maddox et al. (2018); USA	DSM-IV-TR; ADOS-2	ASD: 182 (172)	Age: 9.32 (2.25) IQ: 104.26 (18.67)	BRIEF–shift (parent); RBS-R sameness (parent)	BASC-2 aggression (parent)	*Confounding variables controlled for*: *age, IQ, recruitment site* *CI and EXT*: Greater CI significantly associated with more challenging behaviors when measured using RBS-R sameness scale (B = 0.171, $p < 0.05$), but not BRIEF Shift scale (B = 0.085, $p > 0.05$)	0.82
* Vogan et al. (2018); Canada	ADOS/ADOS-2.	ASD: 39 (34) NT: 34 (20)	Age: ASD: 10.6 (1.8) NT: 11.2 (2.1) FSIQ: ASD: 103.3 (14.7) NT: 115.4 (11.7)	BRIEF–BRI (parent)	CBCL–aggressiveness (parent)	*Confounding variable controlled for*: age *CI and EXT*: In ASD group, BRI (BRIEF) showed significant correlation with CBCL Aggressiveness scale (***r = 0.61***, $p < 0.001$) rated 2 years later. Regression analyses showed that more executive function difficulties at T1 predicted later aggressive behavior.	0.82

(Continues)

TABLE 4 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	N (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Externalizing symptom (EXT) measure	Main findings	Quality score
Dajani et al. (2016); USA	ASD: ADOS-G; ADOS-2; ADI-R; ADHD: DICA-IV; CPRS-R: L.	ASD: 30 (23) ADHD: 93 (72) ASD + ADHD: 66 (55) NT: 128 (98)	Age: ASD: 9.76 (1.36) ADHD: 9.79 (1.21) ASD + ADHD: 10.45 (1.40) NT: 10.03 (1.18) FSIQ: ASD: 106.10 (14.88) ADHD: 107.31 (11.67) ASD + ADHD: 99.99 (15.98) NT: 115.76 (12.23)	BRIEF (parent); NEPSY-II: Statue subtest; WISC-IV: Backward Digit Span (Performance-based)	CBCL 6–18–Aggression (parent)	*Confounding variable controlled for*: *Diagnosis* *CI difficulties*: ASD primarily in the "impaired" class for executive function (78%) (including 47% of children with ASD only, and 92% of children with both ASD and ADHD), with 20% in the "average" class *CI and EXT*: Socioemotional problems (i.e., including highest level of aggression) based on EF profile: "impaired" EF > "average" EF > "above average" EF	0.86
* Andersen et al. (2015); Norway	K-SADS-PL	ASD: 34 (28) NT: 45 (29)	Age: ASD: 11.6 (2.0) NT: 11.4 (1.5) FSIQ: ASD: 99.9 (17.4) NT: 104.5 (13.1)	CW4 (Performance-based)	CBCL–externalizing problems (parent)	*Confounding variable controlled for*: age *CI*: ASD > NT group, and both groups showed similar rates of improvement in flexibility over time *CI and EXT*: At baseline, greater externalizing symptoms did not show significant association with greater CI (***r* = *0.24***)	0.77
Lawson et al. (2015); USA	DSM-IV-TR; ASD: ADI-R; ADOS; ADHD: ADHD Rating Scale-IV.	ASD: 70 (63) ADHD: 55 (39)	Age: ASD: 10.07 (1.77) ADHD: 8.93 (2.69) FSIQ: ASD: 107.01 (19) ADHD: 111.53 (16.85)	BRIEF–shift (parent)	CBCL–aggression (parent)	*Confounding variables controlled for*: *age, gender* *CI*: ASD diagnosis associated with greater CI	0.91

(Continues)

TABLE 4 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	N (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Externalizing symptom (EXT) measure	Main findings	Quality score
						CI and EXT: Across the whole sample, CI was positively associated with CBCL aggressive behavior ($r = 0.30$, $p = 0.001$) scale. For ASD group, greater CI was associated with higher EXT ($B = 0.23$, $p < 0.001$).	
Teunisse et al. (2012); The Netherlands	DSM-IV	ASD: 20 (20)	Age: 13.7 (1) FSIQ: 105.5 (13)	WCST-S; CANTAB ID/ED (Performance-based); BFRS-R (Parent); BRIEF-shift (parent)	CBCL/4–18 Total Problems (Parent)	*Confounding variable controlled for*: *none* *CI*: There is a positive correlation between performance on CANTAB ID/ED and WCST-S ($r = 0.46$, $p < 0.05$) and between both parent-based flexibility rating scales ($r = 0.65$, $p < 0.01$). *CI and Total Problems*: Both parent-based flexibility scales (BFRS-R, $r = 0.51$, $p < 0.05$; BRIEF Shift Score, $r = 0.54$, $p < 0.05$) significantly correlated with total problem score on CBCL. Neuropsychological tests did not significantly correlate with CBCL.	0.64
* Yerys et al. (2009); USA	DSM-IV; ADI/ADI-R; ADOS; ADHD: Inattentive Type on the DSM-IV	ASD: 28 (20) ASD + ADHD: 21 (18) NT: 21 (13)	Age: ASD: 9.7 (2.12) ASD + ADHD: 9.65 (1.62) NT:10.3 (1.76)	BRIEF–shift (parent)	BASC–externalizing problems (parent)	*Confounding variable controlled for*: *none* *CI*: ASD + ADHD > ASD > NT groups.	0.82

(Continues)

TABLE 4 (Continued)

Author (year); country	ASD diagnosis (criteria; measure)	N (male)	Age (years; M, SD); IQ (M, SD)	Cognitive flexibility (CF) measure	Externalizing symptom (EXT) measure	Main findings	Quality score
	ADHD parent rating scale		FSIQ: ASD: 117.39 (18.68) ASD + ADHD: 111.24 (13.56) NT: 116.24 (11.53)			*EXT*: ASD and ASD + ADHD > NT *CI and EXT*: ASD and ASD + ADHD groups combined–CI positively associated with externalizing symptoms ***(r = 0.38)***	
Rogers et al. (2006); UK	DSM-IV	ASD low CU: 18 (18) ASD high CU: 10 (10)	Age: ASD Low CU: 14.51 (2.34) ASD High CU: 14.60 (2.58) FSIQ: ASD Low CU: 92.1 (22.2) ASD High CU: 85.0 (13.5)	CANTAB ID/ED (Performance-based)	APSD (Teacher)	*Confounding variable controlled for*: *none* *CI*: Both CU-high and CU-low children performed poorly on ID/ED task, no group differences on errors.	0.68

Note: *Indicates studies included in meta-analysis. Statistics in italics and bold are correlations used for meta-analysis.

Abbreviations: ADHD, Attention Deficit Hyperactivity Disorder; ADI-(R), Autism Diagnostic Interview (Revised); ADOS, Autism Diagnostic Observation Schedule; APSD, Antisocial Process Screening Device; ASD, Autism Spectrum Disorder; BASC, Behavior Assessment System for Children; BFRS-R, Behavior Flexibility Rating Scale-Revised; BRIEF-(S), Behavior Rating Inventory of Executive Function (Shift subscale); CANTAB ID/ED, Cambridge Neuropsychological Test Automated Battery Intra/Extra dimensional set shift; CBCL, Child Behavior Checklist; CD, Conduct Disorder; CF, Cognitive Flexibility; CI, Cognitive inflexibility; CPRS, Conner's Parent Rating Scale; CU, Callous Unemotional; CW4, Color Word Interference task–condition 4; DAWBA, Development and Wellbeing Assessment; DICA, IV, Diagnostic Interview for Children and Adolescents IV; DSM, Diagnostic Statistical Manual; EXT, Externalizing; FS-R, The Flexibility Scale-Revised; FSIQ, Full Scale IQ; ICD, International Classification of Disease; K-SADS-PL, Kiddie Schedule for Affective Disorders and Schizophrenia for School-Age Children–Present and Lifetime version; NEPSY-II, A Developmental NEuroPSYchological assessment; NT, Neurotypical; ODD, Oppositional Defiant Disorder; PACS, Parental Account of Childhood Symptoms; PKU, Phenylketonuria; RBS-R, Repetitive Behavior Scale–Revised; RCADS, Revised Child Anxiety and Depression Scale; SDQ, Strength and Difficulties Questionnaire; WCST, Wisconsin Card Sorting Task; WISC, Wechsler Intelligence Scale for Children.

ages of 7 and 11, a near-significant trend was observed amongst those with atypical shifting abilities measured at age 8 as reported by parents compared to those with typical shifting abilities (Carter Leno et al., 2022).

Meta-analyses of CI and EXT

The meta-analysis examining the association between CI and EXT ranged from 0.24 and 0.61 across a total of six studies ($n = 295$ children and adolescents with ASD) in five countries (Figure 3). Five of the six studies used a parent report measure to assess CI in adolescents with ASD. A forest plot of the reported correlation coefficient between CI and EXT estimates with 95% confidence intervals for all the included studies are shown in Figure 3. The meta-analysis showed a significant, large effect size, $r = 0.48$, $p < 0.001$, 95% CI [0.38, 0.58], indicating that higher CI was associated with higher levels of EXT. Heterogeneity was low: $Q(5) = 6.40$, $p = 0.27$, $I^2 = 14.63\%$. There was a nonsignificant moderator effect of participants' age ($Q[1] = 0.08$, $p = 0.78$), proportion of autistic male participants ($Q[1] = 0.03$, $p = 0.87$), mean FSIQ ($Q[1] = 0.06$, $p = 0.80$), and study quality ($Q[1] = 0.06$, $p = 0.80$). Funnel plot did not show significant study asymmetry, and neither Egger's regression test ($p = 0.27$) nor Rank Correlation Test ($p = 0.47$) suggested evidence for publication bias. Post hoc sensitivity analyses (Appendix C [b]) showed a significant large effect size was maintained with only studies using parent-report measures of CI (five studies; $r = 0.51$, $p < 0.001$, 95% CI [0.41, 0.60]), and when excluding studies with autistic adolescents and co-occurring ADHD (four studies; $r = 0.52$, $p < 0.001$, 95% CI [0.40, 0.62]).

DISCUSSION

CI, internalizing, and externalizing symptoms

The current systematic review and meta-analysis found a significant and moderate to large effect size between CI and greater internalizing and externalizing symptoms in adolescents with ASD. Findings are robust given the low degree of heterogeneity across studies included in the meta-analyses, and results withstood sensitivity analysis when only including parent-report of CI or performance-based measures of CI (for internalizing symptoms only) and excluding autistic adolescents with co-occurring ADHD diagnosis. CI may be a transdiagnostic factor that can increase one's vulnerability to experiencing rigid or perseverative patterns of unhelpful cognition (e.g., rumination) and behaviors (e.g., avoidance, reduced activity, aggression) (Hollocks et al., 2022), resulting in maladaptive emotion regulation strategies that are less effective in the moment (Cai et al., 2018).

The current study found that the effect size of the association between CI and internalizing symptoms was greater when CI was measured using parent-report measures ($r = 0.48$) compared to performance-based task measures ($r = 0.34$). It is important to note that a major caveat is that only three studies used a performance-based task measure and therefore the generalisability of this finding may be somewhat limited. However, this finding is significant when considering literature has highlighted issues around convergence of measurement between more ecologically valid reporter-based measures (e.g., BRIEF) that assess how CI may affect daily functioning activities, compared to performance-based measures of CI that assess more specific cognitive constructs in a lab-based setting (e.g., WCST) (Uddin, 2021).

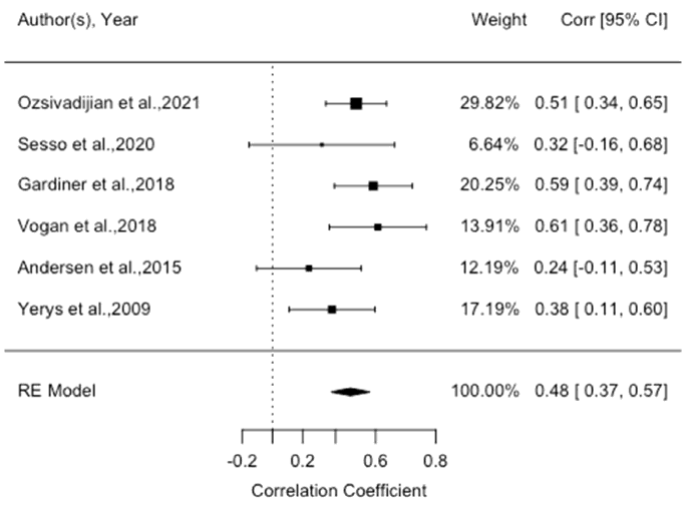

FIGURE 3 Forest plot of correlation between measures of cognitive inflexibility and externalizing behaviors amongst autistic children and adolescents, and 95% confidence interval for random effects (RE) model

The convergence of effect sizes in the current meta-analysis is significant to suggest that there is some shared unitary construct underlying CI, as the association between internalizing symptoms and CI remains when accounting for measurement differences. The stronger association with parent-rated measures may be a combination of shared method variance, and that behavioral implications of CI can be more easily observed across different settings in daily lives by parents/carers. The latter is particularly important when considering how individual differences in cognitive flexibility may be either a risk factor or protective factor in the context of biopsychosocial changes during adolescence, and therefore the impact of CI on daily adaptive functioning and behavior in relation to psychopathology is more important for clinicians to assess and incorporate into formulation and treatment when working with autistic young people.

Although the current meta-analysis did not explicitly examine the reciprocal impact of co-occurring internalizing/externalizing symptoms on autistic adolescents' CI, it is possible that increased symptomatology can negatively impact autistic adolescents' flexible problem solving ability as reflected by frequent "stuck-in-set perseveration" errors during cognitive flexibility tasks (Crawley et al., 2020; Tachibana et al., 2013). For example, rumination over negative thoughts in depression can perpetuate over time, resulting in greater inactive and less flexible ways of thinking, rather than actively engaging with the environment and problem solving (Kashdan, 2010). Over time, pervasive negative cognitive style can also reduce behavioral flexibility and result in more rigid coping behaviors, further affecting one's emotional and social functioning (Kashdan, 2010). Individuals with heightened anxiety may also engage in experiential avoidance to reduce psychological distress, and deploy more rigid patterns of behavioral responses and experience persistent worries regardless of situational context (Borkovec, 1994).

However, the direction of causation between CI and behavioral symptoms remains ambiguous, as only three studies employed a longitudinal research design to provide insight from a developmental perspective (Andersen et al., 2015; Carter Leno et al., 2022; Hollocks et al., 2022). This is especially important as one meta-analysis exploring changes in CI from childhood (<12 years) to adulthood (>18 years) found that adolescence (between 12–18 years) marked a period of significant heterogeneity for CI measured across studies (Demetriou et al., 2018). One study found that increased rigidity in thinking and rumination may be a predisposing and perpetuating factor that results in prolonged experience of distress from family stressful life events for autistic children aged 7–11 years, increasing their vulnerability to developing and maintaining internalizing symptoms across childhood (Carter Leno et al., 2022). However, it is unclear whether greater CI may have a direct effect on the development of externalizing symptoms before puberty (Carter Leno et al., 2022).

During adolescence, although improvements in CI were noted amongst children and adolescents with ASD aged 9–16 years, performance was still poorer compared to their neurotypical peers, and adolescents with ASD maintained greater levels of depression symptoms (Andersen et al., 2015). The relatively protracted maturation of cognitive flexibility for adolescents with ASD compared to neurotypical peers might mean less adaptable ways of coping with the challenges that arise during adolescence, and increase one's vulnerability to developing internalizing symptoms later in adulthood (Andersen et al., 2015).

When transitioning from adolescence to young adulthood, Hollocks et al. (2022) found that CI measured at the age of 16 continued to be associated with symptoms of anxiety and depression and at the age of 23, suggesting that it is an important cognitive mechanism that may influence the development and maintenance of internalizing symptoms over time. The same study also found that when controlling for restricted and repetitive behaviors (RRBs), CI measured at age 16 was significantly associated with externalizing symptoms at the ages of 16 and 23, suggesting that the continued impact of CI on emotion regulation is maintained across adolescent development, independent of RRBs considered to be core to ASD symptomatology.

The overlap between emotion regulation difficulties and CI in autism has been supported by neuroimaging studies where reduced connectivity between frontal and limbic regions of the brain may be associated with ineffective top-down emotion regulation in response to negative emotions (Samson et al., 2015). Reduced top-down emotion regulation may be especially evident during adolescence where the development of frontal lobes and executive functions matures at a slower rate compared to limbic brain regions for emotion processing (Blakemore & Robbins, 2012). Autistic adolescents may be even more vulnerable compared to neurotypical peers to feel overwhelmed by difficult emotions when unable to switch between maladaptive and adaptive emotion regulation strategies due to greater CI.

Measurement of CI

Most studies in the current review relied on parent-report to assess CI, especially the shift scale of BRIEF. Both parent measures and cognitive tasks largely indicate greater CI amongst adolescents with ASD compared to neurotypical peers or peers with other neurodevelopmental conditions, though greater variation in performance were noted when using task-performance based ratings. This may be due to experimental and neurocognitive tasks requiring a range of cognitive processes beyond cognitive flexibility to be employed for successful performance, and therefore it is difficult to unpick the extent to which CI may have contributed towards performance

variance across individuals, without controlling for cognitive processes other than CI (Geurts et al., 2009).

Only one study explored the concordance between parent report of CI and adolescents' performance on neurocognitive tasks (Teunisse et al., 2012). Shared method variance was observed within parental measures and performance measures, though not between these measures of CI. Compared to task-based measures, parental report of CI showed lower specificity as they also positively correlated with general behavioral problems, IQ and ASD symptomatology. The "Halo Effect"[3] on the association between CI and behavioral measures rated by parents may be due to questions about executive function often including a component of emotional control (e.g., items on shift subscale of BRIEF uses words such as "resists," "becomes upset," "is disturbed by"). Parents reporting CI may take into consideration internalizing and externalizing symptoms and result in greater construct overlap. Therefore, it is important to be cautious when interpreting the positive associations identified in this meta-analysis which is largely based on parent measures of CI.

Limitations

The current systematic review/meta-analysis has several limitations. First, the majority of studies relied on parent reports of CI and emotional/behavioral difficulties, and therefore may result in inflated correlation across the measures due to shared methods variance (Podsakoff et al., 2003; Yorke et al., 2018). One recent study found parents perceived the magnitude of CI to be much greater compared to adolescents' self-reports, and parents focused on observable behaviors at home/community compared to adolescents reporting on their inner experiences across multiple contexts including school (Kenworthy et al., 2022). Future studies should aim to assess CI by drawing on a range of perspectives including parents, teachers, self-report, and objective assessment (e.g., cognitive assessment). Furthermore, the few studies that used task-based measures showed greater individual variances in autistic adolescents' CI compared to parent reports, which may suggest greater heterogeneity in construct specificity across different tasks. Future studies may wish to use multiple tasks to extrapolate a latent construct of CI that may be more directly comparable across different studies.

Second, generalisability of findings is limited as study samples mostly failed to include autistic adolescents with intellectual disability. It is unclear for studies that did not report co-occurring conditions amongst autistic adolescents whether this was not assessed/recorded or whether no co-occurring conditions were found within the sample, the latter being unlikely given the high rates of psychiatric co-occurring conditions found in this population (Simonoff et al., 2008). It may be possible that between-subject differences in CI may be attributed to unreported co-occurring conditions (such as ADHD) rather than ASD per se. Future studies can therefore benefit from more robustly assessing and explicitly reporting co-occurring conditions in autistic adolescents.

Finally, the current study samples were largely boys. Sex differences in CI in autism have remained largely unexplored, with only one study including autistic children and adolescents aged 7–14 years suggesting that girls had poorer performance in WCST with greater perseverative errors and completing fewer categories compared to boys (Memari et al., 2013). Future studies can include more autistic females to further explore whether there are sex-based differences in CI observed in autism, in relation to internalizing and externalizing symptoms over the course of development.

Clinical implications

The current meta-analysis explored the association between CI and internalizing and externalizing symptoms in autistic children and adolescents, with the hope to highlight how this domain may be a possible treatment target that will enhance therapeutic outcomes when explicitly addressed in clinical interventions for psychopathology when working with this clinical group. Our findings suggest that CI does have associations with internalizing and externalizing symptoms in autistic children and adolescents, and evidence does support that clinicians should assess for and incorporate individual differences in CI into person-centered formulation, and adapt clinical interventions to either explicitly target CI, or account for how CI may interfere with treatment efficacy and reception perceived by the young person. Accounting for individual differences in CI is especially important given many evidence-based psychological treatments for mental health problems aim to bring about cognitive and behavioral change and thus are reliant on flexibility in both cognition and behavior.

As cognitive flexibility can support individuals to flexibly adapt to different situational demands (Kashdan, 2010), clinicians should more consistently evaluate individual differences in CI to guide assessment and personalization of treatment approach when working with autistic adolescents. Current adaptations to evidence-based treatment for autistic adolescents with mental health conditions often focus on changing the format of communication and session structure, such as by having more frequent sessions and adopting more visual aids to make session material more concrete (Rodgers & South, 2021). However, such adaptations do not directly address constructs such as CI (Scarpa et al., 2021), which might affect engagement and response to therapeutic

[3]The Halo Effect refers to the concept that a reporter rating on someone else's behavior may fail to distinguish between distinct and independent aspects of the behaviors observed, resulting in inflated inflation of correlation between the different types of behaviors observed (Saal et al., 1980).

approaches that aim to increase awareness of alternative patterns of thinking and behavior (e.g., Cognitive Behavioral Therapy) (Rodgers & South, 2021), and reduce intervention effectiveness.

One approach that explicitly targets CI and executive functions such as planning and organization is called "*Unstuck and On Target!*" (Cannon et al., 2011), developed for educators to deliver in classroom settings for autistic students aged 8–11 years without intellectual disability, to support students in learning and utilizing their skills to increase flexibility in real-life (Kenworthy et al., 2014). To increase children's perceived sense of control over flexible decision making in a nonthreatening way, the use of gamified digital platforms that have clear visual cues may help children more easily access, engage with, and adhere to new intervention approaches (Blackwell et al., 2021). Supporting autistic adolescents to internalize flexible thinking can shape their resilience and potentially buffer against adversity, such as family stressful life events, and support them to navigate more complex situations by better balancing self-regulation and goal-oriented behaviors (Scarpa et al., 2021).

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CONFLICT OF INTEREST

Dr. Charman has served as a paid consultant to F. Hooffmann-La Roche Ltd. And Servier; and has received royalties from Sage Publications and Guildford Publications. Dr. Russell has received royalties from Jessica Kingsley (Hachette) Publications. The other authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The current study was exempted from institutional review board review because it was based on reanalysis of published data.

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REFERENCES

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (DSM-5®)*. American Psychiatric.

Andersen, P. N., Skogli, E. W., Hovik, K. T., Egeland, J., & Øie, M. (2015). Associations among symptoms of autism, symptoms of depression and executive functions in children with high-functioning autism: A 2 year follow-up study. *Journal of Autism and Developmental Disorders*, *45*(8), 2497–2507. https://doi.org/10.1007/s10803-015-2415-8

Bennett, J., & Müller, U. (2010). The development of flexibility and abstraction in preschool children. *Merrill-Palmer Quarterly*, *56*(4), 455–473.

Berenguer, C., Roselló, B., Colomer, C., Baixauli, I., & Miranda, A. (2018). Children with autism and attention deficit hyperactivity disorder. Relationships between symptoms and executive function, theory of mind, and behavioral problems. *Research in Developmental Disabilities*, *83*, 260–269. https://doi.org/10.1016/j.ridd.2018.10.001

Bertollo, J. R., Strang, J. F., Anthony, L. G., Kenworthy, L., Wallace, G. L., & Yerys, B. E. (2020). Adaptive behavior in youth with autism Spectrum disorder: The role of flexibility. *Journal of Autism and Developmental Disorders*, *50*(1), 42–50. https://doi.org/10.1007/s10803-019-04220-9

Blackwell, S., Zylberberg, A., Scerif, G., Miller, S., & Woodcock, K. A. (2021). Understanding the psycho-social context for a new early intervention for resistance to change that aims to strike a beneficial balance between structure and flexibility. *BMC Psychiatry*, *21*(1), 621. https://doi.org/10.1186/s12888-021-03519-1

Blakemore, S.-J., & Robbins, T. W. (2012). Decision-making in the adolescent brain. *Nature Neuroscience*, *15*(9), 1184–1191. https://doi.org/10.1038/nn.3177

Borkovec, T. D. (1994). The nature, functions, and origins of worry. In G. Davey & F. Tallis (Eds.), *Worrying: Perspectives on theory, assessment, and treatment* (pp. 5–33). Wiley & Sons.

Bury, S. M., Jellett, R., Spoor, J. R., & Hedley, D. (2020). "It defines who I am" or "It's something I have": What language do [autistic] Australian adults [on the autism Spectrum] prefer? *Journal of Autism and Developmental Disorders.* https://doi.org/10.1007/s10803-020-04425-3

Cai, R. Y., Richdale, A. L., Uljarević, M., Dissanayake, C., & Samson, A. C. (2018). Emotion regulation in autism spectrum disorder: Where we are and where we need to go. *Autism Research*, *11*(7), 962–978. https://doi.org/10.1002/aur.1968

Cannon, L., Kenworthy, L., Alexander, K. C., Werner, M. A., & Anthony, L. (2011). *Unstuck and on target! An executive function curriculum to improve flexibility for children with autism Spectrum disorders*. Brookes Publishing Company.

Carter Leno, V., Wright, N., Pickles, A., Bedford, R., Zaidman-Zait, A., Kerns, C., Mirenda, P., Zwaigenbaum, L., Duku, E., Bennett, T., Georgiades, S., Smith, I., Vaillancourt, T., Szatmari, P., & Elsabbagh, M. (2022). Exposure to family stressful life events in autistic children: Longitudinal associations with mental health and the moderating role of cognitive flexibility. *Autism*, *26*, 1656–1667. https://doi.org/10.1177/13623613211061932

Centers for Disease Control and Prevention. (2019). *Data and statistics on autism Spectrum disorder|CDC. Centers for Disease Control and Prevention*. U.S. Department of Health and Human Services. https://www.cdc.gov/ncbddd/autism/data.html

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge.

Core Team R. (2019). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing.

Cragg, L., & Chevalier, N. (2012). The processes underlying flexibility in childhood. *Quarterly Journal of Experimental Psychology*, *65*(2), 209–232. https://doi.org/10.1080/17470210903204618

Crawley, D., Zhang, L., Jones, E. J. H., Ahmad, J., Oakley, B., Cáceres, A. S. J., Charman, T., Buitelaar, J. K., Murphy, D. G. M., Chatham, C., Ouden, H. d., Loth, E., & Group, the E.-A. L. (2020). Modeling flexible behavior in childhood to adulthood shows age-dependent learning mechanisms and

less optimal learning in autism in each age group. *PLoS Biology*, *18*(10), e3000908. https://doi.org/10.1371/journal.pbio.3000908

Cretenet, J., & Dru, V. (2009). Influence of peripheral and motivational cues on rigid-flexible functioning: Perceptual, behavioral, and cognitive aspects. *Journal of Experimental Psychology*, *138*(2), 201–217. https://doi.org/10.1037/a0015379

Dajani, D. R., Llabre, M. M., Nebel, M. B., Mostofsky, S. H., & Uddin, L. Q. (2016). Heterogeneity of executive functions among comorbid neurodevelopmental disorders. *Scientific Reports*, *6*, 36566. https://doi.org/10.1038/srep36566

Deák, G. O. (2003). *The development of cognitive flexibility and language abilities. In advances in child development and behavior* (Vol. 31, pp. 271–327). Academic Press.

Dekkers, O. M., Vandenbroucke, J. P., Cevallos, M., Renehan, A. G., Altman, D. G., & Egger, M. (2019). COSMOS-E: Guidance on conducting systematic reviews and meta-analyses of observational studies of etiology. *PLoS Medicine*, *16*(2), e1002742. https://doi.org/10.1371/journal.pmed.1002742

Demetriou, E. A., DeMayo, M. M., & Guastella, A. J. (2019). Executive function in autism Spectrum disorder: History, theoretical models, empirical findings, and potential as an Endophenotype. *Frontiers in Psychiatry*, *10*. https://doi.org/10.3389/fpsyt.2019.00753

Demetriou, E. A., Lampit, A., Quintana, D. S., Naismith, S. L., Song, Y. J. C., Pye, J. E., Hickie, I., & Guastella, A. J. (2018). Autism spectrum disorders: A meta-analysis of executive function. *Molecular Psychiatry*, *23*(5), 1198–1204. https://doi.org/10.1038/mp.2017.75

Dieckhaus, M. F. S., Hardy, K. K., Gutermuth Anthony, L., Verbalis, A., Kenworthy, L., & Pugliese, C. E. (2021). Anxiety relates to classroom executive function problems in students with ASD, but not ADHD. *Research in Autism Spectrum Disorders*, *82*, 101739. https://doi.org/10.1016/j.rasd.2021.101739

Dietrich, A., & Kanso, R. (2010). A review of EEG, ERP, and neuroimaging studies of creativity and insight. *Psychological Bulletin*, *136*(5), 822–848. https://doi.org/10.1037/a0019749

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ*, *315*(7109), 629–634. https://doi.org/10.1136/bmj.315.7109.629

Friedman, N. P., & Miyake, A. (2017). Unity and diversity of executive functions: Individual differences as a window on cognitive structure. *Cortex*, *86*, 186–204. https://doi.org/10.1016/j.cortex.2016.04.023

Garcia-Garcia, M., Barceló, F., Clemente, I. C., & Escera, C. (2010). The role of the dopamine transporter DAT1 genotype on the neural correlates of cognitive flexibility. *The European Journal of Neuroscience*, *31*(4), 754–760. https://doi.org/10.1111/j.1460-9568.2010.07102.x

Gardiner, E., & Iarocci, G. (2018). Everyday executive function predicts adaptive and internalizing behavior among children with and without autism spectrum disorder. *Autism Research: Official Journal of the International Society for Autism Research*, *11*(2), 284–295. https://doi.org/10.1002/aur.1877

Geurts, H. M., Corbett, B., & Solomon, M. (2009). The paradox of cognitive flexibility in autism. *Trends in Cognitive Sciences*, *13*(2), 74–82. https://doi.org/10.1016/j.tics.2008.11.006

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). Test review behavior rating inventory of executive function. *Child Neuropsychology*, *6*(3), 235–238. https://doi.org/10.1076/chin.6.3.235.3152

Happé, F., Booth, R., Charlton, R., & Hughes, C. (2006). Executive function deficits in autism spectrum disorders and attention-deficit/hyperactivity disorder: Examining profiles across domains and ages. *Brain and Cognition*, *61*(1), 25–39. https://doi.org/10.1016/j.bandc.2006.03.004

Higgins, J. P. T., Thompson, S. G., Deeks, J. J., & Altman, D. G. (2003). Measuring inconsistency in meta-analyses. *BMJ*, *327*(7414), 557–560. https://doi.org/10.1136/bmj.327.7414.557

Hollocks, M. J., Charman, T., Baird, G., Lord, C., Pickles, A., & Simonoff, E. (2022). Exploring the impact of adolescent cognitive inflexibility on emotional and behavioural problems experienced by autistic adults. *Autism*, 26(5), 1229–1241. https://doi.org/10.1177/13623613211046160

Hollocks, M. J., Jones, C. R. G., Pickles, A., Baird, G., Happé, F., Charman, T., & Simonoff, E. (2014). The association between social cognition and executive functioning and symptoms of anxiety and depression in adolescents with autism spectrum disorders. *Autism Research: Official Journal of the International Society for Autism Research*, *7*(2), 216–228. https://doi.org/10.1002/aur.1361

Ionescu, T. (2012). Exploring the nature of cognitive flexibility. *New Ideas in Psychology*, *30*(2), 190–200. https://doi.org/10.1016/j.newideapsych.2011.11.001

Kashdan, T. B. (2010). Psychological flexibility as a fundamental aspect of health. *Clinical Psychology Review*, *30*(7), 865–878. https://doi.org/10.1016/j.cpr.2010.03.001

Kenny, L., Hattersley, C., Molins, B., Buckley, C., Povey, C., & Pellicano, E. (2016). Which terms should be used to describe autism? Perspectives from the UK autism community. *Autism*, *20*(4), 442–462. https://doi.org/10.1177/1362361315588200

Kenworthy, L., Anthony, L. G., Naiman, D. Q., Cannon, L., Wills, M. C., Luong-Tran, C., Werner, M. A., Alexander, K. C., Strang, J., Bal, E., Sokoloff, J. L., & Wallace, G. L. (2014). Randomized controlled effectiveness trial of executive function intervention for children on the autism spectrum. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *55*(4), 374–383. https://doi.org/10.1111/jcpp.12161

Kenworthy, L., Verbalis, A., Bascom, J., daVanport, S., Strang, J. F., Pugliese, C., Freeman, A., Jeppsen, C., Armour, A. C., Jost, G., Hardy, K., & Wallace, G. L. (2022). Adding the missing voice: How self-report of autistic youth self-report on an executive functioning rating scale compares to parent report and that of youth with attention deficit hyperactivity disorder or neurotypical development. *Autism*, *26*(2), 422–433. https://doi.org/10.1177/13623613211029117

Kmet, L., Lee, R. C., Cook, L. S., Lorenzetti, D., Godlovitch, G., & Einsiedel, E. (2004). Systematic review of the social. In *Ethical, and legal dimensions of genetic cancer risk assessment technologies*. Alberta Heritage Foundatoin for Medical Research.

Lai, M.-C., Kassee, C., Besney, R., Bonato, S., Hull, L., Mandy, W., Szatmari, P., & Ameis, S. H. (2019). Prevalence of co-occurring mental health diagnoses in the autism population: A systematic review and meta-analysis. *The Lancet Psychiatry*, *6*(10), 819–829. https://doi.org/10.1016/S2215-0366(19)30289-5

Lawson, R. A., Papadakis, A. A., Higginson, C. I., Barnett, J. E., Wills, M. C., Strang, J. F., Wallace, G. L., & Kenworthy, L. (2015). Everyday executive function impairments predict comorbid psychopathology in autism spectrum and attention deficit hyperactivity disorders. *Neuropsychology*, *29*(3), 445–453. https://doi.org/10.1037/neu0000145

Leung, R. C., & Zakzanis, K. K. (2014). Brief report: Cognitive flexibility in autism Spectrum disorders: A quantitative review. *Journal of Autism and Developmental Disorders*, *44*(10), 2628–2645. https://doi.org/10.1007/s10803-014-2136-4

Lieb, R. W., & Bohnert, A. M. (2017). Relations between executive functions, social impairment, and friendship quality on adjustment among high functioning youth with autism Spectrum disorder. *Journal of Autism and Developmental Disorders*, *47*(9), 2861–2872. https://doi.org/10.1007/s10803-017-3205-2

Maddox, B. B., Cleary, P., Kuschner, E. S., Miller, J. S., Armour, A. C., Guy, L., Kenworthy, L., Schultz, R. T., & Yerys, B. E. (2018). Lagging skills contribute to challenging behaviors in children with autism spectrum disorder without intellectual disability. *Autism: The International Journal of Research and Practice*, *22*(8), 898–906. https://doi.org/10.1177/1362361317712651

Memari, A. H., Ziaee, V., Shayestehfar, M., Ghanouni, P., Mansournia, M. A., & Moshayedi, P. (2013). Cognitive flexibility impairments in children with autism spectrum disorders: Links to age, gender and child outcomes. *Research in Developmental*

Disabilities, *34*(10), 3218–3225. https://doi.org/10.1016/j.ridd.2013.06.033

Miles, S., Gnatt, I., Phillipou, A., & Nedeljkovic, M. (2020). Cognitive flexibility in acute anorexia nervosa and after recovery: A systematic review. *Clinical Psychology Review*, *81*, 101905. https://doi.org/10.1016/j.cpr.2020.101905

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *BMJ*, *339*, b2535. https://doi.org/10.1136/bmj.b2535

Morris, L., & Mansell, W. (2018). A systematic review of the relationship between rigidity/flexibility and transdiagnostic cognitive and behavioral processes that maintain psychopathology. *Journal of Experimental Psychopathology*, *9*(3), 2043808718779431. https://doi.org/10.1177/2043808718779431

Ozsivadjian, A., Hollocks, M. J., Magiati, I., Happé, F., Baird, G., & Absoud, M. (2021). Is cognitive inflexibility a missing link? The role of cognitive inflexibility, alexithymia and intolerance of uncertainty in externalising and internalising behaviours in young people with autism spectrum disorder. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *62*(6), 715–724. https://doi.org/10.1111/jcpp.13295

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., … Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ*, *372*, n71. https://doi.org/10.1136/bmj.n71

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *The Journal of Applied Psychology*, *88*(5), 879–903. https://doi.org/10.1037/0021-9010.88.5.879

Rietz, E. D., Pettersson, E., Brikell, I., Ghirardi, L., Chen, Q., Hartman, C., Lichtenstein, P., Larsson, H., & Kuja-Halkola, R. (2021). Overlap between attention-deficit hyperactivity disorder and neurodevelopmental, externalising and internalising disorders: Separating unique from general psychopathology effects. *The British Journal of Psychiatry*, *218*(1), 35–42. https://doi.org/10.1192/bjp.2020.152

Rodgers, J., & South, M. (2021). Commentary: Thinking flexibly about mental health and autism - a commentary on Ozsivadjian et al. (2020). *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *62*(6), 725–727. https://doi.org/10.1111/jcpp.13340

Rogers, J., Viding, E., Blair, R. J., Frith, U., & Happé, F. (2006). Autism spectrum disorder and psychopathy: Shared cognitive underpinnings or double hit? *Psychological Medicine*, *36*(12), 1789–1798. https://doi.org/10.1017/S0033291706008853

Saal, F. E., Downey, R. G., & Lahey, M. A. (1980). Rating the ratings: Assessing the psychometric quality of rating data. *Psychological Bulletin*, *88*(2), 413–428. https://doi.org/10.1037/0033-2909.88.2.413

Samson, A. C., Hardan, A. Y., Lee, I. A., Phillips, J. M., & Gross, J. J. (2015). Maladaptive behavior in autism Spectrum disorder: The role of emotion experience and emotion regulation. *Journal of Autism and Developmental Disorders*, *45*(11), 3424–3432. https://doi.org/10.1007/s10803-015-2388-7

Scarpa, A., Swain, D. M., Factor, R. S., Dahiya, A. V., & Bertollo, J. R. (2021). Enhancing flexibility: A biosocial model for resilience to adversity in youth with autism. *SAGE Open*, *11*(3), 21582440211037996. https://doi.org/10.1177/21582440211037997

Sesso, G., Cristofani, C., Berloffa, S., Cristofani, P., Fantozzi, P., Inguaggiato, E., Narzisi, A., Pfanner, C., Ricci, F., Tacchi, A., Valente, E., Viglione, V., Milone, A., & Masi, G. (2020). Autism Spectrum disorder and disruptive behavior disorders comorbidities delineate clinical phenotypes in attention-deficit hyperactivity disorder: Novel insights from the assessment of psychopathological and neuropsychological profiles. *Journal of Clinical Medicine*, *9*(12), E3839. https://doi.org/10.3390/jcm9123839

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric disorders in children with autism Spectrum disorders: Prevalence, comorbidity, and associated factors in a population-derived sample. *Journal of the American Academy of Child & Adolescent Psychiatry*, *47*(8), 921–929. https://doi.org/10.1097/CHI.0b013e318179964f

Strang, J. F., Anthony, L. G., Yerys, B. E., Hardy, K. K., Wallace, G. L., Armour, A. C., Dudley, K., & Kenworthy, L. (2017). The flexibility scale: Development and preliminary validation of a cognitive flexibility measure in children with autism Spectrum disorders. *Journal of Autism and Developmental Disorders*, *47*(8), 2502–2518. https://doi.org/10.1007/s10803-017-3152-y

Tachibana, Y., Hwang, Y., Abe, Y., Goto, S., Sugai, K., & Kawashima, R. (2013). Reading aloud improves executive function of children with autism spectrum disorder: A pilot randomized controlled trial. *International Journal on Disability and Human Development*, *12*(1), 91–101. https://doi.org/10.1515/ijdhd-2012-0128

Teunisse, J.-P., Roelofs, R. L., Verhoeven, E. W. M., Cuppen, L., Mol, J., & Berger, H. J. C. (2012). Flexibility in children with autism spectrum disorders (ASD): Inconsistency between neuropsychological tests and parent-based rating scales. *Journal of Clinical and Experimental Neuropsychology*, *34*(7), 714–723. https://doi.org/10.1080/13803395.2012.670209

Trimarco, B., Manti, F., Nardecchia, F., Melogno, S., Testa, M., Meledandri, G., Carducci, C., Penge, R., & Leuzzi, V. (2020). Executive functioning, adaptive skills, emotional and behavioral profile: A comparison between autism spectrum disorder and phenylketonuria. *Molecular Genetics and Metabolism Reports*, *23*, 100577. https://doi.org/10.1016/j.ymgmr.2020.100577

Tse, V. W. S., Lei, J., Crabtree, J., Mandy, W., & Stott, J. (2021). Characteristics of Older Autistic Adults: a Systematic Review of Literature. *Review Journal of Autism and Developmental Disorders*, *9*(2), 184–207. https://doi.org/10.1007/s40489-021-00238-x

Uddin, L. Q. (2021). Brain mechanisms supporting flexible cognition and behavior in adolescents with autism Spectrum disorder. *Biological Psychiatry*, *89*(2), 172–183. https://doi.org/10.1016/j.biopsych.2020.05.010

Uljarević, M., Frazier, T. W., Rached, G., Busch, R. M., Klaas, P., Srivastava, S., Martinez-Agosto, J. A., Sahin, M., Eng, C., Hardan, A. Y., & Developmental Synaptopathies Consortium. (2022). Brief report: Role of parent-reported executive functioning and anxiety in insistence on sameness in individuals with germline PTEN mutations. *Journal of Autism and Developmental Disorders*, *52*(1), 414–422. https://doi.org/10.1007/s10803-021-04881-5

van Steensel, F. J. A., Bögels, S. M., & Dirksen, C. D. (2012). Anxiety and quality of life: Clinically anxious children with and without autism spectrum disorders compared. *Journal of Clinical Child and Adolescent Psychology: The Official Journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53*, *41*(6), 731–738. https://doi.org/10.1080/15374416.2012.698725

Viechtbauer, W. (2019). Meta-analysis package for R. CRAN.

Vivanti, G. (2020). Ask the editor: What is the Most appropriate way to talk about individuals with a diagnosis of autism? *Journal of Autism and Developmental Disorders*, *50*(2), 691–693. https://doi.org/10.1007/s10803-019-04280-x

Vogan, V. M., Leung, R. C., Safar, K., Martinussen, R., Smith, M. L., & Taylor, M. J. (2018). Longitudinal examination of everyday executive functioning in children with ASD: Relations with social, emotional, and behavioral functioning over time. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.01774

Yerys, B. E., Wallace, G. L., Sokoloff, J. L., Shook, D. A., James, J. D., & Kenworthy, L. (2009). Attention

deficit/hyperactivity disorder symptoms moderate cognition and behavior in children with autism spectrum disorders. *Autism Research: Official Journal of the International Society for Autism Research*, *2*(6), 322–333. https://doi.org/10.1002/aur.103

Yorke, I., White, P., Weston, A., Rafla, M., Charman, T., & Simonoff, E. (2018). The association between emotional and behavioral problems in children with autism Spectrum disorder and psychological distress in their parents: A systematic review and meta-analysis. *Journal of Autism and Developmental Disorders*, *48*(10), 3393–3415. https://doi.org/10.1007/s10803-018-3605-y

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APPENDIX A

Full Electronic Database Search Terms and history of preliminary scoping search results.

Planned search terms (See Appendix A for more information on preliminary scoping searches):

Main search terms include the following search constructs used for both aims:

Autism: ((Autis*) OR (Asperg*) OR (ASD) OR (ASC) OR (PDD)) AND

Children/adolescent: ((adolescen*) OR (young person) OR (young people) OR (youth*) OR (child*) OR (infant*) OR (toddler*)) AND

Cognitive flexibility[†]: ((cognitive flexib*) OR (cognitive inflexib*) OR (cognitive rigid*) OR (rigid*) OR (mental flexib*) OR (set shift*) OR (WCST) OR (Wisconsin Card Sorting Task) OR (Trail Making) OR (Brixton) OR (Haptic illusion) OR (Catbat) OR (Delis-Kaplan Executive Function System) OR (Behavior Rating Inventory*) OR (Cognitive Flexibility Scale*)).

Aim 1 - *Internalizing symptoms*: (Anxiety) OR (internali*) OR (OCD) OR (intrus*) OR (mood) OR (depress*) OR (affect*) OR (suicid*) OR (self-harm*) OR (somati*) OR (PTSD) OR (Trauma*) OR (Phobia).

Aim 2 - *Externalizing symptoms*: (aggress*) OR (antisocial*) OR (externali*) OR (delinquen*) OR (disrupt*) OR (conduct*) OR (anger*) OR (defiant) OR (hyperactiv*) OR (challenging behav*) OR (ADHD) OR (ODD) OR (oppositional*).

Preliminary scoping search results:

1. Main search terms: A preliminary scoping search using the main search terms on PubMed on July 12, 2021 generated 4093 results. Many of the search terms for cognitive flexibility were extracted from a published systematic review exploring cognitive flexibility in patients with Anorexia Nervosa (Miles et al., 2020).
2. Main ssarch terms and Aim 1: A preliminary scoping search using the main search terms and search terms unique to Aim 1 in PubMed on July 12, 2021 generated 1012 results.
3. Main search terms and Aim 2: A preliminary scoping search using the main search terms and search terms unique to Aim 2 in PubMed on July 12, 2021 generated 1097 results.

[†]Summary of main measures of cognitive flexibility as reported in (Miles et al., 2020).

1. Neurocognitive assessment measures and cognitive tasks

Wisconsin Cart Sorting Task (WCST).
Trail Making Test (TMT).
Berg's Card Sorting Task.
Brixton Spatial Anticipation Test.
CANTAB Intra-and Extra-Dimensional Task (ID/ED).
CatBat.
Controlled Oral Word Association Test.
Delis-Kaplan Executive Function System (D-KEFS) – in particular the color-word interference task, TMT and verbal fluency task.
Haptic Illusions Task.
Hayling Sentence Completion Task.

2. Self-report measures

Cognitive Flexibility Scale (CFS).
Shift subscale of Behavior Rating Inventory of Executive Functioning.
Detail and Flexibility questionnaire.

APPENDIX B

Description of the Quality Appraisal Tool (Kmet et al., 2004):

This 14-item tool has a detailed scoring protocol for examining (1) description of study objectives, (2) appropriateness of study design for addressing research question, (3) method of participant selection, (4) quality of participant information reported, (5) random allocation to treatment group (if applicable), (6) intervention blinding of investigators (if applicable), (7) intervention blinding of participants (if applicable), (8) description of outcome variables, (9) appropriateness of sample size, (10) appropriateness of statistical analysis, (11) estimate of variance for main results, (12) control for confounding variables, (13) sufficient detail in reporting of results, (14) whether results support conclusions drawn. Each item is rated on a scale of yes (2 points), partial (1 point), no

(0 point) and not applicable (N/A). The summary score (between 0 and 1) is calculated in three steps: (1) calculate the total sum score = (number of "yes" *2 points) + (number of "partials" *1 point), (2) calculate the total possible sum = 28–(total number of "N/A" * 2 points); (3) create summary score (range 0–1) = total sum/total possible sum. This tools has been successfully used in the past for systematic reviews examining quantitative research in older adults with autism (Tse et al., 2021).

APPENDIX C

a. Sensitivity analyses for cognitive inflexibility and internalizing symptoms.

To explore whether the effect size observed above between internalizing symptoms and cognitive flexibility remains when accounting for differences in method of measurement (i.e., parent report vs. task-based measure), a post hoc sensitivity analysis was completed including only studies that used a parent report measure of cognitive flexibility (n = 6). The sensitivity analysis showed a significant, moderate effect size, $r = 0.48$, $p < 0.001$, 95% CI [0.36, 0.52], indicating that higher cognitive inflexibility was associated with higher levels of internalizing symptoms. There was no substantial degree of heterogeneity, Q(5) = 2.48, $p = 0.78$, $I^2 = 0\%$. Funnel plot did not show significant study asymmetry, and neither Egger's regression test ($p = 0.56$) nor Rank Correlation Test ($p = 1.00$) suggested evidence for publication bias.

A separate post hoc sensitivity analysis was completed including only studies that used performance-based measures of cognitive flexibility (n = 3). The sensitivity analysis showed a significant, moderate effect size, $r = 0.34$, $p < 0.001$, 95% CI [0.25, 0.44], indicating that higher cognitive inflexibility was associated with higher levels of internalizing symptoms. There was no substantial degree of heterogeneity, Q(2) = 1.74, $p = 0.41$, $I^2 = 0.01\%$. Funnel plot did not show significant study asymmetry, and neither Egger's regression test ($p = 0.66$) nor Rank Correlation Test ($p = 1.00$) suggested evidence for publication bias.

To explore the extent to which the effect size observed between internalizing symptoms and cognitive flexibility is affected by co-occurring ADHD, a post hoc sensitivity analysis was completed by excluding the two studies with young people with ASD and ADHD (Sesso et al., 2020; Yerys et al., 2009), leaving a total of seven studies in this analysis. The sensitivity analysis showed a significant, moderate effect size, $r = 0.38$, $p < 0.001$, 95% CI [0.31, 0.45], indicating that higher cognitive inflexibility was associated with higher levels of internalizing symptoms. There was no substantial degree of heterogeneity, Q (6) = 7.09, $p = 0.31$, $I^2 = 16.99\%$. Funnel plot did not show significant study asymmetry, and neither Egger's regression test ($p = 0.26$) nor Rank Correlation Test ($p = 0.56$) suggested evidence for publication bias.

a. Sensitivity analyses for cognitive inflexibility and externalizing symptoms.

To explore whether the effect size observed above between externalizing symptoms and cognitive flexibility remains when accounting for differences in method of measurement (i.e., parent report vs. task-based measure), a post hoc sensitivity analysis was completed including only studies that used a parent report measure of cognitive flexibility (n = 5). The sensitivity analysis showed a significant, a significant, large effect size, $r = 0.51$, $p < 0.001$, 95% CI [0.41, 0.60], indicating that higher cognitive inflexibility was associated with higher levels of externalizing symptoms. There was no substantial degree of heterogeneity, Q(4) = 3.58, $p = 0.47$, $I^2 = 0\%$). Funnel plot did not show significant study asymmetry, and neither Egger's regression test ($p = 0.54$) nor Rank Correlation Test ($p = 0.82$) suggested evidence for publication bias. Given only one study used behavioral task to measure cognitive flexibility, a sensitivity analysis could not be conducted.

To explore the whether the effect size observed between externalizing symptoms and cognitive flexibility remains when accounting for co-occurring ADHD, a post hoc sensitivity analysis was completed by excluding the two studies with young people with ASD and ADHD (Sesso et al., 2020; Yerys et al., 2009), leaving a total of four studies in the analysis. The sensitivity analysis showed a significant, large effect size, $r = 0.52$, $p < 0.001$, 95% CI [0.40, 0.62], indicating that higher cognitive inflexibility was associated with higher levels of externalizing symptoms. There was no substantial degree of heterogeneity, Q(3) = 4.63, $p = 0.20$, $I^2 = 17.96\%$. Funnel plot did not show significant study asymmetry, and neither Egger's regression test ($p = 0.56$) nor Rank Correlation Test ($p = 0.75$) suggested evidence for publication bias.

Chapter 2

Empirical Project

Understanding the relationship between social camouflaging in autism and safety behaviours in social anxiety in autistic and non-autistic adolescents

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Abstract

Background: Social camouflaging in autism includes factors such as masking and compensating for one's neurodevelopmental differences, and to assimilate or "fit in" with non-autistic peers. Efforts to hide one's authentic self and autism traits (masking) resemble impression management in safety behaviours identified in Clark and Wells' (1995) cognitive model of social anxiety. Given the high co-occurrence of social anxiety amongst autistic children and young people, the current study explores the relationship between social camouflaging in autism and safety behaviours in social anxiety amongst autistic and non-autistic adolescents.

Methods: 115 adolescents (14-19 years) with (n = 61; 36 female) and without (n = 54; 37 female) a clinical diagnosis of autism matched on age and social anxiety symptom severity were recruited from clinics, schools and online. Adolescents completed online measures of autism traits, social anxiety symptoms, social camouflaging behaviours, social anxiety-related safety behaviours and social anxiety-related negative cognitions, depression symptoms, and generalised anxiety symptoms. Partial and bivariate Pearson's correlations and structural equation modelling were used to understand the relationship between social camouflaging behaviour, safety behaviours, autism traits, and social anxiety in both groups. Exploratory factor analysis assessed item-level factor cross-loading between social camouflaging and safety behaviours.

Results: Across both groups, masking and impression management behaviours were significantly associated with social anxiety symptom severity, not autism traits, via social anxiety related social cognitions. Exploratory factor analysis indicated construct overlap across masking, assimilation, impression management and avoidance behaviours, and identified factors analogous to self-focused attention, social avoidance and mental rehearsal identified in the Clark and Wells' (1995) model of social anxiety.

Conclusions: This is the first study to use group-matched design to identify that masking (factor in social camouflaging) and impression management both relate to social anxiety in autistic and non-autistic adolescents. Improving assessment and formulation of potential construct overlap between masking and impression management behaviours may inform both psychoeducation and adaption of social anxiety treatment for autistic adolescents.

Keywords: autism, autism spectrum disorder, autism spectrum condition, social anxiety, social camouflaging, masking, safety behaviours, cognitive behaviour therapy, adolescent

1. Introduction

Autism Spectrum Disorder (ASD) is a neurodevelopmental condition characterised by social communication difficulties, restricted and repetitive behaviour and sensory anomalies (American Psychiatric Association, 2013) that affects 1 in 54 children (Centers for Disease Control and Prevention, 2019). Between 29% - 57% of autistic children and young people have co-occurring Social Anxiety Disorder (SAD) (Bellini, 2006; Hollocks et al., 2022; Kuusikko et al., 2008; Simonoff et al., 2008), a prevalence rate that is considerably higher than the 7% to 12% reported in the non-autistic adolescent population (Fehm et al., 2005; Izgiç et al., 2004; Kessler et al., 2012; Ruscio et al., 2008). From an aetiological perspective, common mechanisms have been identified that mediate the relationship between social anxiety and autism traits in both autistic and non-autistic adolescents (Hollocks et al., 2016; Lei & Russell, 2020; Pickard et al., 2020). Cognitive mechanisms include fear of negative evaluation by others (Lei & Russell, 2020), greater attentional bias towards threatening faces and more negative interpretation of ambiguous social situations (Hollocks et al., 2016), and intolerance of uncertainty (Pickard et al., 2020). Additional mechanisms include alexithymia and interoceptive sensibility (Pickard et al., 2020). Common aetiological factors underlying social anxiety in both adolescent groups suggest that it may be possible to extend existing cognitive therapy for SAD in non-autistic adolescents to autistic adolescents (Hollocks et al., 2016; Pickard et al., 2020; Sukhodolsky et al., 2013).

Developments in cognitive therapy for SAD in non-autistic adolescents have been guided by maintenance models of social anxiety (Clark & Wells, 1995; Ingul et al., 2014; Leigh & Clark, 2018, 2021; Rapee & Heimberg, 1997), which pay close attention to a range of cognitive and behavioural factors that influence how an individual prepares for, responds to, and reflects on social situations and that perpetuate their social anxiety over time (Wong & Rapee, 2016). Compared to aetiological factors, little is known about the relationship between maintenance factors of social anxiety and autistic traits in adolescents, and this gap in our knowledge may be associated with the limited evidence available for the applicability, adaptation and success of using cognitive therapy for SAD developed for non-autistic individuals for autistic individuals (Spain et al., 2017). In a systematic review of both aetiological and maintenance models of SAD by Wong and Rapee (2016), the authors identified safety behaviours to be an important maintenance factor across all of the prominent maintenance models of SAD. Safety behaviours are defined as “advanced, elaborate, and creative

strategies that aim to eliminate social-evaluative threat in these circumstances [social situations] without physically removing oneself" (Wong & Rapee, 2016, pp.95).

In the Clark and Wells (1995) cognitive model of SAD, individuals who perceive social situations to be threatening engage in safety behaviours (either social avoidance or managing how they come across in social interactions) in order to prevent or mitigate the feared social outcome. The many unintended negative consequences of safety behaviours also include enhanced self-focused attention during social interactions, directly causing feared outcomes to occur (e.g., gripping a cup so tightly it may accidentally spill), and contaminating social interactions (Clark & Wells, 1995). Therefore, safety behaviours maintain social anxiety as they prevent the individual from learning that their own appraisal of how they appear to others based on internal cues is not an accurate representation of how others perceive them in social situations (Clark & Wells, 1995). A key component of cognitive therapy for SAD focuses on helping individuals discover that safety behaviours maintain social anxiety and supporting individuals to practise dropping their safety behaviours when in social situations (Clark & Wells, 1995).

Studies in non-autistic socially anxious adults and adolescents have found that safety behaviours largely fall into two categories, avoidance (e.g., avoid eye contact, keep quiet, being more passive and standing on the edge of social groups) and impression management (e.g., putting on an appearance of being more sociable and normal, even if behaviours are not genuine) (Evans et al., 2021). Whilst both types of safety behaviours prevent socially anxious individuals from learning that their feared outcome is unlikely to happen, only avoidance safety behaviours can have additional negative effect on social interaction (e.g., avoiding eye contact may lead to a more critical appraisal from others compared to rehearsing sentences in one's mind) (Evans et al., 2021; Gray et al., 2019).

While avoidance behaviours are often readily identified by an individual and observers, efforts at impression management may be less accessible. Impression management is thought to constitute conscious and unconscious way for minoritized groups such as autistic individuals to mitigate discrimination by concealing a stigma-associated identity (Ai et al., 2022; Goffman, 1959, 1968). The use of safety behaviours to 'hide' one's social anxiety draws parallels to the recent literature on social camouflaging in autism, where autistic people describe the use of many behavioural strategies to 'mask' one's autism, in order to appear 'normal' and 'fit in' with non-autistic individuals in social situations (Hull et al., 2017; Hull, Petrides, et al.,

2020). Social camouflaging is conceptualised as including compensation strategies that address social and communication difficulties associated with autism (e.g., I practice my facial expressions and body language to make sure they look normal), masking strategies that allows one to present a non-autistic persona to others (e.g., I am always aware of the impression I make on other people), and assimilation strategies used to fit in to social situations that may be uncomfortable (e.g., In social situations, I feel like I am pretending to be 'normal') (Hull et al., 2019). Masking is described as the use of simple or "shallow" behavioural strategies to regulate autism-associated behaviours, compared to "deep" compensation where social cognitive strategies are actively used to generate new social behaviours adapted to specific social contexts to help individuals fit in (Livingston, Colvert, et al., 2019; Livingston, Shah, et al., 2019). Similar to the negative consequences of safety behaviours maintaining social anxiety over time, recent studies have linked social camouflaging behaviours to exhaustion and burnout, greater symptoms of social anxiety, generalised anxiety, and depression in autistic adults (Beck et al., 2020; Cage & Troxell-Whitman, 2019; Hull et al., 2019, 2021; Lai et al., 2019). One study found that autistic adults who engaged in high levels of camouflaging across multiple social contexts reported greater anxiety, and the authors conjectured whether heightened social camouflaging may be driven by high levels of social anxiety rather than autism alone (Cage & Troxell-Whitman, 2019).

A shared motivation behind both social camouflaging and impression management safety behaviours may be to live up to other people's expectation of the self and are driven by a fear of negative evaluation and/or a desire to be accepted by others (Gino et al., 2020). Amongst non-autistic adults, such behaviours result in presenting an inauthentic version of the self to cater to perceived external expectations, which can exacerbate anxiety as well as leading to cognitive exhaustion by having to manage the inherent uncertainty in trying to predict the listener's preferences and responses in order to adapt one's own actions accordingly (Gino et al., 2020). The propensity for impression management may be even greater for individuals from minoritized groups such as autistic individuals who are more vulnerable to experiencing social stigma (Ai et al., 2022; Goffman, 1959, 1968). Impression management may be both a conscious and unconscious way of mitigating discrimination by concealing stigma-associated identities (Ai et al., 2022; Goffman, 1959, 1968). Anecdotal reports from autistic adults suggest that there are also tangible benefits from social camouflaging, such as avoiding bullying by others and getting by in conventional work and education settings (Cage & Troxell-Whitman, 2019). Therefore, one potential difference between social camouflaging behaviours and

impression management safety behaviours may be that the former is used to disguise objective social communication differences in autism, whereas the latter are used to address the self-perceived social inadequacy in social anxiety and in the absence of objective social skill difficulties.

Given that there may be some degree of conflation between the safety behaviours that are part of in social anxiety (particularly impression management factor due to potential construct overlap in measurement of self-presentation strategies in social situations) and social camouflaging in autism, it is important to examine to what extent such behaviours can be differentiated when using conventional self-report measures during assessment. Understanding the construct overlap between safety behaviours and social camouflaging in relation to social anxiety and autistic traits has important implications for treating social anxiety in autistic individuals, as the balance of potential social benefits and costs of social camouflaging behaviours need to be more carefully considered compared to safety behaviours. This study will explore to what extent both autistic and non-autistic adolescents with elevated levels of social anxiety engage in safety behaviours relevant to social anxiety versus behaviours used to camouflage their autism or autistic traits, as captured by conventional self-report measures used in clinic and research to identify safety behaviours and social camouflaging. Understanding the relationship between social camouflaging and impression management safety behaviours will enable clinicians to assess and formulate how maintenance factors identified in cognitive models of SAD for non-autistic adolescents are shared by autistic adolescents and adapt intervention accordingly.

The current study aimed to explore construct overlap between social camouflaging behaviours in autism and safety behaviours in social anxiety amongst autistic and non-autistic adolescents with similar levels of social anxiety symptoms. We compared and contrasted factor structure invariance using measurements for social camouflaging behaviour (Camouflaging Autistic Traits Questionnaire; CAT-Q) in autism, and safety behaviours (Adolescent Social Behaviour Questionnaire; ASBQ) in social anxiety in autistic and non-autistic adolescents, when accounting for individual differences in autistic traits and symptoms of social anxiety. Using Structural Equation Modelling (SEM), we also investigated the relative independent contributions of autism traits and social anxiety on social camouflaging and safety behaviours. Finally, we conducted an exploratory factor analysis to examine factor cross-loadings of items related to social camouflaging and safety behaviours to explore construct overlap at the item level using CAT-Q and ASBQ. Understanding the relationship between both sets of behaviours will provide valuable insight into

assessment and formulation of how maintenance factors identified in cognitive models of SAD for non-autistic adolescents are shared by autistic adolescents, with clinical implications for adapting cognitive behavioural treatment of SAD for autistic adolescents.

2. Methods

2.1 Participants

This study included 115 adolescents (14-19 years old), recruited following attendance at child and adolescent mental health services in South London (Autism: 89%; Non-Autism: 98%), a university transition programme to support university transition for autistic students (Autism: 3%) and online (Autism: 8%; Non-Autism: 2%). Autistic young people (n = 61) had a clinical diagnosis of autism (DSM-5 autism spectrum disorder) by a qualified professional gathered either from clinical records from their local child and adolescent mental health service access or provided by parent/carer electronically. Non-autistic young people (n = 54) did not have any clinical diagnosis of autism as per clinical records, nor self and parent/carer disclosure. Exclusion criteria for both autism and non-autism groups included a diagnosis of intellectual disability, diagnosis of epilepsy, genetic or psychotic conditions, have current risk of harm to self or from others, current in-patient, or non-fluent in written English. Assessment for exclusion criteria is based on parent report and clinical records as held by the child and adolescent mental health service accessed by the young person, as well as cross-checking with their local care co-ordinator when there is unclear information to rule out exclusion criteria.

2.2 Measures

Demographic information. Participants completed demographic questions including age, gender identity, and ethnicity. Socioeconomic status is estimated from participants report the type of school attended, eligibility for free school meals, parental education, and employment. Participants also reported co-occurring mental and physical health conditions. Disclosure of co-occurring conditions were coded as “yes”, “no”, “unsure” and “prefer not to say”, and named conditions were tallied across each group.

Receptive One-Word Picture Vocabulary Test, 4th Edition *(ROWPVT-4, Martin & Brownell, 2010)* An individually administered task assessing how well the participant is able to match a spoken word (in English) to objects, actions or concepts presented in full-colour pictures using multiple choice questions. The

14–16-year-old version was used in the current study to assess and match participants' basic English comprehension between the autism and non-autism groups, and ROWPVT-4 has been used with autistic children and young people in previous research (Cascia & Barr, 2017).

Autism Quotient-28 *(AQ-28; Hoekstra et al., 2011)* A self-report 28-item questionnaire assessing autistic traits, abbreviated from the full Autism Quotient with good convergent validity (r = .94). Participants rate to what extent they agree with each of autistic traits from definitely agree (1) to definitely disagree (4) without timeframe. In the present sample, AQ-28 has good internal consistency for the total score (α = .82), as well as for Social Behaviour factor (α = 0.79) and Numbers/Patterns factor (α = 0.78). The AQ-28 has been previously used with autistic children and adolescents (Dewinter et al., 2017; Martini et al., 2023).

Social Phobia Inventory *(SPIN; Johnson et al., 2006)* A self-report 17-item questionnaire assessing symptoms of social anxiety. Participants rate how much they were bothered by each of the symptoms in the past week from not at all (0) to extremely (4). In the present sample, SPIN has good internal consistency for the total score (α = 0.92). In community adolescent samples, a cut-off score of 21 has good sensitivity (68.3%) and specificity (81.4%) (Johnson et al., 2006).

Mini-Social Phobia Inventory *(Mini-SPIN; Connor et al., 2001)* Initial screening for social anxiety in non-autism sample used the 3-item Mini-SPIN (timeframe is for last two weeks), where a cut-off score of 6 or greater has a sensitivity of 88.7% and specificity of 90% in detecting high levels of social anxiety symptoms.

Camouflaging Autistic Traits Questionnaire *(CAT-Q; Hull et al., 2019)* A self-report 25-item questionnaire assessing social camouflaging behaviour without timeframe, including subscales assessing masking, compensation and assimilation. Participants rate the extent to which they agree with each statement of a camouflaging behaviour on a scale of 1 (strongly disagree) to 7 (strongly agree). In the present sample, CAT-Q has good internal consistency for the total score (α = 0.92) and for the subscales (α = 0.80-0.91), comparable to those found in autistic and non-autistic adult community samples (total score (α = 0.94), subscales (α = 0.85-0.92). The CAT-Q has previously been used with autistic adolescents (Bernardin et al., 2021; Jorgenson et al., 2020).

Adolescent Social Behaviours Questionnaire *(ASBQ; Leigh et al., 2021)*A self-report 28-item questionnaire assessing safety behaviours without timeframe including avoidance and impression

management, adapted from the adult Social Behaviours Questionnaire. Participants rate the frequency in which they do each behaviour from 0 (never) to 3 (always). In the present sample, ASBQ has good internal consistency for the total score ($\alpha = 0.87$), as well as for the two subscales ($\alpha = 0.82$-0.84).

Adolescent Social Cognitions Questionnaire *(ASCQ; Leigh & Clark, 2021)* A self-report 28-item questionnaire assessing common social anxiety-related cognition in the past week, adapted from the adult Social Cognitions Questionnaire. Participants rate the frequency of experiencing each cognition when feeling socially anxious from 1 (never) to 5 (every time), and the extent to which they believe the thought to be true from 0 (not at all) to 100 (totally). ASCQ has good convergent validity with other measures of social anxiety ($r > 0.45$). In the present sample, ASCQ has good internal consistency ($\alpha = 0.95$).

Revised Children's Anxiety and Depression Scale – Depression and Generalised Anxiety subscale *(RCADS-Dep, RCADS-GAD; Baron et al., 2021)* A self-report routine outcome measure for participants to rate how often each statement applies to them from 0 (never) to 3 (always) without timeframe, with 10 items focused on symptoms associated with low mood and 6 items associated with generalised anxiety. RCADS has been used with autistic children and young people in previous research (Hallett et al., 2013). In the present sample, both low mood ($\alpha = 0.87$) and generalised anxiety ($\alpha = 0.87$) subscales have good internal consistency.

2.3 Procedure

The current study anticipated that young people in the autism group (with or without formal diagnosis of social anxiety disorder) may experience high levels of social anxiety, and therefore screened for non-autistic young people in attempt to match levels of social anxiety reported by young people in both groups. Screening was completed using the 3-item Mini-SPIN (Connor et al., 2001). At the point of initial contact, non-autistic young people or their parent/carer were asked to complete the Mini-SPIN with those scoring 6 or higher invited to take part in the full questionnaire session. Young people who met study eligibility criteria used a link to access the full questionnaire session hosted on Qualtrics, where they first read through the study information sheet, provided written assent (aged 14-15 years, with parents providing written consent) or consent (aged 16-19 years) depending on their age, before completing demographic information and questionnaires. At the end of the Qualtrics session, participants were taken to the one-word reading task

hosted on Gorilla, to assess their reading ability. Young people who successfully completed the full Qualtrics session were reimbursed £5 in gift vouchers to compensate for their time.

All procedures in the current study comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975 (revised in 2008) and those involving participants were approved by the London Brent Research Ethics Committee (21/LO/0750), IRAS project number 300879.

2.4 Analyses

Descriptive statistics and exploratory factor analyses were performed using SPSS v28, confirmatory factor analyses and path analyses were performed using the *lavaan* package in *R* (R Core Team 2013). All participants completed all questionnaires, with no missing data in the full complete dataset used for subsequent analyses. First, between-group differences in age, reading performance, social anxiety, autistic traits, social camouflaging, safety behaviours, and social anxiety-related cognitions were completed using independent samples t-test. Between-group differences in gender identity, ethnicity, parental education and employment, type of school attended, and eligibility for free school meal were evaluated using chi-squared tests.

Second, we conducted bivariate correlations independently in autism and non-autism groups to investigate the association between factors underlying social camouflaging and safety behaviours, and social anxiety related cognitions. We also completed partial correlations to control for severity of co-occurring symptoms of depression (RCADS-DEP) and generalised anxiety (RCADS-GAD), to examine the impact of co-occurring mental health difficulties on possible construct overlap between social camouflaging and safety behaviours in social anxiety. To control for multiple comparisons, Bonferroni corrections were applied such that only correlations with $p < .003$ remained statistically significant.

Third, a confirmatory factor analysis was conducted to explore to what extent factors identified from prior literature on CAT-Q and ASBQ can be replicated in the current sample of autistic and non-autistic adolescents. The rationale for testing factor measurement invariance for each questionnaire was to provide justification for combining both autism and non-autism groups for subsequent path analyses. To test for factor measurement invariance across the two groups for each measure, we compared the configural invariance model (where factor structure was equal across both groups) to the strict invariance model (where item

residuals were equal across the groups) to see whether there are overall differences in factor structure estimates across the two groups. Goodness of fit of each model were evaluated using Standardised Root Mean Square Residual (SRMR), the Root Mean Square Error of Approximation (RMSEA), and the Comparative Fit Index (CFI). Adequate fit was indicated by a SRMR value of less than 0.08, RMSEA value below 0.06, and CFI value of 0.90 or greater (Hu & Bentler, 1999). The two models were compared using Chi square likelihood ratio test of comparative model fit, using CFI and RMSEA. For all CFA analyses, we used Diagonally Weighted Least Square Means (DWLS) estimator.

Fourth, we collapsed the two groups into a single sample and used SEM to assess independent associations between social camouflaging behaviours and both autistic traits and social anxiety, as well as between safety behaviours and both autistic traits and social anxiety. We also conducted a second model by adding group as a covariate and regressed onto social camouflaging and safety behaviours, to explore whether the SEM structure would differ when accounting for group differences. We conducted a final model by adding social cognitions associated with social anxiety into the model, to assess to what social cognitions were also associated with autistic traits, social anxiety, and social camouflaging and safety behaviours. Full information maximum likelihood was used to fit raw data to the model. We note that although an adequate model fit would usually be indicated by a chi-square likelihood ratio test *p*-value $\geq$.05, CFI $\geq$ .90, and RMSEA $\leq$ .08 (Hu & Bentler, 1999), the combination of small sample size and reduced degrees of freedom will likely result in larger RMSEA that will falsely indicate a poor model fit (Kenny et al., 2015). We also report SRMR to provide standardised effect size of overall model misfit in addition to RMSEA, as SRMR is more appropriate for smaller samples (Maydeu-Olivares et al., 2018; Rosseel, 2020).

Finally, we completed a post-hoc exploratory analysis to identify possible construct overlap at the item level across ASBQ and CAT-Q. In the absence of factor structural variance across the two groups, we combined the two groups into a simple sample and conducted an exploratory factor analysis (EFA) to explore individual item loadings across different factors underlying ASBQ and CAT-Q, to see whether there were specific impression management or avoidance-based safety behaviours that overlap with masking, assimilation and compensation underlying social camouflaging. An oblique rotation (Oblimin) was used for EFA in anticipation of correlation amongst the extrapolated factors. Both scree plot and parallel analysis were

used to help determine the number of factors to extract from the EFA, with only items that had a loading 0.4 or greater on a single factor retained in each factor (Stevens, 2012).

3. Results

Participant demographic information and all outcome variables for each group can be found in Tables 1 and 2. Groups were matched on age (t (113) = 1.07, p = .29), reading ability (% correct trials) (t (94) = -.53, p = .60), gender identity (X^2 (5, 115) = 6.80, p = .24), ethnicity (X^2 (3, 115) = 4.14, p = .25), presence of mental health difficulties (X^2 (3, 115) = 3.81, p = .28), parental education (X^2 (2, 115) = 3.96, p = .14) and employment status (X^2 (2, 115) = 0.76, p = .68), and eligibility for free school meals (X^2 (2, 115) = 1.66, p = .44). Participants did differ on type of school attended (X^2 (6, 115) = 18.57, p < .01), with autistic young people more likely to be home-schooled or attending private school education compared to non-autistic young people. Autistic young people scored higher on autism traits (t(113) = 3.58, p <.001) and lower on masking behaviours (t(113) = -2.13, p = .03) compared to non-autistic young people. Both groups were matched on symptoms of social anxiety (p = .97), Assimilation (p = .40) and Compensation (p = .23) behaviours, social anxiety related safety behaviours (p = .30 to .75) and cognitions (p = .71), and symptoms of depression (p = .29) and generalised anxiety (p = .08).

Using self-report measures, non-autistic young people with elevated social anxiety scored higher on masking behaviours captured by CAT-Q than autistic young people, which is in line with previous studies in adolescent samples (Bernardin et al., 2021; Jorgenson et al., 2020). Both groups also scored more highly on the CAT-Q compared to the previous adolescent samples, and scores in the autistic adolescent group in particular is comparable to those found in autistic adults (Hull et al., 2019; see Table 3a). Elevated social anxiety symptoms reported in the autism group is somewhat comparable to those found in other autistic adolescent samples from non-clinical settings (Cooper et al., 2022; Lei & Russell, 2020; Wood et al., 2022; see Table 3b), though anxiety symptoms in non-autism group recruited from clinical sample is higher than those found in the community (Lei & Russell, 2020; Ranta et al., 2007; see Table 3b).

Table 1.

Participant demographic information.

	Autism (n = 61) (Mean, SD)	**Non-Autism (n = 54) (Mean, SD)**
Age (Years)	16.34 (1.69)	16.02 (1.56)
Reading task	**(n = 51)**	**(n = 45)**
% Correct	74.75	75.86
Gender	**(n, %)**	**(n, %)**
Male	17 (27.87)	11 (20.37)
Female	36 (59.02)	37 (68.52)
Gender variant/non-conforming	6 (9.84)	1 (1.85)
Other / Prefer not to say	2 (3.28)	3 (5.56)
Ethnicity		
White	50 (81.97)	37 (68.52)
Black	3 (4.92)	8 (14.81)
Asian	1 (1.64)	2 (3.70)
Mixed/Other	7 (11.48)	7 (12.96)
Education (school type)		
State school	35 (57.38)	48 (88.89)
Private school (bursary/scholarship)	8 (13.11)	1 (1.85)
Private school (full fees)	6 (9.84)	3 (5.56)
Home-schooled	8 (13.11)	1 (1.85)
Other/Prefer not to say	4 (6.56)	1 (1.85)
Eligible for free school meals	19 (31.15)	21 (38.89)
Parent education ≥1 parent with university degree or higher	40 (65.57)	26 (48.15)
Parent employment ≥ 1 parent in full-time employment	56 (91.80)	47 (87.04)
Co-occurring diagnosis	**(n, %)**	**(n, %)**
Any (≥1) mental health condition(s)	49 (80.33)	38 (70.37)
Any (≥1) physical health condition(s) diagnosis	17 (27.87)	8 (14.81)
Any (>1) co-occurring (either mental or physical) condition(s)	54 (88.52)	39 (72.22)
Mental Health Condition	**(n, %)**	**(n, %)**
ADHD	9 (14.75)	0 (0)
Generalised Anxiety Disorder	22 (36.07)	19 (35.19)
Social Anxiety Disorder	19 (31.15)	8 (14.81)
Obsessive Compulsive Disorder	21 (34.43)	15 (27.78)
Panic	1 (1.64)	1 (1.85)
Post-Traumatic Stress Disorder	2 (3.28)	4 (7.41)
Depression	17 (27.87)	13 (24.07)
Eating disorder	6 (9.84)	3 (5.56)
Physical Health Condition	**(n, %)**	**(n, %)**
Diabetes	1 (1.64)	0 (0)
Anaemia	1 (1.64)	0 (0)
Hypermobility	2 (3.28)	0 (0)
Chronic Pain	2 (3.28)	2 (3.70)
Chronic Fatigue Syndrome	1 (1.64)	0 (0)
Asthma	2 (3.28)	1 (1.85)
Hypothyroidism	1 (1.64)	1 (1.85)

Note. ADHD = Attention Deficit Hyperactivity Disorder

Table 2.

Participant characterisation using outcome measures.

	Autism (n = 61)		**Non-Autism (n = 54)**		***t* value *(df* = 113*)***
	Mean, SD	Range	Mean, SD	Range	
AQ28 Total	77.93 (10.23)	51 - 100	70.74 (11.28)	39 – 98	3.58***
Social Behaviours Total	69.07 (10.39)	41 - 94	62.35 (10.85)	36 – 88	3.39***
Numbers Patterns Total	13.26 (3.57)	5 - 20	12.24 (4.09)	5 – 20	1.43
SPIN Total	39.41 (14.40)	4 - 63	39.52 (14.12)	8 – 61	-0.041
CATQ Total	115.02 (29.65)	48 - 169	114.31 (24.06)	48 – 159	0.138
Compensation	37.75 (14.23)	11 – 63	34.69 (12.75)	9 – 60	1.21
Masking	37.26 (10.82)	8 – 54	41.02 (7.41)	19 – 54	-2.13*
Assimilation	40 (9.04)	12 - 56	38.61 (8.56)	9 – 53	0.84
ASBQ Total	41.41 (14.18)	6 – 75	42.98 (11.33)	11 – 63	-0.65
Avoidance	19.38 (7.34)	3 – 36	18.94 (6.84)	1 – 30	0.33
Impression Management	14.3 (5.66)	3 – 24	15.33 (4.85)	5 – 23	-1.04
ASCQ Total	94.54 (25.88)	30 – 129	92.74 (25.22)	29 – 125	.377
RCADS – Dep	18.54 (6.85)	4 – 30	17.17 (6.91)	1- 30	1.07
RCADS - GAD	10.67 (4.38)	1 - 18	12.11 (3.23)	2 - 18	-1.79

Note. AQ-28 = Autism Quotient 28; ASBQ = Adolescent Social Behaviour Questionnaire; ASCQ = Adolescent Social Cognition Questionnaire; CATQ = Camouflaging Autistic Traits Questionnaire; Dep = Depression; GAD = Generalised Anxiety Disorder; RCADS = Revised Children's Anxiety and Depression Scale; SPIN = Social Phobia Inventory. *$p < .05$; ***$p < .001$.

Table 3.

Comparison of scores from current study to previous studies in autistic and non-autistic samples:

a) CAT-Q Scores (Social Camouflaging) in adolescent and adult samples

	Autism				Non-Autism		
	Current study	Hull et al. (2019)	Hull et al. (2020)	Jorgenson et al. (2020) / Bernardin et al. (2021)[1]	Current study	Hull et al. (2019)	Jorgenson et al. (2020) / Bernardin et al. (2021)[1]
Sample size (n female)	61 (36)	200	58 (29)	78 (23)	54 (37)	202	62 (35)
Mean age (years)	16.34	~37.02[2]	14.48	15.03	16.02	~37.02[2]	15.31
Compensation (M)	37.75	39.78	35.29	33.60	34.69	26.01	32.92
Masking (M)	37.26	36.4	35.93	31.29	41.02	34.32	38.26
Assimilation (M)	40	42.32	33.82	33.56	38.61	34.4	26.21
CAT-Q Total (M)	115.02	119.75	105.03	99.46	114.31	87	98.39

Note. [1]Same participant sample from SPARK study. [2]Mean age for combined autism and non-autism sample in study. CAT-Q = Camouflaging Autistic Traits Questionnaire.

b) Social anxiety scores in adolescent samples

	Autism				Non-Autism		
	Current study – SPIN total	Wood et al. (2022) – SPIN total	Cooper et al. (2022) – SAS-A	Lei et al. (2021) – SAS-A	Current study – SPIN total	Ranta et al. (2007) – SPIN total	Lei et al. (2021) – SAS-A
Sample size (n female)	61 (36)	72 (32)	121 (36)	145 (43)	54 (37)	5252 (2658)	267 (213)
Mean age (years)	16.34	17.91	17.60	17.59	16.02	15.30	18.28
Social Anxiety (M; SD)	39.41 (14.40)	23.88 (13.44)	61.66 (13.93)	59.99 (13.97)	39.52 (14.12)	12.2 (8.70)	56.02 (11.94)

Note. SPIN = Social Phobia Inventory (range: 0-68; clinical cut-off score is 24); SAS-A = Social Anxiety Scale for Adolescents (range: 18-90; clinical cut-off score is 50). All comparative samples were recruited from general population and not from clinical services.

3.1 Bivariate and partial correlations between social camouflaging and safety behaviours

Results of all bivariate and partial correlations are shown in Table 4. Bivariate correlations showed that within the autism group, all factors within CAT-Q and ASBQ were significantly correlated within each measure and between the two measures, and all factors were also correlated with ASCQ. Within the non-autism group, all factors between CAT-Q, ASBQ and ASCQ were significantly positively correlated with each other, except for masking in CAT-Q, which only significantly correlated with impression management in ASBQ (r = .63).

When controlling for symptom severity of low mood, partial correlations showed that Impression Management was associated with Masking (r = .72 and .56 respectively) and Compensation (r = .61 and .56 respectively) in both autism and non-autism groups, but with Assimilation only in the autism group (r = .52). Avoidance was associated with Assimilation (r = .49 and .55 respectively) in both groups, but only with Compensation in the non-autism group (r = .46). ASCQ was only associated with Impression Management (r = .54 and .46) in both groups, though was also associated with Compensation (r = .43) and Assimilation (r = .47) in autism group, and Avoidance (r = .46) in the non-autism group.

When controlling for symptom severity in generalised anxiety, partial correlations showed that Impression Management was associated with all social camouflaging factors in both autism and non-autism groups (r = .41 to .69). Avoidance was associated with Assimilation in both autism and non-autism groups (r = .59 and .55 respectively), but with Compensation only in the non-autism group (r = .49). ASCQ was associated with Assimilation (r = .50 and .39 respectively) and Impression Management (r = .39 and .51 respectively) in both autism and non-autism groups, but with Compensation only in the non-autism group (r = .49).

Table 4.

Bivariate and partial correlations between social camouflaging, safety behaviours, and social cognitions in autism and non-autism groups.

a. Bivariate correlations

	Autism					Non-Autism				
	Mask	Assim	Av	IM	ASCQ	Mask	Assim	Av	IM	ASCQ
Compensation[1]	.76*	.56*	.49*	.71*	.59*	.64*	.56*	.53*	.63*	.49*
Masking[1]	-	.50*	.38*	.77*	.50*	-	.35	.21	.63*	.34
Assimilation[1]	-	-	.69*	.67*	.66*	-	-	.61*	.49*	.52*
Avoidance[2]	-	-	-	.61*	.63*	-	-	-	.40*	.56*
Impression M[2]	-	-	-	-	.69*	-	-	-	-	.61*
ASCQ	-	-	-	-	-	-	-	-	-	-

b. Partial correlations controlling for symptom severity of low mood

	Autism					Non-Autism				
	Mask	Assim	Av	IM	ASCQ	Mask	Assim	Av	IM	ASCQ
Compensation[1]	.71*	.41*	.26	.61*	.43*	.58*	.49*	.46*	.56*	.35
Masking[1]	-	.37	.16	.72*	.35	-	.25	.09	.56*	.12
Assimilation[1]	-	-	.49*	.52*	.47*	-	-	.55*	.39	.38
Avoidance[2]	-	-	-	.38*	.35	-	-	-	.29	.46*
Impression M[2]	-	-	-	-	.54*	-	-	-	-	.46*
ASCQ	-	-	-	-	-	-	-	-	-	-

c. Partial correlations controlling for symptom severity of generalised anxiety

	Autism					Non-Autism				
	Mask	Assim	Av	IM	ASCQ	Mask	Assim	Av	IM	ASCQ
Compensation[1]	.69*	.42*	.31	.58*	.36	.62*	.53*	.49*	.61*	.49*
Masking[1]	-	.35	.18	.69*	.23	-	.31*	.15	.61*	.29
Assimilation[1]	-	-	.59*	.53*	.50*	-	-	.55*	.41*	.39*
Avoidance[2]	-	-	-	.43*	.43*	-	-	-	.30*	.45*
Impression M[2]	-	-	-	-	.39*	-	-	-	-	.51*
ASCQ	-	-	-	-	-	-	-	-	-	-

Note. [1]CAT-Q = Camouflaging of Autistic Traits Questionnaire; [2]ASBQ = Adolescent Social Behaviour Questionnaire; ASCQ = Adolescent Social Cognitions Questionnaire; Assim = Assimilation; Av =

Avoidance; IM = Impression Management; Mask = Masking. Bonferroni corrections to control for multiple comparisons within each group: * $p < .003$.

3.2 Structural invariance of factors across autism and non-autism group

For CAT-Q, the configural model showed acceptable RMSEA (0.059, 90% confidence interval [CI]: 0.040, 0.076)), though CFI (0.865), TLI (0.851) and SRMR (0.104) did not meet the recommended threshold. The strict model showed acceptable RMSEA (0.053, 90% CI: 0.032, 0.070), though CFI (0.878), TLI (0.881) and SRMR (0.126) did not meet the recommended threshold. A chi-square likelihood ratio test suggested no significant differences in the fit parameters between the configural and strict invariance models (X^2 *diff* (69, 115) = 78.16, $p = .21$), indicating invariance in factor loadings across the two groups.

For ASBQ, the configural model showed poor model fit, as the RMSEA (0.064, 90% CI: 0.041, 0.083), SRMR (0.114), CFI (0.846) and TLI (0.828) did not meet threshold. Similarly, the strict model also showed poor model fit, as the RMSEA (0.062, 90% CI: 0.041, 0.08), SRMR (0.132), CFI (0.831) and TLI (0.836) did not meet threshold, suggesting the factor structure is not optimal. However, a chi-square likelihood ratio test suggested no difference in the fit parameters between the configural and strict invariance models (X^2 *diff* (59, 115) = 74.868, $p = .08$), and indicated invariance in factor loadings across the two groups.

3.3 Associations between autistic traits, social anxiety, social camouflaging, and safety behaviours

As group invariance in factor loadings has been demonstrated, both autism and non-autism groups were combined into one sample to treat autism traits and social anxiety symptom as lying on a continuum. We regressed participants' autistic traits and social anxiety symptom severity onto the three factors underlying social camouflaging (assimilation, masking, compensation) and the two factors underlying safety behaviours (avoidance and impression management). This analysis indicated inconsistent model fit (X^2 (1) = 23.61, $p < .001$; CFI = 0.95, RMSEA = 0.443 (90% CI: 0.30, 0.606), SRMR = 0.138 (90% CI: 0.08, 0.194)) (Figure 1a), and indicated that a greater degree of masking and impression management were associated with greater social anxiety symptoms only ($\beta = .277$, SE = 0.06, $p = .002$; $\beta = .447$, SE = 0.03, $p < .001$; respectively) and not autistic traits ($\beta = .044$, SE = 0.08, $p = .62$; $\beta = .125$, SE = 0.038, $p = .13$; respectively). In comparison, assimilation, compensation and avoidance were significantly associated with greater autism traits ($\beta = .44$, SE

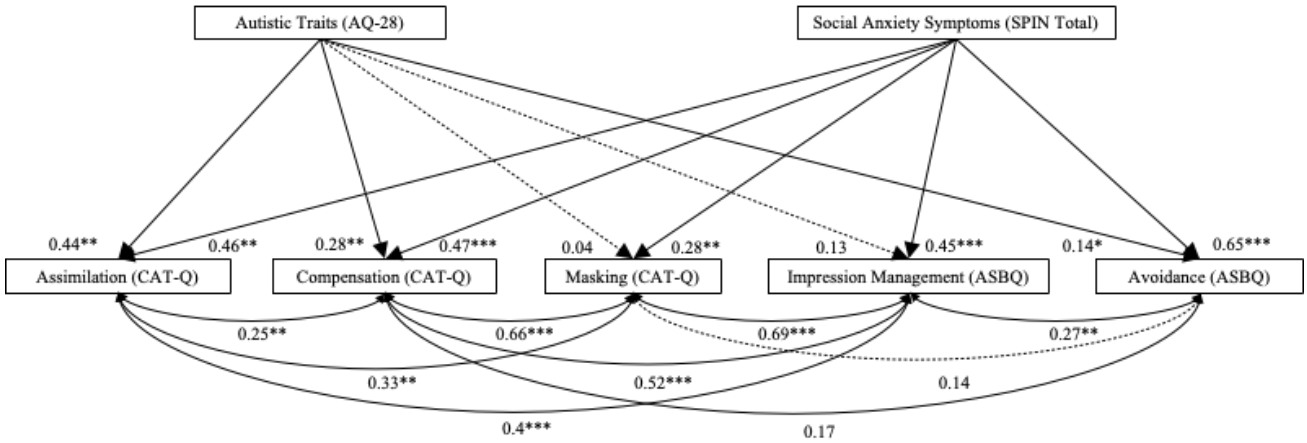
= 0.05, p <.001; β = .28, SE = 0.09, p <.001; β = .14, SE = 0.04, p = .041, respectively) and social anxiety (β = .47, SE = 0.04, p <.001; β = .47, SE = 0.07, p <.001; β = .65, SE = 0.03, p <.001, respectively).

Regressing group onto the dependent variables (Figure 1b), the overall model also showed inconsistent model fit (X^2 (3) = 39.19, p < .001; CFI = 0.92, RMSEA = 0.32 (90% CI: 0.238, 0.418), SRMR = 0.133 (90% CI: 0.08, 0.179)), and group had a significant effect on masking (β = .242, SE = 1.64, p = .005), as non-autism group had higher levels of masking than autism group. Patterns of associations between autism traits, social anxiety, social camouflaging, and safety behaviours remained the same as model shown in Figure 1a, with the only change being impression management is significantly associated with autism traits (β = .19, SE = 0.04, p = .021).

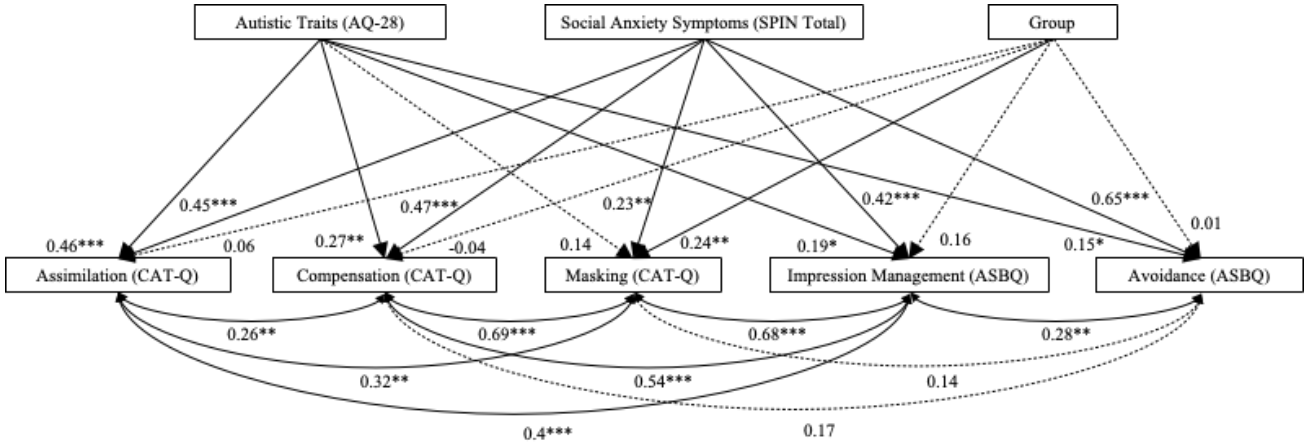
Adding social cognitions to the overall model (Figure 1c), the model also showed inadequate model fit (X^2 (1) = 23.61, p < .001; CFI = 0.958, RMSEA = 0.443 (90% CI: 0.30, 0.606), SRMR = 0.134 (90% CI: 0.08, 0.188)), and greater social anxiety related social cognitions was only associated with social anxiety symptom severity (β = .67, SE = 0.123, p < .001), and not autistic traits (β = .03, SE = 0.155, p = .661). Social anxiety related social cognitions also mediated the associations between social anxiety symptoms and masking (β = .40, SE = 0.04, p = .001) and impression management (β = .59, SE = 0.02, p <.001). Patterns of associations between autism traits, social anxiety, and assimilation, compensation and avoidance remained the same as shown in Figure 1a.

Figure 1.

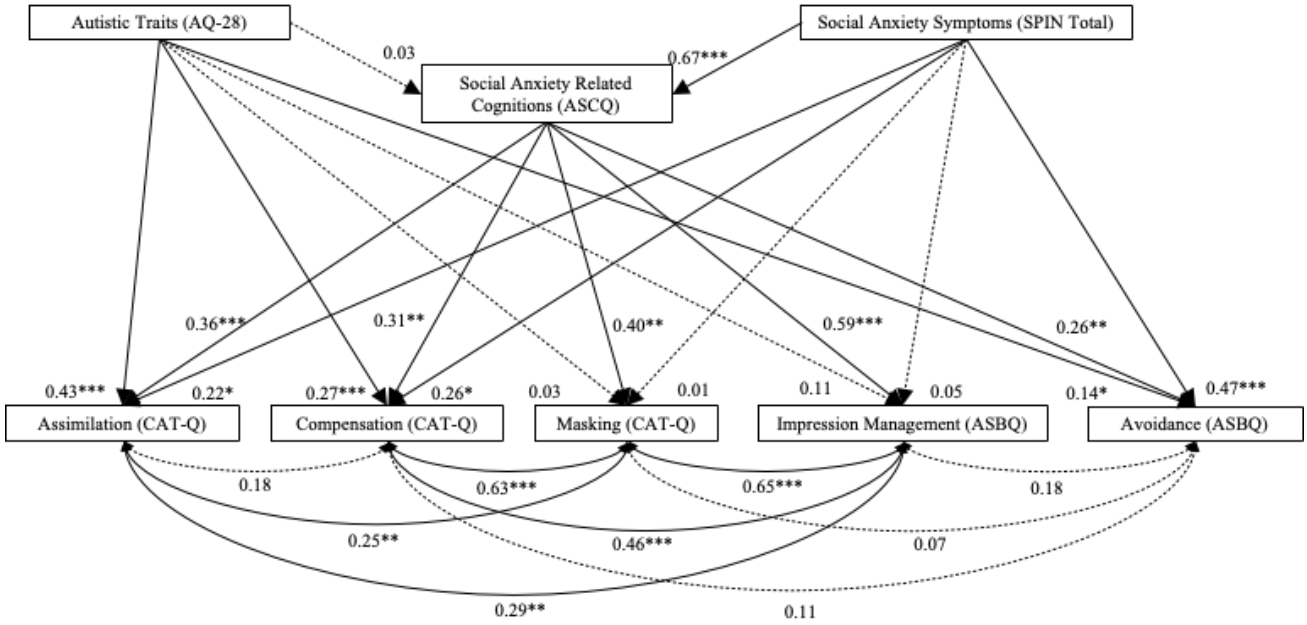
*Structural equation models showing independent associations between a) autistic traits, social anxiety symptoms, and social camouflaging and safety behaviours; b) when accounting for the effect of group on social camouflaging and safety behaviours; c) when accounting for individual differences in social cognition associated with social anxiety. Standardised coefficients and covariances are shown. * p < .05, ** p < .01, *** p < .001.*



a)



b)



c)

Note. AQ-28 = Autism Quotient-28; ASBQ = Adolescent Social Behaviour Questionnaire; ASCQ = Adolescent Social Cognitions Questionnaire; CAT-Q = Camouflaging Autistic Traits Questionnaire.

Given constraints in model fit parameters using SEM, we also completed a sensitivity analysis to examine associations between social camouflaging, safety behaviours and autism traits and social anxiety by conducting two sets of partial correlations (see Table 5). When controlling for social anxiety symptom severity, partial correlations show that autism traits is significantly associated with compensation (r = .289, p = .002) and assimilation only (r = .456, p < .001) but not masking, impression management or avoidance. When controlling for autism traits, partial correlations show that social anxiety symptom severity is significantly associated with all factors underlying social camouflaging and safety behaviours associated with social anxiety (r = .25 to .62, p < .01). This suggests that both masking from social camouflaging behaviours, as well as impression management and avoidance from safety behaviours, are all only associated with symptom severity of social anxiety, and not autism traits.

Table 5.

Partial correlations between social camouflaging, safety behaviours, social anxiety and autism traits across combined autism and non-autism groups.

a. Controlling for social anxiety symptom severity measured by SPIN

	Compensation	Masking	Assimilation	Impression Management	Avoidance
Autism Traits	.29**	.04	.46***	.13	.17
Compensation	-	.64***	.35***	.53***	.21*
Masking	-	-	.31***	.69***	.15
Assimilation	-	-	-	.41***	.42***
Impression Management	-	-	-	-	.29**
Avoidance	-	-	-	-	-

b. Controlling for autism traits measured by AQ-28

	Compensation	Masking	Assimilation	Impression Management	Avoidance
Social Anxiety	.45***	.25**	.48***	.42***	.62***
Compensation	-	.68***	.41***	.61***	.40***
Masking	-	-	.40***	.71***	.26**
Assimilation	-	-	-	.52***	.57***
Impression Management	-	-	-	-	.45***
Avoidance	-	-	-	-	-

Note. [1]CAT-Q = Camouflaging of Autistic Traits Questionnaire; [2]ASBQ = Adolescent Social Behaviour Questionnaire; AQ-28 = Autism Quotient-28; SPIN = Social Phobia Inventory. *** p < .001, ** p < .01, * p < .05.

Further exploratory analyses to examine gender-based effects looked at partial correlation results in individuals who self-identified as male (n = 28) and female (n = 73) across autism and non-autism groups (See Table 6). When controlling for social anxiety symptom severity, only assimilation showed significant association with autism traits in both males (r = .48, p = .01) and females (r = .50, p < .001). When controlling for autism traits, Compensation, Assimilation and Avoidance all showed significant associations with social anxiety symptom severity in both males and females (r = .24 to .79), though Masking and Impression Management only showed significant associations with social anxiety symptom severity in males (r = .49 to .70), and not in females. Using Fisher's Z test, only the correlation between Impression Management and Social Anxiety showed statistically significant difference between the two gender groups (z = 2.85, p = .004), and not Masking (z = 1.96, p = .05). This suggests that those who self-identified as male in the study, albeit a small sample, reported greater use of safety behaviours in the context of social anxiety symptom severity as opposed to autism traits when compared to those who identified as female.

Table 6.

Partial correlations between social camouflaging, safety behaviours, social anxiety and autism traits across self-identified males and females in both autism and non-autism groups.

a. Controlling for social anxiety symptom severity measured by SPIN

	Male (n = 28)					Female (n = 73)				
	Compensation	Masking	Assimilation	Impression Management	Avoidance	Compensation	Masking	Assimilation	Impression Management	Avoidance
Autism Traits	-.04	-.23	.48*	-.16	.18	.29*	.05	.50***	.16	.17
Compensation	-	.41*	-.03	.17	-.03	-	.66**	.50***	.59***	.31**
Masking	-	-	.27	.62***	.12	-	-	.33**	.70***	.17
Assimilation	-	-	-	.18	.55**	-	-	-	.47***	.37**
IM	-	-	-	-	.32	-	-	-	-	.29*
Avoidance	-	-	-	-	-	-	-	-	-	-

b. Controlling for autism traits measured by AQ-28

	Male (n = 28)					Female (n = 73)				
	Compensation	Masking	Assimilation	Impression Management	Avoidance	Compensation	Masking	Assimilation	Impression Management	Avoidance
Social Anx	.79***	.49*	.45*	.70***	70***	.24*	.08	.45***	.20	.57***
Compensation	-	.61***	.35	.63***	.54**	-	.67***	.48***	.59***	.35**
Masking	-	-	.57**	.72***	.45*	-	-	.35**	.70***	.18
Assimilation	-	-	-	.50**	.65***	-	-	-	.49***	.50***
IM	-	-	-	-	.67***	-	-	-	-	.34**
Avoidance	-	-	-	-	-	-	-	-	-	-

Note. [1]CAT-Q = Camouflaging of Autistic Traits Questionnaire; [2]ASBQ = Adolescent Social Behaviour Questionnaire; AQ-28 = Autism Quotient-28; IM = Impression Management; SPIN = Social Phobia Inventory. *** $p < .001$, ** $p < .01$, * $p < .05$.

3.4 Exploring construct overlap at individual item level between social camouflaging and safety behaviours

We explored potential construct overlap between items from the CAT-Q and ASBQ through exploratory factor analysis. Data was suitable for exploratory factor analysis as Kaiser-Meyer-Olkin measure of sampling adequacy (KMO = 0.834) and Bartlett's test of sphericity (X^2 (1035) = 3408.12, $p < .001$) both met threshold. Parallel analysis and inspection of the scree plot both indicated that four factors would be suitable for extraction and interpretation. The four-factor solution explained 49.84% of the variance, with the first factor explaining 30.61% of the variance, the second factor explaining 8.82%, the third factor explaining 5.80%, and the fourth factor explaining 4.60% of the variance. Standardised factor loadings are shown in Table 7. The four factors showed various degrees of correlation between 0.073 to 0.395, suggesting that there is some overlap across the underlying constructs, though they were not identical to each other. Factor 1 reflects 'self-focused attention', factor 2 reflects 'social avoidance', factor 3 reflects 'assimilation' and factor 4 reflects 'mental rehearsal'.

Table 7.
Exploratory Factor Analysis combining items from CAT-Q (Assimilation, Masking, Compensation) and items from ASBQ (Avoidance, Impression Management).

Scale	Subscale	Item	F1	F2	F3	F4
CATQ 15	Masking	I monitor my body language or facial expressions so that I appear interested by the person I am interacting with	**0.86**	-0.06	-0.03	0.105
CATQ 6	Masking	I adjust my body language or facial expressions so that I appear interested by the person I am interacting with	**0.85**	0.014	-0.07	-0.075
CATQ 2	Masking	I monitor my body language or facial expressions so that I appear relaxed	**0.77**	-0.004	0.047	-0.053
CATQ 21	Masking	I adjust my body language or facial expressions so that I appear relaxed	**0.738**	0.092	0.01	0.056
ASBQ 2	Impression Management	Make an effort to get your words right	**0.602**	-0.055	0.163	0.046
ASBQ 4	Avoidance	Avoid eye contact	-0.036	**0.71**	0.045	-0.009
CATQ 13	Assimilation	I have to force myself to interact with people when I am in social situations	0.018	**0.55**	0.104	0.027
CATQ 16	Assimilation	When in social situations, I try to find ways to avoid interacting with others	0.059	**0.493**	0.039	0.163
ASBQ 1	Avoidance	Try not to attract attention	0.027	**0.444**	0.113	0.209
CATQ 22*	Assimilation	When talking to other people, I feel like the conversation flows naturally*	-0.277	0.164	**0.698**	0.11
CATQ 19*	Assimilation	I feel free to be myself when I am with other people*	0.072	0.047	**0.675**	0.072
ASBQ 25	Impression Management	Try to fit in and 'act normal'	0.176	-0.149	**0.628**	-0.046
CATQ 25	Assimilation	In social situations, I feel like I am pretending to be 'normal'	0.203	0.203	**0.551**	0.032
CATQ 3*	Assimilation	I rarely feel the need to put on an act in order to get through a social situation*	0.106	-0.175	**0.518**	-0.117
ASBQ 13	Impression Management	Rehearse sentences in your mind	-0.088	0.023	0.036	**0.777**
ASBQ 14	Impression Management	Check what you are going to say	-0.053	0.006	-0.035	**0.731**
ASBQ 28	Impression Management	Planning things to talk about before a conversation	0.087	0.02	0.115	**0.611**
CATQ 4	Compensation	I have developed a script to follow in social situations (for example, a list of questions or topics of conversation)	0.179	0.167	0.344	**0.428**

Note. ASBQ = Adolescent Social Behaviour Questionnaire; CAT-Q = Camouflaging Autistic Traits Questionnaire; *item reverse scored. Items highlighted in bold have factor loadings ≥ 0.04.

4. Discussion

This is the first study to investigate construct overlap between safety behaviours associated with social anxiety and social camouflaging behaviours associated with autism in adolescents. The strong positive association between masking and impression management persisted over and above symptoms of low mood and GAD in both groups. The current study found that masking and impression management were not associated with autism traits but were significantly associated with social anxiety symptom severity in both groups. Exploratory analysis of gender-based effects in self-identified males and females across both groups also showed that the association between safety behaviours and social anxiety symptoms is greater in males than in females. With the caveat that sample sizes to explore potential sex-based differences based on self-identified gender in the current study is much smaller compared to the overall sample, this is the first study to suggest that potential differences in safety behaviours observed between males and females may be associated with differences in co-occurring social anxiety symptoms above and beyond that of autism traits.

The overlap between social camouflaging and impression management suggest that current standardised measures may not be able to distinguish underlying functions of observed behaviours, and the phenomenon of hiding one's social differences may not be unique to autistic adolescents in the context of their autism traits but apply to young people more generally in the context of social anxiety. Behavioural changes such as greater self-monitoring and impression management during adolescence may be associated with biological changes in the developing adolescent brain, which prioritises peer acceptance and approval and is very sensitive to the threat of rejection (Blakemore & Robbins, 2012; Foulkes & Blakemore, 2018).

Consistent with the Clark and Wells' (1995) social anxiety model, the current study found that the relationship between safety/masking behaviours and social anxiety is via a path through social anxiety related cognitions. Item-level breakdown of CAT-Q and ASBQ also indicate some construct overlap across masking, assimilation, impression management and avoidance, with items loading onto latent factors that resemble maintaining behavioural and cognitive factors identified in the Clark and Wells' (1995) model of social anxiety, such as self-focused attention, social avoidance and mental rehearsal. The finding that social anxiety related social cognitions were associated with social anxiety, masking, and impression management, also suggests that the self-monitoring involved in masking may be analogous to increased self-focused attention

that is core to processing of self as a social object in the cognitive model of social anxiety. Although masking under social camouflaging is conceptualised as "behaviours used to hide autistic characteristics or present a non-autistic personality" (Hull et al., 2019), in the context of heightened social anxiety during adolescence, the increase in self-focused attention may inadvertently also reinforce anxious thoughts (such as related to fear of negative evaluation and believing that oneself will act outside of social norm), and safety behaviours (further impression management and/or social avoidance) that maintain social anxiety over time.

Given that most young people in both groups were actively engaged with mental health services and are group-matched on social anxiety, individual differences in masking and impression management may be involved in hiding self-perceived social differences beyond those associated with autism diagnosis or autistic traits alone. Although previous cross-sectional studies measuring the association between CAT-Q and mental health difficulties in adolescents and adults have suggested that greater camouflaging behaviours is associated with burnout, exhaustion and poorer mental health outcomes (Beck et al., 2020; Bernardin et al., 2021; Hull et al., 2019, 2021; Hull, Lai, et al., 2020; Mandy, 2019), it is important to highlight that without longitudinal designs, the direction of causation between camouflaging and mental wellbeing cannot be determined.

The current finding that non-autism group scored higher on masking than autistic young people supports the issue of construct overlap between social anxiety and CAT-Q has been previously highlighted by Fombonne (2020), who stated that aspects of camouflaging such as masking and compensation may be conceptualised as coping strategies in social situations that are not unique to autism. In a response, Lai et al. (2021) also emphasised that social camouflaging is neither female specific nor should be considered a core aspect of autism, but to acknowledge that autistic people may express different levels of intent in camouflage, and do with varying degrees of success. Given that the majority of early work done in social camouflaging were completed in autistic adults (Hull et al., 2017, 2019, 2021), without explicitly collating measures on co-occurring mental health diagnosis or using clinical samples of autistic adults who may be currently experiencing mental health difficulties and accessing services, it is unclear to what extent self-report levels of camouflaging may be formulated as part of concurrent mental health difficulties.

Given that impression management behaviour has long been outlined as a key mechanism underlying self-presentation (Goffman, 1959), effective self-presentation also relies on self-other monitoring to collate information from the external environment to enable one to assess the success of impression management

behaviours and adjust accordingly in the social situation. In the context of safety behaviours in social anxiety (i.e., behaviours that one does in response to anxiety in social situations and to reduce fear of negative evaluation from others), one key difference is that the focus of attention is largely internal and on the self, such that behaviours may be driven by one's own belief that one is coming across badly in social situations, rather than relying on external feedback from others to check the facts of how one is really presenting oneself in the eyes of others. Impression management behaviours in such contexts do serve the function of improving self-presentation as they do not have a negative effect on social interactions compared to avoidance-based safety behaviours, though the reliance and dependence on such strategies in social situations may also serve to maintain social anxiety over time.

Given that masking and assimilation subscales of social camouflaging show construct overlap with impression management in safety behaviours, it may be that such behaviours are driven by internal focus of attention in social situations, in response to anxiety and to keep oneself safe from doing things that may increase negative evaluation from others. In contrast, the lack of association between compensation and impression management behaviours may suggest that such behaviours are more related to external focus of attention and monitoring the behaviour of others (e.g., "I deliberately copy their language or facial expressions", "I have tried to improve my understanding of social skills by watching other people"). As Ai and colleagues (2022) discussed, the presence of the double empathy problem in cross-neurotype coupling along with reduced tolerance of uncertainty (Jenkinson et al., 2020) in social situations might make impression management a far more cognitively effortful process for autistic individuals to engage in and may require greater monitoring of others through external focus of attention. The external focus of attention to monitor the environment and others may also reflect impression management behaviours in the general population beyond that of safety behaviours in the context of social anxiety.

This is one of the first studies to provide some psychometric validation for the use of CAT-Q in autistic and non-autistic adolescents, the degree of discrepancy in social camouflaging scale scores between the two groups is considerably smaller than previous studies in adults (Hull et al., 2019; Hull, Lai, et al., 2020). Given that adolescence is a developmental period marked by heightened awareness of peer acceptance/rejection and identity development (Blakemore & Robbins, 2012; Leigh & Clark, 2018), behaviours related to self-presentation in social contexts (both encapsulating camouflaging as well as

impression management behaviours) may be of particular importance to young people during this developmental stage to ensure they fit in with their peers, irrespective of autism diagnosis.

Finally, the current study also noted that when controlling for low mood, masking and assimilation were no longer significantly associated with each other in both groups, and that when controlling for generalised anxiety, masking was only significantly associated with assimilation in the non-autism group. In contrast, compensation remained significantly associated with both assimilation and masking in both groups when controlling for both low mood and generalised anxiety. This suggests that masking or hiding one's social differences may go beyond that of autism characteristics, but also extend to other emotion regulation difficulties such as low mood and anxiety in both adolescent groups. Previous research suggested that adolescents in secondary education are particularly prone to experiencing elevated distress from academic and social pressures, but also experience distress from hiding their emotional difficulties from others so to not come across as different (Flett et al., 2018). The hiding of one's psychological distress during adolescence has long been associated with increased risk of "flying under the radar" and not receiving adequate and timely support, which overtime can further negatively impact their self-esteem and ability to cope with external stressors (Elliott, 1982). The current study presents preliminary evidence to support the notion that masking one's true self may not be uniquely associated with autism specific differences during adolescence, but may reflect an exaggeration of the more commonly observed developmental phenomenon of choosing to present one's false self to gain social acceptance and validation from others during this turbulent time of change (Harter et al., 1996).

In contrast, assimilation showed overlap with both avoidance and impression management aspects of safety behaviours, suggesting that the construct may also be capturing a broad range of behaviours with potentially different underlying motives of escape and 'acting normal', both of which may be affected by low motivation associated with low mood. Given the cross-sectional nature of this study, it is not possible to determine the direction of causation between camouflaging behaviours, low mood, and generalised anxiety during adolescence, and future studies will need to adopt a longitudinal design to further partition whether mood and anxiety may enhance the masking and assimilation discrepancy, or whether greater social camouflaging behaviours contribute towards worsening of mental health.

4.1 Strengths, Limitations, and Future Directions

A major strength of this paper is in using a well-matched and largely clinical sample of autistic and non-autistic adolescents, with comparable levels of social anxiety symptom severity. However, this study has several limitations to consider when interpreting findings. First, the sample size of the study is modest. In addition, given that the majority from both young people groups were recruited from clinical samples in Child and Adolescent Mental Health Services in the UK, the degree of co-occurring mental and physical health conditions alongside autism traits and symptoms in both groups is particularly striking. As the non-autism group in the current sample is defined as the young person not having a clinical diagnosis of autism at the point of participating in the research study, it is possible that there may be some young people in this group who may meet diagnosis of autism if assessed clinically by professionals, given the high degree of autism traits noted at the group level.

However, a novelty in the design of the current study is to match both groups on social anxiety symptom severity, and it can be argued that the standardised assessment measures for social anxiety (SPIN) and autism traits (AQ-28) may also show construct overlap when there is high degree of social anxiety present, and the young person may conflate some of the behaviours reported across both questionnaires, resulting in higher scores on both measures using self-reports (S. W. White et al., 2012). In particular, given the high degree of construct overlap across masking subscale of the camouflaging measure and impression management subscale of the safety behaviour measure, it is possible that at the item level – young people in the non-autism group who also experienced high levels of social anxiety reported greater self-monitoring due to increased internal focus of attention (e.g., "I monitor my body language or facial expressions so that I appear interested by the person I am interacting with" (CAT-Q, Masking), and "Try to stay in control of your behaviour" (ASBQ, Impression Management). At high levels of social anxiety, it may be possible that behaviours underlying impression management and masking may look increasingly similar, and young people may not be able to disentangle such behaviours between social anxiety and autism traits when using self-report measures.

Clinically, it would be helpful for future studies to ask clinicians to consider using observer ratings and clinician ratings to triangulate anxiety and autism trait reports across individuals and contexts, to try and disentangle potential symptom overlap and reduce possible diagnostic overshadowing. Given that our main

analyses were conducted across the entire sample (i.e., collapsing both the autism and non-autism group into a single sample), we treated both autism traits and social anxiety symptom severity as lying on a continuum when exploring the associations between social camouflaging behaviours and impression management behaviours, rather than by diagnostic group. By having a comparison group that also showed similar profile of complexity in clinical presentation that was matched by social anxiety symptom severity, we are more interested in the impact of differences in autism traits between the groups that may have an impact on social camouflaging differences when controlling for social anxiety symptom severity. Therefore, the generalisability of the patterns of results may not be limited by autism diagnosis per se, but rather extend to young people with higher levels of autism and social anxiety traits. Future studies may benefit from having a control sample of adolescents with low levels of social anxiety without autism following formal assessment to further compare similarities and differences in social camouflaging and safety behaviours. Using a larger and more diverse sample of adolescents across all three groups will allow future studies to examine possible interaction effects with social identity characteristics such as race, sex assigned at birth and gender identity, as well as explore whether social camouflaging and impression management behaviours may be related to other sociodemographic characteristics beyond autism and social anxiety symptomatology.

The current study also did not have information on age of autism diagnosis for the autism group, and recent studies have suggested that the perceived need to camouflage may be associated with age at autism diagnosis, such that the prolonged autism diagnostic process for many autistic females might increase their self-awareness of autism traits and use of camouflaging to manage social communication differences in social situations (Begeer et al., 2013; Milner et al., 2022). Furthermore, like previous literature in social camouflaging, the current study is cross-sectional in nature, and future studies that adopt a longitudinal design may also consider the impact that age of autism diagnosis may have on children's development over the course of adolescence. Longitudinal studies can offer further insight into the direction of causality between social camouflaging, safety behaviours, and social anxiety among autistic and non-autistic youths, whilst accounting for potential interaction between age at diagnosis and sex-based differences in autism presentation across development. Future studies might also wish to take a developmental perspective by comparing CAT-Q scores across younger children, adolescents, and adults, to further explore changes in social camouflaging behaviours over time.

The current study was limited to measuring social camouflaging using self-report measures and did not use the behaviour-cognition discrepancy approach by identifying mismatch between observable social behaviours and underlying social cognitions (Milner et al., 2022). Studies may wish to employ both methods to evaluate effectiveness of young people's safety and social camouflaging behaviours in social situations and explore whether there may be between-group differences in observer ratings on how each group performs when accounting for social anxiety and autistic traits. Finally, the current study also did not randomise the order of administration of questionnaires across participants. We prioritised the collection of autism traits, social anxiety, camouflaging, and safety behaviour measures first. CAT-Q questions used an ascending scale, and ASBQ used a mixture of ascending and descending scales, both to reduce potential left-side selection bias or primacy effect as part of response-order effects when completing written questionnaires (Chyung et al., 2018). Young people were also given the option to take two breaks during the session to reduce fatigue. To further reduce response-order effects, future studies may wish to randomise the order of questionnaires in the session, as well as randomise ascending and descending scales across items in different questionnaires.

4.2 Clinical implications

Using a group-matched design, the current study suggests that characterising all camouflaging behaviours as being related to autism traits may overshadow how some of these behaviours may be better accounted for by co-occurring social anxiety and other mental health difficulties during assessment and formulation. Therefore, it is important for clinicians working with autistic adolescents, as well as highly socially anxious adolescents who may have elevated levels of autism traits, to formulate associated behaviours and cognitions from both social camouflaging and safety behaviours perspective. The current study raises the possibility that "masking" as a construct defined in CAT-Q may be a perpetuating factor in maintaining social anxiety amongst adolescents with and without autism diagnosis. Including the young person in formulating social camouflaging and safety behaviours in relation to autism traits and social anxiety symptoms may help clinicians strike a balance between autism psychoeducation and supporting the young person to drop safety behaviours in cognitive therapy for social anxiety during treatment planning.

In the context of social anxiety, literature in neurotypical adolescents have shown that although impression management maintains social anxiety over time, it is not associated with additional negative effects on social interaction when compared to avoidance behaviours (Evans et al., 2021; Gray et al., 2019).

However, as literature suggests that increased social camouflaging behaviours is associated with poorer mental health in autistic young people and adults (Bernardin et al., 2021; Hull et al., 2021), it is interesting for clinicians to carefully assess and formulate with the young person the short and long-term pros and cons of camouflaging versus social avoidance in relation to social anxiety and autism traits, so to avoid any potential increases in increasing negative effects on social interactions were young people to reduce social camouflaging and/or impression management behaviours.

The overlap between masking and impression management is particularly important for clinicians to note when considering adapting cognitive therapy for social anxiety for autistic young people, and young people with high levels of autism traits. Given that cognitive therapy for social anxiety assumes that individuals do not have underlying social skill differences when asked to drop safety behaviours, autistic individuals asked to drop social anxiety-related safety behaviours may still use social camouflaging to hide their social skill difficulties, and therefore does not let one's true authentic self be revealed. Moreover, given that socially anxious individuals who engage in impression management as their safety behaviours may be less vulnerable to experiencing peer victimisation and better friendship quality than those who engage in avoidance (Evans et al., 2021; Plasencia et al., 2011), it is important to consider how to help autistic individuals understand how the potential short-term benefits associated with masking may be outweighed by potential maintenance of social anxiety in the long-term.

It is important to note that the current findings are preliminary in highlighting those standardised measures of social behaviours, whether camouflaging or safety behaviours, do not allude to the underlying reason or intent of why that individual has chosen to engage in that specific behaviour. Formulating with the young person (and possibly with family) to develop a person-centred understanding of the reasons behind different types of impression management behaviours, may help both parties develop a profile of behaviours that may be perpetuating co-occurring mental health difficulties over time. The underlying consistent message behind impression management is the fundamental worry of how others may perceive oneself if one's authentic self was to be shown (Goffman, 1959, 1968), especially if aspects of one's identity is associated with social stigma in mainstream society. Clinical interventions may consider using psychoeducation to help young people conceptualise behaviours both from social camouflaging and safety behaviours perspective to understand how they may perpetuate mental health difficulties over time. Promoting self-knowledge and

reflection of the intersection between one's autism and mental health difficulties can raise young people's conscious awareness of what their 'mask' looks like when compared to core parts of self-identity in order to make informed decisions about whether or not to 'unmask' (Pearson & Rose, 2021). By adopting a strength-based approach to build a more positive autism identity (Cooper et al., 2017, 2022), it is important to support autistic young people to develop more self-compassion towards their differences in both individual and group-based interventions where social acceptance of neurodiversity can be modelled (Bernardin et al., 2021; Chapman et al., 2022).

Finally, it is important to consider wider systemic changes and the need for professionals to actively advocate to reduce autism-related stigma in society, given that social camouflaging and impression management behaviours may both be responses to manage and reduce experiences of stigma for those with elevated autism traits and social communication differences (Perry et al., 2022). Although previous studies in university student samples have found that disclosure of autism diagnosis is associated with reduced negative affective response towards autism associated behaviours from non-autistic peers (Brosnan & Mills, 2016), diagnosis disclosure did not change younger non-autistic adolescents' (11-16 year olds) attitude towards wanting greater social and emotional distance from autistic peers (R. White et al., 2020). Although autism diagnosis disclosure in secondary schools led non-autistic peers to externalise any social communication differences to be perceived as part of a 'medical illness' instead of blaming autistic peers to be personally responsible for their behaviours, the reduction of blame was not directly mirrored by increase in empathy and inclusivity of autistic peers in social interactions (R. White et al., 2020). Considering that social acceptance and fear of peer rejection is a pivotal part of adolescence, the need for professionals to simultaneously reduce stigma associated with autism and to actively promote acceptance and inclusivity of autistic young people by non-autistic peers may play a pivotal role to reduce environmentally induced demands for young people to socially camouflaging or manage their impressions in social situations.

5. References

Ai, W., Cunningham, W. A., & Lai, M.-C. (2022). Reconsidering autistic 'camouflaging' as transactional impression management. *Trends in Cognitive Sciences*, *26*(8), 631–645. https://doi.org/10.1016/j.tics.2022.05.002

American Psychiatric Association. (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM-5®)*. American Psychiatric Pub.

Baron, I., Hurn, R., Adlington, R., Maguire, E., & Shapiro, L. (2021). *Revised Children's Anxiety and Depression Scale (RCADS): Psychometric Properties in a Clinical Sample in the United Kingdom*. http://uhra.herts.ac.uk/handle/2299/25861

Beck, J. S., Lundwall, R. A., Gabrielsen, T., Cox, J. C., & South, M. (2020). Looking good but feeling bad: "Camouflaging" behaviors and mental health in women with autistic traits. *Autism*, *24*(4), 809–821. https://doi.org/10.1177/1362361320912147

Begeer, S., Mandell, D., Wijnker-Holmes, B., Venderbosch, S., Rem, D., Stekelenburg, F., & Koot, H. M. (2013). Sex Differences in the Timing of Identification Among Children and Adults with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, *43*(5), 1151–1156. https://doi.org/10.1007/s10803-012-1656-z

Bellini, S. (2006). The Development of Social Anxiety in Adolescents With Autism Spectrum Disorders. *Focus on Autism and Other Developmental Disabilities*, *21*(3), 138–145. https://doi.org/10.1177/10883576060210030201

Bernardin, C. J., Lewis, T., Bell, D., & Kanne, S. (2021). Associations between social camouflaging and internalizing symptoms in autistic and non-autistic adolescents. *Autism*, *25*(6), 1580–1591. https://doi.org/10.1177/1362361321997284

Blakemore, S.-J., & Robbins, T. W. (2012). Decision-making in the adolescent brain. *Nature Neuroscience*, *15*(9), 1184–1191. https://doi.org/10.1038/nn.3177

Brosnan, M., & Mills, E. (2016). The effect of diagnostic labels on the affective responses of college students towards peers with 'Asperger's Syndrome' and 'Autism Spectrum Disorder'. *Autism*, *20*(4), 388–394. https://doi.org/10.1177/1362361315586721

Cage, E., & Troxell-Whitman, Z. (2019). Understanding the Reasons, Contexts and Costs of Camouflaging for Autistic Adults. *Journal of Autism and Developmental Disorders*, *49*(5), 1899–1911. https://doi.org/10.1007/s10803-018-03878-x

Cascia, J., & Barr, J. J. (2017). Associations Among Vocabulary, Executive Function Skills and Empathy in Individuals with Autism Spectrum Disorder. *Journal of Applied Research in Intellectual Disabilities*, *30*(4), 627–637. https://doi.org/10.1111/jar.12257

Centers for Disease Control and Prevention. (2019, April 5). *Data and Statistics on Autism Spectrum Disorder | CDC*. Centers for Disease Control and Prevention. https://www.cdc.gov/ncbddd/autism/data.html

Chapman, L., Rose, K., Hull, L., & Mandy, W. (2022). "I want to fit in… but I don't want to change myself fundamentally": A qualitative exploration of the relationship between masking and mental health for autistic teenagers. *Research in Autism Spectrum Disorders*, *99*, 102069. https://doi.org/10.1016/j.rasd.2022.102069

Chyung, S. Y. (Yonnie), Kennedy, M., & Campbell, I. (2018). Evidence-Based Survey Design: The Use of Ascending or Descending Order of Likert-Type Response Options. *Performance Improvement*, *57*(9), 9–16. https://doi.org/10.1002/pfi.21800

Clark, D. M., & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg, M. R. Liebowitz, D. A. Hope, & F. R. Schneier (Eds.), *Social phobia: Diagnosis, assessment, and treatment* (pp. 69–93). The Guilford Press.

Connor, K. M., Kobak, K. A., Churchill, L. E., Katzelnick, D., & Davidson, J. R. T. (2001). Mini-SPIN: A brief screening assessment for generalized social anxiety disorder. *Depression and Anxiety*, *14*(2), 137–140. https://doi.org/10.1002/da.1055

Cooper, K., Russell, A., Lei, J., & Smith, L. G. E. (2022). The impact of a positive autism identity and autistic community solidarity on social anxiety and mental health in autistic young people. *Autism*. https://doi.org/10.1177/13623613221118351

Cooper, K., Smith, L. G. E., & Russell, A. (2017). Social identity, self-esteem, and mental health in autism. *European Journal of Social Psychology*, *47*(7), 844–854. https://doi.org/10.1002/ejsp.2297

Dewinter, J., De Graaf, H., & Begeer, S. (2017). Sexual Orientation, Gender Identity, and Romantic Relationships in Adolescents and Adults with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*, *47*(9), 2927–2934. https://doi.org/10.1007/s10803-017-3199-9

Elliott, G. C. (1982). Self-esteem and self-presentation among the young as a function of age and gender. *Journal of Youth and Adolescence*, *11*(2), 135–153. https://doi.org/10.1007/BF01834709

Evans, R., Chiu, K., Clark, D. M., Waite, P., & Leigh, E. (2021). Safety behaviours in social anxiety: An examination across adolescence. *Behaviour Research and Therapy*, *144*, 103931. https://doi.org/10.1016/j.brat.2021.103931

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

Flett, G. L., Hewitt, P. L., Nepon, T., & Zaki-Azat, J. N. (2018). Children and Adolescents "Flying Under the Radar": Understanding, Assessing, and Addressing Hidden Distress Among Students. In A. W. Leschied, D. H. Saklofske, & G. L. Flett (Eds.), *Handbook of School-Based Mental Health Promotion: An Evidence-Informed Framework for Implementation* (pp. 357–381). Springer International Publishing. https://doi.org/10.1007/978-3-319-89842-1_19

Fombonne, E. (2020). Camouflage and autism. *Journal of Child Psychology and Psychiatry*, *61*(7), 735–738. https://doi.org/10.1111/jcpp.13296

Foulkes, L., & Blakemore, S.-J. (2018). Studying individual differences in human adolescent brain development. *Nature Neuroscience*, *21*(3), Article 3. https://doi.org/10.1038/s41593-018-0078-4

Gino, F., Sezer, O., & Huang, L. (2020). To be or not to be your authentic self? Catering to others' preferences hinders performance. *Organizational Behavior and Human Decision Processes*, *158*, 83–100. https://doi.org/10.1016/j.obhdp.2020.01.003

Goffman, E. (1959). *The Presentation of Self in Everyday Life*. Penguin Group.

Goffman, E. (1968). *Stigma—Notes on the Management of Spoiled Identity*. Peguin Group.

Gray, E., Beierl, E. T., & Clark, D. M. (2019). Sub-types of safety behaviours and their effects on social anxiety disorder. *PLOS ONE*, *14*(10), e0223165. https://doi.org/10.1371/journal.pone.0223165

Hallett, V., Ronald, A., Colvert, E., Ames, C., Woodhouse, E., Lietz, S., Garnett, T., Gillan, N., Rijsdijk, F., Scahill, L., Bolton, P., & Happé, F. (2013). Exploring anxiety symptoms in a large-scale twin study of children with autism spectrum disorders, their co-twins and controls. *Journal of Child Psychology and Psychiatry*, *54*(11), 1176–1185. https://doi.org/10.1111/jcpp.12068

Harter, S., Marold, D. B., Whitesell, N. R., & Cobbs, G. (1996). A model of the effects of perceived parent and peer support on adolescent false self behavior. *Child Development*, *67*(2), 360–374.

Hoekstra, R. A., Vinkhuyzen, A. A. E., Wheelwright, S., Bartels, M., Boomsma, D. I., Baron-Cohen, S., Posthuma, D., & van der Sluis, S. (2011). The construction and validation of an abridged version of the autism-spectrum quotient (AQ-Short). *Journal of Autism and Developmental Disorders*, *41*(5), 589–596. https://doi.org/10.1007/s10803-010-1073-0

Hollocks, M. J., Leno, V. C., Chandler, S., White, P., Yorke, I., Charman, T., Pickles, A., Baird, G., & Simonoff, E. (2022). Psychiatric conditions in autistic adolescents: Longitudinal stability from childhood and associated risk factors. *European Child & Adolescent Psychiatry*. https://doi.org/10.1007/s00787-022-02065-9

Hollocks, M. J., Pickles, A., Howlin, P., & Simonoff, E. (2016). Dual Cognitive and Biological Correlates of Anxiety in Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, *46*(10), 3295–3307. https://doi.org/10.1007/s10803-016-2878-2

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*, 1–55. https://doi.org/10.1080/10705519909540118

Hull, L., Lai, M.-C., Baron-Cohen, S., Allison, C., Smith, P., Petrides, K., & Mandy, W. (2020). Gender differences in self-reported camouflaging in autistic and non-autistic adults. *Autism*, *24*(2), 352–363. https://doi.org/10.1177/1362361319864804

Hull, L., Levy, L., Lai, M.-C., Petrides, K. V., Baron-Cohen, S., Allison, C., Smith, P., & Mandy, W. (2021). Is social camouflaging associated with anxiety and depression in autistic adults? *Molecular Autism*, *12*(1), 13. https://doi.org/10.1186/s13229-021-00421-1

Hull, L., Mandy, W., Lai, M.-C., Baron-Cohen, S., Allison, C., Smith, P., & Petrides, K. V. (2019). Development and Validation of the Camouflaging Autistic Traits Questionnaire (CAT-Q). *Journal of Autism and Developmental Disorders*, *49*(3), 819–833. https://doi.org/10.1007/s10803-018-3792-6

Hull, L., Petrides, K. V., Allison, C., Smith, P., Baron-Cohen, S., Lai, M.-C., & Mandy, W. (2017). "Putting on My Best Normal": Social Camouflaging in Adults with Autism Spectrum Conditions. *Journal of Autism and Developmental Disorders*, *47*(8), 2519–2534. https://doi.org/10.1007/s10803-017-3166-5

Hull, L., Petrides, K. V., & Mandy, W. (2020). The Female Autism Phenotype and Camouflaging: A Narrative Review. *Review Journal of Autism and Developmental Disorders*, *7*(4), 306–317. https://doi.org/10.1007/s40489-020-00197-9

Ingul, J. M., Aune, T., & Nordahl, H. M. (2014). A randomized controlled trial of individual cognitive therapy, group cognitive behaviour therapy and attentional placebo for adolescent social phobia. *Psychotherapy and Psychosomatics*, *83*(1), 54–61. https://doi.org/10.1159/000354672

Izgiç, F., Akyüz, G., Doğan, O., & Kuğu, N. (2004). Social phobia among university students and its relation to self-esteem and body image. *Canadian Journal of Psychiatry. Revue Canadienne De Psychiatrie*, *49*(9), 630–634. https://doi.org/10.1177/070674370404900910

Jenkinson, R., Milne, E., & Thompson, A. (2020). The relationship between intolerance of uncertainty and anxiety in autism: A systematic literature review and meta-analysis. *Autism: The International Journal of Research and Practice*, *24*(8), 1933–1944. https://doi.org/10.1177/1362361320932437

Johnson, H. S., Inderbitzen-Nolan, H. M., & Anderson, E. R. (2006). The Social Phobia Inventory: Validity and reliability in an adolescent community sample. *Psychological Assessment*, *18*(3), 269–277. https://doi.org/10.1037/1040-3590.18.3.269

Jorgenson, C., Lewis, T., Rose, C., & Kanne, S. (2020). Social Camouflaging in Autistic and Neurotypical Adolescents: A Pilot Study of Differences by Sex and Diagnosis. *Journal of Autism and Developmental Disorders*, *50*(12), 4344–4355. https://doi.org/10.1007/s10803-020-04491-7

Kenny, D. A., Kaniskan, B., & McCoach, D. B. (2015). The Performance of RMSEA in Models With Small Degrees of Freedom. *Sociological Methods & Research*, *44*(3), 486–507. https://doi.org/10.1177/0049124114543236

Kessler, R. C., Petukhova, M., Sampson, N. A., Zaslavsky, A. M., & Wittchen, H. (2012). Twelve-month and lifetime prevalence and lifetime morbid risk of anxiety and mood disorders in the United States. *International Journal of Methods in Psychiatric Research, 21*(3), 169–184. https://doi.org/10.1002/mpr.1359

Kuusikko, S., Pollock-Wurman, R., Jussila, K., Carter, A. S., Mattila, M.-L., Ebeling, H., Pauls, D. L., & Moilanen, I. (2008). Social Anxiety in High-functioning Children and Adolescents with Autism and Asperger Syndrome. *Journal of Autism and Developmental Disorders*, *38*(9), 1697–1709. https://doi.org/10.1007/s10803-008-0555-9

Lai, M.-C., Hull, L., Mandy, W., Chakrabarti, B., Nordahl, C. W., Lombardo, M. V., Ameis, S. H., Szatmari, P., Baron-Cohen, S., Happé, F., & Livingston, L. A. (2021). Commentary: 'Camouflaging' in autistic people – reflection on Fombonne (2020). *Journal of Child Psychology and Psychiatry*, *62*(8). https://doi.org/10.1111/jcpp.13344

Lai, M.-C., Kassee, C., Besney, R., Bonato, S., Hull, L., Mandy, W., Szatmari, P., & Ameis, S. H. (2019). Prevalence of co-occurring mental health diagnoses in the autism population: A systematic review and meta-analysis. *The Lancet Psychiatry*, *6*(10), 819–829. https://doi.org/10.1016/S2215-0366(19)30289-5

Lei, J., & Russell, A. (2020). I Have a Fear of Negative Evaluation, Get Me Out of Here! Examining Latent Constructs of Social Anxiety and Autistic Traits in Neurotypical and Autistic Young People. *Journal of Autism and Developmental Disorders*. https://doi.org/10.1007/s10803-020-04657-3

Leigh, E., Chiu, K., & Clark, D. M. (2021). Self-focused attention and safety behaviours maintain social anxiety in adolescents: An experimental study. *PLOS ONE, 16*(2), e0247703. https://doi.org/10.1371/journal.pone.0247703

Leigh, E., & Clark, D. M. (2018). Understanding Social Anxiety Disorder in Adolescents and Improving Treatment Outcomes: Applying the Cognitive Model of Clark and Wells (1995). *Clinical Child and Family Psychology Review*, *21*(3), 388–414. https://doi.org/10.1007/s10567-018-0258-5

Leigh, E., & Clark, D. M. (2021). Development and Preliminary Validation of the Child & Adolescent Social Cognitions Questionnaire. *Child Psychiatry & Human Development*. https://doi.org/10.1007/s10578-021-01163-0

Livingston, L. A., Colvert, E., Social Relationships Study Team, Bolton, P., & Happé, F. (2019). Good social skills despite poor theory of mind: Exploring compensation in autism spectrum disorder. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *60*(1), 102–110. https://doi.org/10.1111/jcpp.12886

Livingston, L. A., Shah, P., & Happé, F. (2019). Compensatory strategies below the behavioural surface in autism: A qualitative study. *The Lancet Psychiatry*, *6*(9), 766–777. https://doi.org/10.1016/S2215-0366(19)30224-X

Mandy, W. (2019). Social camouflaging in autism: Is it time to lose the mask? *Autism*, *23*(8), 1879–1881. https://doi.org/10.1177/1362361319878559

Martin, N. A., & Brownell, R. (2010). *ROWPVT4 Receptive OneWord Picture Vocabulary TestFourth Edition*. https://www.proedinc.com/Products/13688/rowpvt4-receptive-oneword-picture-vocabulary-testfourth-edition.aspx

Martini, M. I., Merkelbach, I., & Begeer, S. (2023). Gestational Age in Autistic Children and Adolescents: Prevalence and Effects on Autism Phenotype. *Journal of Autism and Developmental Disorders*, *53*(5), 1906–1914. https://doi.org/10.1007/s10803-022-05466-6

Maydeu-Olivares, A., Shi, D., & Rosseel, Y. (2018). Assessing Fit in Structural Equation Models: A Monte-Carlo Evaluation of RMSEA Versus SRMR Confidence Intervals and Tests of Close Fit. *Structural Equation Modeling: A Multidisciplinary Journal*, *25*(3), 389–402. https://doi.org/10.1080/10705511.2017.1389611

Milner, V., Colvert, E., Mandy, W., & Happé, F. (2022). A comparison of self-report and discrepancy measures of camouflaging: Exploring sex differences in diagnosed autistic versus high autistic trait young adults. *Autism Research: Official Journal of the International Society for Autism Research*. https://doi.org/10.1002/aur.2873

Pearson, A., & Rose, K. (2021). A Conceptual Analysis of Autistic Masking: Understanding the Narrative of Stigma and the Illusion of Choice. *Autism in Adulthood*, *3*(1), 52–60. https://doi.org/10.1089/aut.2020.0043

Perry, E., Mandy, W., Hull, L., & Cage, E. (2022). Understanding Camouflaging as a Response to Autism-Related Stigma: A Social Identity Theory Approach. *Journal of Autism and Developmental Disorders*, *52*(2), 800–810. https://doi.org/10.1007/s10803-021-04987-w

Pickard, H., Hirsch, C., Simonoff, E., & Happé, F. (2020). Exploring the cognitive, emotional and sensory correlates of social anxiety in autistic and neurotypical adolescents. *Journal of Child Psychology and Psychiatry*, *n/a*(n/a). https://doi.org/10.1111/jcpp.13214

Plasencia, M. L., Alden, L. E., & Taylor, C. T. (2011). Differential effects of safety behaviour subtypes in social anxiety disorder. *Behaviour Research and Therapy*, *49*(10), 665–675. https://doi.org/10.1016/j.brat.2011.07.005

Ranta, K., Kaltiala-Heino, R., Koivisto, A.-M., Tuomisto, M. T., Pelkonen, M., & Marttunen, M. (2007). Age and gender differences in social anxiety symptoms during adolescence: The Social Phobia Inventory (SPIN) as a measure. *Psychiatry Research*, *153*(3), 261–270. https://doi.org/10.1016/j.psychres.2006.12.006

Rapee, R. M., & Heimberg, R. G. (1997). A cognitive-behavioral model of anxiety in social phobia. *Behaviour Research and Therapy*, *35*(8), 741–756. https://doi.org/10.1016/S0005-7967(97)00022-3

Rosseel, Y. (2020). Small Sample Solutions for Structural Equation Modeling. In *Small Sample Size Solutions* (1st ed., pp. 226–238). Routledge. https://doi.org/10.4324/9780429273872-19

Ruscio, A. M., Brown, T. A., Chiu, W. T., Sareen, J., Stein, M. B., & Kessler, R. C. (2008). Social fears and social phobia in the USA: Results from the National Comorbidity Survey Replication. *Psychological Medicine*, *38*(1), 15–28. https://doi.org/10.1017/S0033291707001699

Simonoff, E., Pickles, A., Charman, T., Chandler, S., Loucas, T., & Baird, G. (2008). Psychiatric Disorders in Children With Autism Spectrum Disorders: Prevalence, Comorbidity, and Associated Factors in a Population-Derived Sample. *Journal of the American Academy of Child & Adolescent Psychiatry*, *47*(8), 921–929. https://doi.org/10.1097/CHI.0b013e318179964f

Spain, D., Rumball, F., O'Neill, L., Sin, J., Prunty, J., & Happé, F. (2017). Conceptualizing and Treating Social Anxiety in Autism Spectrum Disorder: A Focus Group Study with Multidisciplinary Professionals. *Journal of Applied Research in Intellectual Disabilities*, *30*(S1), 10–21. https://doi.org/10.1111/jar.12320

Stevens, J. P. (2012). *Applied multivariate statistics for the social sciences.* Routledge.

Sukhodolsky, D. G., Bloch, M. H., Panza, K. E., & Reichow, B. (2013). Cognitive-behavioral therapy for anxiety in children with high-functioning autism: A meta-analysis. *Pediatrics*, *132*(5), e1341-1350. https://doi.org/10.1542/peds.2013-1193

White, R., Barreto, M., Harrington, J., Kapp, S. K., Hayes, J., & Russell, G. (2020). Is disclosing an autism spectrum disorder in school associated with reduced stigmatization? *Autism*, *24*(3), 744–754. https://doi.org/10.1177/1362361319887625

White, S. W., Bray, B. C., & Ollendick, T. H. (2012). Examining Shared and Unique Aspects of Social Anxiety Disorder and Autism Spectrum Disorder Using Factor Analysis. *Journal of Autism and Developmental Disorders*, *42*(5), 874–884. https://doi.org/10.1007/s10803-011-1325-7

Wong, Q. J. J., & Rapee, R. M. (2016). The aetiology and maintenance of social anxiety disorder: A synthesis of complementary theoretical models and formulation of a new integrated model. *Journal of Affective Disorders*, *203*, 84–100. https://doi.org/10.1016/j.jad.2016.05.069

Wood, H., Rusbridge, S., Lei, J., Lomax, C., Elliston, J., & Russell, A. (2022). Exploring the Cognitive Model of Social Anxiety in Autistic Young People—The Central Role of Bodily Symptoms. *Journal of Autism and Developmental Disorders*, *52*(12), 5500–5514. https://doi.org/10.1007/s10803-021-05359-0

6. Appendices

Appendix 1: Recruitment Letter

Recruitment Email 1: NHS Recruitment

Dear Colleagues,

My name is Jiedi Lei and I am a first year Clinical Psychology Trainee at Institute of Psychiatry, Psychology and Neuroscience, King's College London.

I am reaching out to you to see if you are able to support me with recruitment for my thesis project entitled: "***Social camouflaging and safety behaviours in autism and social anxiety."*** *This study is being undertaken as part of an educational project for my doctoral studies.

This study has been approved by South London and Maudsley (SLaM) Research & Development (REC: 21/LO/0750) and the NHS Ethic Committee (IRAS: 300879). For your information, I've attached both the study protocol and NHS Ethics approval for you to review.

We kindly ask you to share the attached study information with any young person and their parent/carer in your service who meet the inclusion criteria and may be interested in taking part in this study (more information below) and support us in our study recruitment.

Young people and their parent/carer can review participant information sheets and register their interest in taking part in the study by using this link: https://tinyurl.com/SocAnxReg
They can also contact me at: jiedi.lei@kcl.ac.uk to ask any questions about the study.

If possible – we also kindly ask you to share the study poster (attached) with clinicians in your service, and with young people and their parent/carer. The poster also has the relevant contact information and link to register their interest for the study as detailed above.

Thank you so much for your support and please do let me know if you have any questions about this study and/or recruitment.

Best wishes,
Jiedi

Jiedi Lei
Trainee Clinical Psychologist

Institute of Psychiatry, Psychology and Neuroscience, King's College London
16 De Crespigny Park | Denmark Hill | London | SE5 8AB

Please note that Mondays and Fridays are my academic days, and Tuesdays-Thursdays are my clinical days.

A brief summary of the study is as below:

Study Summary:

This study is open to young people **aged 14-19 years old with and without autism**. In this study, we aim to understand the relationship between certain social camouflaging and safety seeking behaviours in social situations by young people who might experience **high levels of social anxiety**. Young people and their

parent/carer will be invited to complete a set of online questionnaires about the young person including their levels of social anxiety, autistic traits, and also behaviours in social situations. The **online questionnaire session** should take around **45-60 minutes for the young person** to complete, **and 20-30 minutes for the parent/carer** to complete. ***Young people will be reimbursed £5 in gift vouchers upon completion of the questionnaire session.***

Inclusion criteria:

- Young person is aged 14-19 years old
- Both young person and parent/carer are fluent in written and spoken English
- We are especially interested in hearing from any young person who has a clinical diagnosis of Autism Spectrum Disorder

Risks in taking part:

We do not anticipate any serious adverse events to occur during this study, due to the study nature being an online questionnaire session for young people and their parent/carer. There could also be potential distress due to answering questions about anxiety and depression. No information about risk to self or others are collected during the online questionnaire study. Young people and their parent/carer will be signposted to a debrief sheet at the end of the online questionnaire session about how to keep themselves safe and who they should contact if they are worried about their own safety and mental health difficulties. Gatekeepers in schools/clinics will be responsible for continuing to hold responsibility for safeguarding.

Recruitment Email 2: Secondary Education Schools

Dear Headmaster/Headmistress OR Head of Year,

My name is Jiedi Lei and I am a first year Clinical Psychology Trainee at Institute of Psychiatry, Psychology and Neuroscience, King's College London. *This study is being undertaken as part of an educational project for my doctoral studies.

I am reaching out to you to see if you are able to support me with recruitment for my thesis project entitled ***"'Social camouflaging and safety behaviours in autism and social anxiety."***

We know social situations, peer relationships and friendships can be particularly anxiety provoking for young people, and high levels of social anxiety can negatively impact young people's mental wellbeing and peer support network. We want to better understand how young people's behaviours in social situations are related to their social anxiety, and social communication skills. In this study – young people and their parent/carer will be invited to complete a set of online questionnaires about the young person including their levels of social anxiety, autistic traits, and also behaviours in social situations. The **online questionnaire session** should take around **45-60 minutes for the young person** to complete, **and 20-30 minutes for the parent/carer** to complete. ***Young people will be reimbursed £5 in gift vouchers upon completion of the questionnaire session.***

In particular, we are looking for young people who meet the below **inclusion criteria** to take part in this online study:

- Young person is aged **14-19 years old (Relevant Year Groups: 10-13)**
- Both young person and parent/carer are **fluent in written and spoken English**
- We are ***especially interested*** in hearing from any young person who has a clinical diagnosis of Autism Spectrum Disorder

This study has been approved by South London and Maudsley NHS Trust (REC: 21/LO/0750) and the NHS Ethic Committee (IRAS: 300879). A brief summary of the study and its risk is outlined at the end of the email. We have also attached the Participant Information Sheet for young people and their parent/carer for you to review – to help you determine if this study may be suitable for young people in your school.

If possible, we kindly ask you to share the study poster (attached) with form tutors and hear of year groups in your school, who may be able to disseminate this information to young people and their parent/carer who meet inclusion criteria and may be interested in taking part in the study. The poster also has the relevant contact information and link to register their interest for the study as detailed below:

Young people and their parent/carer can review participant information sheets and register their interest in taking part in the study by using this link: https://tinyurl.com/SocAnxReg
They can also contact me at: jiedi.lei@kcl.ac.uk to ask any questions about the study.

Thank you so much for your support and please do let me know if you have any questions about this study and/or recruitment.

Best wishes,
Jiedi

Jiedi Lei
Trainee Clinical Psychologist

Institute of Psychiatry, Psychology and Neuroscience, King's College London
16 De Crespigny Park | Denmark Hill | London | SE5 8AB

Please note that Mondays and Fridays are my academic days, and Tuesdays-Thursdays are my clinical days.

A brief summary of the study is as below:

Study Summary:

This study is open to young people **aged 14-19 years old with and without autism**. In this study, we aim to understand the relationship between certain social camouflaging and safety seeking behaviours in social situations by young people who might experience **high levels of social anxiety**. Young people and their parent/carer will be invited to complete a set of online questionnaires about the young person including their levels of social anxiety, autistic traits, and also behaviours in social situations. The **online questionnaire session** should take around **45-60 minutes for the young person** to complete, **and 20-30 minutes for the parent/carer** to complete. ***Young people will be reimbursed £5 in gift vouchers upon completion of the questionnaire session.***.

Inclusion criteria:

- Young person is aged 14-19 years old (Relevant Year Groups: 10-13)
- Both young person and parent/carer are fluent in written and spoken English
- We are especially interested in hearing from any young person who has a clinical diagnosis of Autism Spectrum Disorder

Risks in taking part:

We do not anticipate any serious adverse events to occur during this study, due to the study nature being an online questionnaire session for young people and their parent/carer. There could also be potential distress due to answering questions about anxiety and depression. No information about risk to self or others are collected during the online questionnaire study. Young people and their parent/carer will be signposted to a debrief sheet at the end of the online questionnaire session about how to keep themselves safe and who they should contact if they are worried about their own safety and mental health difficulties. Gatekeepers in schools/clinics will be responsible for continuing to hold responsibility for safeguarding.

Recruitment Material for Social Media Posts:

1) Twitter (280 characters):

Version 1: For everyone

Are you aged 14-19 and experience social anxiety? Help researchers support young people like you by completing questionnaires online.
Watch a short video to learn more: https://tinyurl.com/SocAnxVideo
Interested? Sign up here: https://tinyurl.com/SocAnxReg

Version 2: For autistic young people

Are you aged 14-19, have Autism, and experience social anxiety? Help researchers support young people like you by completing questionnaires online.
Watch a short video to learn more: https://tinyurl.com/SocAnxVideo
Interested? Sign up here: https://tinyurl.com/SocAnxReg

2) Facebook and other social media platforms – to be shared along with recruitment poster:

Version 1: For everyone

Are you aged 14-19 and experience the following in social situations?

- My fear of embarrassment causes me to avoid doing things or speaking to people
- I avoid activities where I am the centre of attention
- Being embarrassed or looking stupid are amongst my worst fears

You can help researchers support young people like you by understanding your thoughts, feelings and behaviours in social situations by completing questionnaires online.

Watch a short video to learn more: https://tinyurl.com/SocAnxVideo
Interested? *Sign up here*: https://tinyurl.com/SocAnxReg

You will receive £5 in gift voucher upon completing the study.

Version 2: For autistic young people

Are you aged 14-19, have Autism / Asperger's Syndrome, and experience the following in social situations?

- My fear of embarrassment causes me to avoid doing things or speaking to people
- I avoid activities where I am the centre of attention
- Being embarrassed or looking stupid are amongst my worst fears

You can help researchers support young people like you by understanding your thoughts, feelings and behaviours in social situations by completing questionnaires online.

Watch a short video to learn more: https://tinyurl.com/SocAnxVideo
Interested? *Sign up here*: https://tinyurl.com/SocAnxReg

You will receive £5 in gift voucher upon completing the study.

Social Camouflaging and Safety Behaviours in Autism and Social Anxiety *This is an educational project as part of a doctoral degree.
REC: 2022/004 IRAS: 300879 Version: 2 Date: 12/11/2021

Do you experience anxiety in social situations?

SCAN ME
For a short video about the study

Sound familiar to you?
Said YES to any bubbles?
WE NEED YOUR HELP!

Sign up before 28th February 2023

Take part in **an online questionnaire study** to help researchers understand young people's anxiety and behaviours in social situations.

Do you have Autism Spectrum Condition? We also want to hear from you!

Who can take part?

- Young people aged 14-19 years and their parent/carer
- Fluent in spoken/written English

How do I take part / Find out more?

- Register at: https://tinyurl.com/SocAnxReg
- You and your parent/carer can read through more study information to read to help you decide if you want to take part
- Questions? Email the researcher (Jiedi Lei) at: jiedi.lei@kcl.ac.uk

What do I have to do if I decide to take part?

- You and your parent/carer will be asked to complete questionnaires about your anxiety and behaviours in social situations online (~ 45-60 minutes for you, ~20 minutes for your parent/carer)

Young person will be reimbursed £5 in gift voucher too!

INFORMATION SHEET FOR YOUNG PEOPLE (14-15 YEAR OLDS)

Ethical Clearance Reference Number: 2022/004

Study Title

Social camouflaging and safety behaviours in autism and social anxiety

You are invited to take part in a research study

Before you decide if you want to take part, it is important you understand why we are doing this study and what it will involve. Please take time to read this information sheet carefully. Talk to others if you wish and ask us if there is anything that is unclear or you want more information. Our contact information are on page 5.

*This study is being undertaken as part of an educational project for doctoral studies.

Please note, we are not able to offer you any medical advice or treatment.

What is the study about?

People differ in how they interact with other people and how they behave in social situations. In this study, we are interested in your behaviours and any anxiety you may experience in social situations. In total, we aim to ask 114 young people to take part in this research.

Do I have to take part?

No, it is entirely up to you to decide if you would like to take part. You should only take part if you want to and choosing not to take part will not affect you in any way.

What does taking part involve?

You are invited to take part in an online research study. You can take part in this study at home using a computer or laptop, or even via a digital tablet or mobile phone. The study will take around 45-60 minutes to complete. In this study, you will be asked to complete some online questionnaires that ask you about feelings of anxiety, and also your behaviours and thoughts in social situations. At the end of the questionnaire session, you will be asked to complete a short online one-word reading task.

The questionnaires can be completed in one or two sessions. If you would like to take a break, please do this when you get to the break page. When you are having your break please minimise or close the webpage. If you don't want to have a break you can keep going and complete all of the questionnaires.

Please make sure you read the instructions and questions carefully. If you are unhappy and do not want to answer any questions for any reason, please skip that question and move on to the next one. If you would like to stop answering questions and no longer wish to finish the session, please close the webpage and the questions will stop.

All of your answers will be kept private and if you found out about this study from school they will not know that you took part or how you answer. None of the questionnaires are a test. To thank you for taking part, you will be reimbursed £5 in gift vouchers upon completion of the questionnaire session.

I would like to take part. What do I do next?

If you would like to take part in the study, please continue reading through the rest of the information carefully, and you will be asked to complete a form at the end of the information sheet. This will let us know that you are happy to take part.

Please note, given that you are aged 14-15 years old, you will only be able to take part in the study when we have received completed consent forms from your chosen parent/carer. We will let you know when they have consented and will send you a link to access the online questionnaires.

What information will be collected from me?

1) Demographic information

Your will be asked to complete a series of questions about your age, gender, ethnicity and also whether or not you receive free school meals.

2) Autism diagnosis and/or other mental health/physical health diagnoses

You will be asked to indicate whether you have a clinical diagnosis for Autism Spectrum Disorder or equivalent (e.g., Asperger's Syndrome, Autism Spectrum Condition, Childhood Autism) from a healthcare professional, as well as any other current or past mental and/or physical health conditions.

3) Questionnaires

You will be asked to complete a series of questionnaires that assess your thoughts, feelings and behaviours in social situations, including questions about anxiety in social and non-social situations. You will also be asked to complete a short online reading activity. None of the questionnaires/activities are tests, and the information will not be shared with anyone else outside of the research team.

Please note: The online questionnaires will take place via Qualtrics Platform, and you can find out more about information privacy here: https://www.qualtrics.com/privacy-statement/. The online reading task will take place via Gorilla Platform, and you can find out more about information privacy here: https://app.gorilla.sc/privacy. We will not collect any personal / identifiable information about you via Gorilla platform.

Is there anything I need to be worried about if I take part?

There may be some questions in the questionnaires that you find difficult, upsetting or uncomfortable. If you are not comfortable answering any of the questions, you can skip them and move on. You can also take a break and come back to it or stop completing it if you want to.

Please note, we are not able to offer you any medical advice or treatment.

If you think you need support, you should speak to your GP or other healthcare provider, or call NHS 111, as soon as possible. If you need urgent medical care, please go to a local hospital Emergency Department or call 999. You will find details for other helpful resources and information about young people's mental health on this website: https://www.slam.nhs.uk/our-services/camhs/ .

In particular, you may find YoungMinds (https://youngminds.org.uk/) and Samaritans (https://www.samaritans.org/) to provide helpful information to support young people.

For resources about Autism Spectrum Disorder, please visit National Autistic Society (https://www.autism.org.uk/) and Autistica (https://www.autistica.org.uk/) for more information on the condition, and how to access support as a young person.

What if I change my mind?

If you do decide to take part, you can change your mind about taking part at any time during the study without giving a reason. Just let us know if you no longer want to take part (our contact information can be found on page 5). Stopping taking part will not affect you in any way. Information collected up until that time will still be used unless you ask us not to.

Please note that you can ask us to remove your questionnaire responses from the project up until 28th February 2023, after which we will no longer be able to remove your responses as they will have been committed to the final report. If you choose to no longer take part in the study, any information that may be used to identify you will be destroyed.

Will the study help me?

No, but you may find it helpful to anonymously disclose your experiences and feelings in social situations. You may like taking part in a study that will help us understand how to better help other young people in the future. At the end of the study, we will send you a certificate of participation as a thank you for your contribution to this research.

How will my information be used?

King's College London and South London and Maudsley Trust are co-sponsors for this study based in the United Kingdom. This means that King's College London and South London and Maudsley Trust are responsible for ensuring your information is stored and used properly. King's College London and South London and Maudsley Trust will keep identifiable information about you until your 25th birthday if you are aged 16 years old and under.

- We will need to use the information you provide from the online questionnaires for the this study.
- People who do not need to know who you are will not be able to see your name or contact details. Your information will have a code number instead.
- We will keep all your information strictly confidential. The only time we may need to break confidentiality is if we are aware of a serious risk to you or to someone else, in which case we may need to share this information with the relevant authorities. But we would contact you first to discuss it.

- Once we have finished the study, we will keep some of the information so we can check the results. We will write our reports on the results in a way that no-one can work out that you took part in the study. A summary of the results will be distributed to you via email.

Where can I find out more about how my information is being used?

Your data will be processed in accordance with the General Data Protection Regulation 2016 (GDPR). If you would like more information about how your data will be processed in accordance with GDPR please visit the link below:

https://www.kcl.ac.uk/research/support/research-ethics/kings-college-london-statement-on-use-of-personal-data-in-research

https://www.slam.nhs.uk/about-us/privacy-and-gdpr

You can also find out more about how we use your information using the following resources:

- At www.hra.nhs.uk/information-about-patients/
- By contacting us on the contact details on page 6.
- By contacting King's College London's Data Protection Office at info-compliance@kcl.ac.uk
- By contacting South London and Maudsley Data Protection Office at dataprotectionoffice@slam.nhs.uk

Will the data collected about me be used for other purposes?

We may wish to use fully anonymised data collected from you for other research projects in the future taking place within South London and Maudsley (SLaM) NHS Foundation Trust and King's College London (KCL). Fully anonymised data (that means data which does not include any information that can be used to identify who you are, such as name, contact information, date of birth, address) used for future research projects will only be shared for research projects sponsored by the two host organisations (i.e., SLaM and/or KCL). No identifiable information from the current study will be shared for any future research purposes. No data (anonymised and identifiable information) will be transferred overseas or be used for commercial purposes by any institutions. Choosing for your anonymised data to be used for future research projects held at KCL and/or SLaM is fully optional and done on a voluntary basis. Your decision will not have any impact on your ability to take part in the current research study (i.e., choosing not to share your anonymised data for future research purposes at SLaM/KCL does not affect your ability to take part in the current study).

What if I have further questions, or if something goes wrong?

If you have a concern about any part of this study, first you should contact the Principal investigator (Dr. Jiedi Lei, jiedi.lei@kcl.ac.uk) at the first instance and we will do our best to answer your question. If you remain unhappy, you can contact the South London and Maudsley NHS Foundation Trust Patient Advice and Liaison Service using the freephone 0800 731 2864 (option 2) or by email at pals@slam.nhs.uk .

If you have a complaint, you can contact the Director of Research Quality:

Dr. Gill Dale, Director of Research Quality

South London and Maudsley NHS Foundation Trust, R&D Department,
Room W1.08, Institute of Psychiatry, Psychology & Neuroscience (IoPPN)
De Crespigny Park, London SE5 8AF
Tel: 020 7848 0339

Who has reviewed this study?

All research in the NHS is looked at by an independent group of people, called a Research Ethics Committee, to protect participants' interests. This study has been reviewed and given favourable opinion by the Brent Research Ethics Committee (21/LO/0750).

Statement about insurance cover

In the event that something does go wrong and you are harmed during the study, you may have grounds for legal action for compensation against King's College London and/or South London & Maudsley NHS Foundation Trust, but you may have to pay your legal costs. The normal NHS complaints mechanisms will still be available to you (if appropriate). King's College London has obtained insurance which provides no-fault compensation i.e., for non-negligent harm, you may be entitled to make a claim for this.

Who should I contact for further information?

If you have any questions or require more information about this project, please contact the research team using the following contact details:

Principal Investigator: Dr Jiedi Lei
Address: Institute of Psychiatry, Psychology & Neuroscience,
King's College London. De Crespigny Park, SE5 8AF.
Email: jiedi.lei@kcl.ac.uk

Thank you for reading this information sheet and for considering taking part in this research. Please ask us if you have any questions.

INFORMATION SHEET FOR PARENTS AND CARERS OF YOUNG PEOPLE (Aged 14-15 years old)

Ethical Clearance Reference Number: 2022-004

Study Title

Social camouflaging and safety behaviours in autism and social anxiety

You and your child are invited to take part in a research study

We would like to invite you and your child to participate in this research project. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Your child will have a separate information sheet for them to read. Please discuss it with them. Talk to others if you wish and ask us if there is anything that is unclear or you want more information. Our contact information are on page 6.

*This study is being undertaken as part of an educational project for doctoral studies.

Please note, we are not able to offer your child any medical advice or treatment.

What is the purpose of the project?

This project is open to young people aged 14-19 years old with and without autism. In this study, we aim to understand the relationship between certain behaviours in social situations by young people who might experience high levels of social anxiety by using online questionnaires. This may help us develop better interventions for young people expressing social anxiety difficulties, especially for adapting intervention for autistic young people by better understanding how their behaviours in social situations are related to autism and/or social anxiety. In total, we aim to recruit 114 families into this study.

Why has my child been invited to take part in the study?

Your child is invited to take part because they may have accessed one of the services below:

1) They were seen at a mental health service in South London and Maudsley NHS Foundation Trust.
2) They have signed up to take part at Bath Autism Summer School programme held at University of Bath.
3) They have signed up as part of research participation database at either King's College London, South London and Maudsley Trust, and/or University of Bath to take part in ongoing psychology-related research.

In all of the above cases, you or your child agreed researchers could contact you both about relevant studies to find out if your child would be interested in taking part.

Alternatively:

1) Your child may have been invited to take part because they attend one of the local schools in one of the South London Boroughs (including Southwark, Lambeth, Croydon, Lewisham),

and the school has agreed for the research team to disseminate information about this study to young people in the relevant age groups.

2) You may have seen our study advertisement through a mental health or autism related charity (e.g., National Autistic Society, Autistica) via social media.

In all cases, your child is the right age to take part in this study as we want to understand the behaviours in social situations of young people aged between 14-19 years old.

Do my child and I have to take part?

No, it is your child's choice. Participation is completely voluntary. Your child should only take part if they want to and you agree. Choosing not to take part will not affect the care they receive (if they are receiving ongoing care) or disadvantage you in anyway. Once you have read the information sheet, please contact us if you have any questions that will help you make a decision about taking part. If you decide to take part we will ask you to complete an online consent form.

What will happen if my child and I decide to take part?

If your child is aged 14-15 years and would like to take part and you agree, your child will need to confirm this by completing an assent form and you will need to confirm this by completing a consent form online. You will also be asked to complete a consent form for yourself to take part in the parent/carer portion of the study.

Following completing the relevant consent/assent forms depending on your child's age, your child will each be asked to complete some questionnaires about themself online. These questionnaires will ask your child about their emotions and behaviours, and how they act in different social situations.

The online questionnaire session should take around 45-60 minutes for your child to complete. The questionnaire session can be completed in one to two sessions (Part 1 and Part 2), with a short break in between. We ask that your child complete all questionnaires in a quiet room at home, ideally on a desktop computer or laptop with a mouse connected, or if not possible, via a touchscreen device or mobile phone connected to the internet.

At the end of the online questionnaire session your child will be reimbursed £5 in gift vouchers upon completion of the questionnaire session as a thank you.

What information will be collected from my child?

1) Demographic information

Your child will be asked to complete a series of questions on key demographic information including their age, gender, ethnicity and also whether or not they receive free school meals.

2) Autism diagnosis and/or other mental health/physical health diagnoses

Your child will be asked to indicate whether they have received a clinical diagnosis for Autism Spectrum Disorder or equivalent (e.g., Asperger's Syndrome, Autism Spectrum Condition,

Childhood Autism) from a healthcare professional, as well as any other current or past mental and/or physical health conditions.

If your child has a clinical diagnosis of Autism Spectrum Disorder (ASD) or equivalent, we will also ask you to provide verification of the diagnosis by submitting a digital copy of the original diagnosis letter, any exchange with a qualified healthcare and/or education professional where the child's clinical diagnosis of Autism is clearly stated, or equivalent.

3) Questionnaires

Your child will be asked to complete a series of questionnaires that assess autistic traits/autism symptoms, as well as general symptoms of anxiety and low mood.

Your child will also be asked to complete a couple of additional questionnaires that specifically explores their behaviours and thinking patterns in social situations. Your child will also be asked to complete a short online reading task to evaluate their reading comprehension skills.

Please note: The online questionnaires will take place via Qualtrics Platform, and you can find out more about information privacy here: https://www.qualtrics.com/privacy-statement/. The online reading task will take place via Gorilla Platform, and you can find out more about information privacy here: https://app.gorilla.sc/privacy. We will not collect any personal / identifiable information about your child via Gorilla platform.

What are the possible disadvantages and risks of taking part?

We do not anticipate any risks associated with this study over and above those encountered in everyday life. There may be some questions in the questionnaires that your child find difficult, upsetting or uncomfortable. For the child, there is a small chance that they could find completing the online questionnaires anxiety provoking, frustrating or stressful. To minimise any potential negative experiences, your child will be allowed to stop the study at any time by closing the webpage, without giving a reason. Your child can also take a break and come back to the online questionnaires to complete in multiple sessions if you would like to.

Please note, we are not able to offer your child any medical advice or treatment.

If you think your child needs support, you should speak to their GP or other healthcare provider, or call NHS 111, as soon as possible. If your child needs urgent medical care, please go to a local hospital Emergency Department or call 999. You will find details for other organisations that your child might find helpful on the Child and Adolescent Mental Health support page for South London & Maudsley NHS Foundation trust: https://www.slam.nhs.uk/our-services/camhs/ .

In particular, you may find YoungMinds (https://youngminds.org.uk/) and Samaritans (https://www.samaritans.org/) to provide helpful information to support young people. Also, YoungMinds offers free confidential support Monday to Friday 9:30am-4pm via telephone, email and webchat for adults in need of advice about a child. (Website: www.youngminds.org.uk/find-help/for-parents/parents-helpline/.)

For resources about Autism Spectrum Disorder, please visit National Autistic Society (https://www.autism.org.uk/) and Autistica (https://www.autistica.org.uk/) for more information on the condition, and how to provide support for autistic young people.

What are the possible benefits of taking part?

There is no direct benefit to your child in taking part in this study. There may be some indirect benefits to your child in taking part. Your child may find it helpful to anonymously disclose their experiences and feelings in social situations. Your child may like contributing to research that will help us understand how to better help other young people in the future. At the end of the study, we will send your child a certificate of participation as a thank you for their contribution to this research.

Incentives

To thank your child for taking part, they will be reimbursed £5 in gift vouchers upon completion of the questionnaire session.

What will happen if my child changes their mind about taking part?

Your child is free to stop taking part in the study at any point, without giving a reason. Withdrawing from the study will not affect your child in any way. Information collected until your child's withdrawal will be used, unless you ask us not to.

Please note that you and/or your child can withdraw your child's data from the project up until 28th February 2023, after which withdrawal of your child's data will no longer be possible as the data will have been committed to the final report. If your child choose to withdraw from the project, any identifiable data collected about them will be destroyed.

Data handling and confidentiality

King's College London and South London and Maudsley Trust are co-sponsors for this study based in the United Kingdom. This means that King's College London and South London and Maudsley Trust are responsible for ensuring your information is stored and used properly. King's College

London and South London and Maudsley Trust will keep identifiable information about your child until their 25th birthday.

Your child's data will be processed in accordance with the General Data Protection Regulation 2016 (GDPR). If you give consent for your child to take part in the study, you will be asked to create an identification (ID) number and any responses from your child will only be linked to this ID number. This will ensure that all information is anonymised, with the exception of the consent form, which will contain both yours and your child's personal information and ID number. The consent documents will be securely stored on a password protected encrypted hard drive away from any unidentifiable data that contains your unique ID number.

All data will be collected using secure online platforms. All data collected through online questionnaires and activities will be downloaded into an encrypted password protected computer and promptly erased from the online storage repository. Data will only be shared within the research team.

Your child's responses will remain confidential unless either your or your child bring to the researcher's attention anything to suggest that your child's health and safety is currently in danger (e.g. extreme distress or abuse). If this happens, information directly related to the emergency will be brought to the attention of the appropriate bodies. Please note that should you have been contacted through your child's school or other third part organisation they will not know if you have/have not participated and will not have access to any of the data.

Once we have finished the study, we will keep some of the information so we can check the results. We will write our reports on the results in a way that no-one can work out that your child took part in the study, with all information fully anonymised and results will be reported at the group level, not on an individual basis. A summary of the results will be distributed to your child via email.

Data Protection Statement

Your data will be processed in accordance with the General Data Protection Regulation 2016 (GDPR). If you would like more information about how your data will be processed in accordance with GDPR please visit the link below:

https://www.kcl.ac.uk/research/support/research-ethics/kings-college-london-statement-on-use-of-personal-data-in-research

https://www.slam.nhs.uk/about-us/privacy-and-gdpr

You can also find out more about how we use your child's information using the following resources:

- At www.hra.nhs.uk/information-about-patients/
- By contacting us on the contact details on page 6.
- By contacting King's College London's Data Protection Office at info-compliance@kcl.ac.uk
- By contacting South London and Maudsley Data Protection Office at dataprotectionoffice@slam.nhs.uk

Will the data collected about my child and/or I be used for other purposes?

We may wish to use fully anonymised data collected from your child for other research projects in the future taking place within South London and Maudsley (SLaM) NHS Foundation Trust and King's College London (KCL). Fully anonymised data used for future research projects will only be shared for research projects sponsored by the two host organisations (i.e., SLaM and/or KCL). No identifiable information from the current study will be shared for any future research purposes. No data (anonymised and identifiable information) will be transferred overseas or be used for commercial purposes by any institutions. Choosing for your child's anonymised data to be used for future research projects held at KCL and/or SLaM is fully optional and done on an voluntary basis. Your decision will not have any impact on your child's ability to take part in the current research study (i.e., choosing not to share your child's anonymised data for future research purposes at SLaM/KCL does not affect their ability to take part in the current study).

What will happen to the results of the project?

The results of the project will primarily be summarised in reports published in academic journals. The research team will email you a copy of any published reports upon request.

What if I have further questions, or if something goes wrong?

If you or your child have a concern about any part of this study, first you should contact the Principal investigator (Dr. Jiedi Lei, jiedi.lei@kcl.ac.uk) at the first instance and we will do our best to answer your question. If you or your child remain unhappy, you can contact the South London and Maudsley NHS Foundation Trust Patient Advice and Liaison Service using the freephone 0800 731 2864 (option 2) or by email at pals@slam.nhs.uk .

If you have a complaint, you can contact the Director of Research Quality:

Dr. Gill Dale, Director of Research Quality
South London and Maudsley NHS Foundation Trust, R&D Department,
Room W1.08, Institute of Psychiatry, Psychology & Neuroscience (IoPPN)
De Crespigny Park, London SE5 8AF
Tel: 020 7848 0339

Who has reviewed this study?

All research in the NHS is looked at by an independent group of people, called a Research Ethics Committee, to protect participants' interests. This study has been reviewed and given favourable opinion by the Brent Research Ethics Committee (21/LO/0750).

Statement about insurance cover

In the event that something does go wrong and your child is harmed during the study, you may have grounds for legal action for compensation against King's College London and/or South London & Maudsley NHS Foundation Trust, but you may have to pay your legal costs. The normal NHS complaints mechanisms will still be available to you (if appropriate). King's College London has

obtained insurance which provides no-fault compensation i.e., for non-negligent harm, you may be entitled to make a claim for this.

Who should I contact for further information?

If you have any questions or require more information about this project, please contact the research team using the following contact details:

Principal Investigator: Dr Jiedi Lei
Address: Institute of Psychiatry, Psychology & Neuroscience,
King's College London. De Crespigny Park, SE5 8AF.
Email: jiedi.lei@kcl.ac.uk

Thank you for reading this information sheet and for considering taking part in this research. Please ask us if you have any questions.

INFORMATION SHEET FOR YOUNG PEOPLE (16-19 YEAR OLDS)

Ethical Clearance Reference Number: 2022-004

Study Title

Social camouflaging and safety behaviours in autism and social anxiety

You are invited to take part in a research study

Before you decide if you want to take part, it is important you understand why we are doing this study and what it will involve. Please take time to read this information sheet carefully. Talk to others if you wish and ask us if there is anything that is unclear or you want more information. Our contact information are on page 5.

*This study is being undertaken as part of an educational project for doctoral studies.

Please note, we are not able to offer you any medical advice or treatment.

What is the study about?

People differ in how they interact with other people and how they behave in social situations. In this study, we are interested in your behaviours and any anxiety you may experience in social situations. In total, we aim to ask 114 young people to take part in this research.

Do I have to take part?

No, it is entirely up to you to decide if you would like to take part. You should only take part if you want to and choosing not to take part will not affect you in any way.

What does taking part involve?

You are invited to take part in an online research study. You can take part in this study at home using a computer or laptop, or even via a digital tablet or mobile phone. The study will take around 45-60 minutes to complete. In this study, you will be asked to complete some online questionnaires that ask you about feelings of anxiety, and also your behaviours and thoughts in social situations. At the end of the questionnaire session, you will be asked to complete a short online one-word reading task.

The questionnaires can be completed in one or two sessions. If you would like to take a break, please do this when you get to the break page. When you are having your break please minimise or close the webpage. If you don't want to have a break you can keep going and complete all of the questionnaires.

Please make sure you read the instructions and questions carefully. If you are unhappy and do not want to answer any questions for any reason, please skip that question and move on to the next one. If you would like to stop answering questions and no longer wish to finish the session, please close the webpage and the questions will stop.

All of your answers will be kept private and if you found out about this study from school they will not know that you took part or how you answer. None of the questionnaires are a test. To thank you for taking part, you will be reimbursed £5 in gift vouchers upon completion of the questionnaire session.

I would like to take part. What do I do next?

If you would like to take part in the study, please continue reading through the rest of the information carefully, and you will be asked to complete a form at the end of the information sheet. This will let us know that you are happy to take part.

Given that you are aged 16-19 years old, you will be able to complete the online questionnaires after you have provided consent to take part in the study. We strongly encourage you to share with your parent/carer about your participation in the current study. Please note that we will contact your parent/carer to ask them to complete some online questionnaires also about your experiences.

What information will be collected from me?

1) Demographic information

Your will be asked to complete a series of questions about your age, gender, ethnicity and also whether or not you receive free school meals.

2) Autism diagnosis and/or other mental health/physical health diagnoses

You will be asked to indicate whether you have a clinical diagnosis for Autism Spectrum Disorder or equivalent (e.g., Asperger's Syndrome, Autism Spectrum Condition, Childhood Autism) from a healthcare professional, as well as any other current or past mental and/or physical health conditions.

3) Questionnaires

You will be asked to complete a series of questionnaires that assess your thoughts, feelings and behaviours in social situations, including questions about anxiety in social and non-social situations. You will also be asked to complete a short online reading activity. None of the questionnaires/activities are tests, and the information will not be shared with anyone else outside of the research team.

Please note: The online questionnaires will take place via Qualtrics Platform, and you can find out more about information privacy here: https://www.qualtrics.com/privacy-statement/. The online reading task will take place via Gorilla Platform, and you can find out more about information privacy here: https://app.gorilla.sc/privacy. We will not collect any personal / identifiable information about you via Gorilla platform.

Is there anything I need to be worried about if I take part?

There may be some questions in the questionnaires that you find difficult, upsetting or uncomfortable. If you are not comfortable answering any of the questions, you can skip them and move on. You can also take a break and come back to it or stop completing it if you want to.

Please note, we are not able to offer you any medical advice or treatment.

If you think you need support, you should speak to your GP or other healthcare provider, or call NHS 111, as soon as possible. If you need urgent medical care, please go to a local hospital Emergency Department or call 999. You will find details for other helpful resources and information about young people's mental health on this website: https://www.slam.nhs.uk/our-services/camhs/ .

In particular, you may find YoungMinds (https://youngminds.org.uk/) and Samaritans (https://www.samaritans.org/) to provide helpful information to support young people.

For resources about Autism Spectrum Disorder, please visit National Autistic Society (https://www.autism.org.uk/) and Autistica (https://www.autistica.org.uk/) for more information on the condition, and how to access support as a young person.

What if I change my mind?

If you do decide to take part, you can change your mind about taking part at any time during the study without giving a reason. Just let us know if you no longer want to take part (our contact information can be found on page 5). Stopping taking part will not affect you in any way. Information collected up until that time will still be used unless you ask us not to.

Please note that you can ask us to remove your questionnaire responses from the project up until 28th February 2023, after which we will no longer be able to remove your responses as they will have been committed to the final report. If you choose to no longer take part in the study, any information that may be used to identify you will be destroyed.

Will the study help me?

No, but you may find it helpful to anonymously disclose your experiences and feelings in social situations. You may like taking part in a study that will help us understand how to better help other young people in the future. At the end of the study, we will send you a certificate of participation as a thank you for your contribution to this research.

How will my information be used?

- King's College London and South London and Maudsley Trust are co-sponsors for this study based in the United Kingdom. This means that King's College London and South London and Maudsley Trust are responsible for ensuring your information is stored and used properly. King's College London and South London and Maudsley Trust will keep identifiable information about you until your 25th birthday if you are aged 16 years old or under, and until your 26th birthday if you are aged 17 years old. If you are aged 18-19 years old, King's College London and South London and Maudsley Trust will keep identifiable information about you for 10 years after the study is completed.
- We will need to use the information you provide from the online questionnaires for the this study.
- People who do not need to know who you are will not be able to see your name or contact details. Your information will have a code number instead.

- We will keep all your information strictly confidential. The only time we may need to break confidentiality is if we are aware of a serious risk to you or to someone else, in which case we may need to share this information with the relevant authorities. But we would contact you first to discuss it.
- Once we have finished the study, we will keep some of the information so we can check the results. We will write our reports on the results in a way that no-one can work out that you took part in the study. A summary of the results will be distributed to you via email.

Where can I find out more about how my information is being used?

Your data will be processed in accordance with the General Data Protection Regulation 2016 (GDPR). If you would like more information about how your data will be processed in accordance with GDPR please visit the link below:

https://www.kcl.ac.uk/research/support/research-ethics/kings-college-london-statement-on-use-of-personal-data-in-research

https://www.slam.nhs.uk/about-us/privacy-and-gdpr

You can also find out more about how we use your information using the following resources:

- At www.hra.nhs.uk/information-about-patients/
- By contacting us on the contact details on page 6.
- By contacting King's College London's Data Protection Office at info-compliance@kcl.ac.uk
- By contacting South London and Maudsley Data Protection Office at dataprotectionoffice@slam.nhs.uk

Will the data collected about me be used for other purposes?

We may wish to use fully anonymised data collected from you for other research projects in the future taking place within South London and Maudsley (SLaM) NHS Foundation Trust and King's College London (KCL). Fully anonymised data (that means data which does not include any information that can be used to identify who you are, such as name, contact information, date of birth, address) used for future research projects will only be shared for research projects sponsored by the two host organisations (i.e., SLaM and/or KCL). No identifiable information from the current study will be shared for any future research purposes. No data (anonymised and identifiable information) will be transferred overseas or be used for commercial purposes by any institutions. Choosing for your anonymised data to be used for future research projects held at KCL and/or SLaM is fully optional and done on a voluntary basis. Your decision will not have any impact on your ability to take part in the current research study (i.e., choosing not to share your anonymised data for future research purposes at SLaM/KCL does not affect your ability to take part in the current study).

What if I have further questions, or if something goes wrong?

If you have a concern about any part of this study, first you should contact the Principal investigator (Dr. Jiedi Lei, jiedi.lei@kcl.ac.uk) at the first instance and we will do our best to answer your question. If you remain unhappy, you can contact the South London and Maudsley NHS Foundation Trust

Patient Advice and Liaison Service using the freephone 0800 731 2864 (option 2) or by email at pals@slam.nhs.uk .

If you have a complaint, you can contact the Director of Research Quality:

Dr. Gill Dale, Director of Research Quality
South London and Maudsley NHS Foundation Trust, R&D Department,
Room W1.08, Institute of Psychiatry, Psychology & Neuroscience (IoPPN)
De Crespigny Park, London SE5 8AF
Tel: 020 7848 0339

Who has reviewed this study?

All research in the NHS is looked at by an independent group of people, called a Research Ethics Committee, to protect participants' interests. This study has been reviewed and given favourable opinion by the Brent Research Ethics Committee (21/LO/0750).

Statement about insurance cover

In the event that something does go wrong and you are harmed during the study, you may have grounds for legal action for compensation against King's College London and/or South London & Maudsley NHS Foundation Trust, but you may have to pay your legal costs. The normal NHS complaints mechanisms will still be available to you (if appropriate). King's College London has obtained insurance which provides no-fault compensation i.e., for non-negligent harm, you may be entitled to make a claim for this.

Who should I contact for further information?

If you have any questions or require more information about this project, please contact the research team using the following contact details:

Principal Investigator: Dr Jiedi Lei
Address: Institute of Psychiatry, Psychology & Neuroscience,
King's College London. De Crespigny Park, SE5 8AF.
Email: jiedi.lei@kcl.ac.uk

Thank you for reading this information sheet and for considering taking part in this research. Please ask us if you have any questions.

IRAS ID: 300879 Version 2 – 12/11/2021

Centre Number: Study Number: 300879

Participant Identification Number for this trial:

YOUNG PERSON ASSENT FORM (Aged 14-15 Years)

Title of Project: Social camouflaging and safety behaviours in autism and social anxiety*

*This study is being undertaken as part of an educational project for doctoral studies.

Name of Researcher: Dr. Jiedi Lei

Please initial box

1. I confirm that I have read the information sheet dated 12/11/2021 (version 2) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to stop taking part at any time before 28th February 2023 without giving any reason, without my medical care or legal rights being affected. ☐
3. I confirm that my parent/carer is aware of my participation in the study, and they will also be completing some questionnaires about me as part of this study. ☐
4. I understand that I will only be able to participate in this study when my parent/carer has provided written consent for me to take part in the above study. ☐
5. I confirm that I am between 14-15 years old. ☐
6. I confirm that I can read and write English fluently. ☐
7. I agree to take part in the above study. ☐
8. (Please circle either YES/NO – please note information sharing is optional) I agree for the information collected about me during this study to be used anonymously to support other research in the future. I understand this may involve my information being shared anonymously with other researchers. Yes / No
9. Please state the FULL NAME of your parent/carer who has provided consent for your participation: (INSERT NAME)

Name of Young Person (14 -15 years)	Date	Signature
Name of Researcher	Date	Signature

When completed: 1 for participant; 1 for researcher site file.

IRAS ID: 300879 Version 2 – 12/11/2021

Centre Number: Study Number: 300879

Participant Identification Number for this trial:

PARENT CONSENT FORM (Young Person Aged 14-15 Years)

Title of Project: Social camouflaging and safety behaviours in autism and social anxiety*

*This study is being undertaken as part of an educational project for doctoral studies.

Name of Researcher: Dr. Jiedi Lei

Please initial box

1. I confirm that I have supported my child to read through the infor mation sheet dated 12/11/2021 (version 2) for the above study. I have checked in with my child to see if they had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my child's participation is voluntary and that they are free to withdraw at any time before 28th February 2023 without giving any reason, without their medical care or legal rights being affected. ☐
3. I confirm that my child is between 14 and 15 years old. ☐
4. I confirm that my child can read and write in English fluently. ☐
5. I agree for my child to take part in the above study. ☐
6. (For parents of children with Autism Spectrum Disorder) I confirm that my child has been diagnosed with Autism Spectrum Disorder (or equivalent), and that I am able to send the required document to verify my child's diagnosis to the research team. ☐
7. (Please circle either YES/NO – please note information sharing is optional) I agree for the information collected about my child during this study to be used anonymously to support other research in the future. I understand this may involve their information being shared anonymously with other researchers. Yes / No
8. Please state the FULL NAME of your child (aged 14-15 years) taking part in the study: (INSERT NAME)

Name of Parent/Carer	Date	Signature
Name of Researcher	Date	Signature

When completed: 1 for participant; 1 for researcher site file.

IRAS ID: 300879 Version 2 – 12/11/2021

Centre Number: Study Number: 300879

Participant Identification Number for this trial:

YOUNG PERSON CONSENT FORM (Aged 16-19 Years)

Title of Project: Social camouflaging and safety behaviours in autism and social anxiety*

*This study is being undertaken as part of an educational project for doctoral studies.

Name of Researcher: Dr. Jiedi Lei

Please initial box

1. I confirm that I have read the information sheet dated 12/11/2021 (version 2) for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to stop taking part at any time before 28th February 2023 without giving any reason, without my medical care or legal rights being affected. ☐
3. I confirm that my parent/carer is also aware of my participation in the study, and they will also be completing some questionnaires about me as part of this study. ☐
4. I confirm that I am between 16 and 19 years old. ☐
5. I confirm that I can read and write fluently in English. ☐
6. I agree to take part in the above study. ☐
7. (Please circle either YES/NO – please note information sharing is optional) I agree for the information collected about me during this study to be used anonymously to support other research in the future. I understand this may involve my information being shared anonymously with other researchers. Yes / No
8. If you agree for a named parent/carer to be contacted about the study, please provide the FULL NAME of your parent/carer whom we can contact to answer some questionnaires about you as stated in the Participant Information Sheet: (INSERT NAME)

Name of Young Person (16-19 years)	Date	Signature
Name of Researcher	Date	Signature

When completed: 1 for participant; 1 for researcher site file.

IRAS ID: 300879

DEBRIEF SHEET FOR YOUNG PEOPLE

Ethical Clearance Reference Number: 2022-004

Study Title

Social camouflaging and safety behaviours in autism and social anxiety

Thank you for taking part in our research study, and for completing all the online questionnaires. We are trying to gain a better understanding of how young people's anxiety and social communication differences might be related to their behaviours and patterns of thinking in social situations. We hope you find the information below helpful, and should you have any questions, or wish to withdraw from the study at any point ***before 28th February 2023****, please do not hesitate to contact the primary researcher:* **Jiedi Lei (jiedi.lei@kcl.ac.uk).** *This study is being undertaken as part of an educational project for doctoral studies.

Further Support for Mental Health Difficulties

Completing the questionnaires may have brought up some difficulties you are experiencing with regards to anxiety and low mood. If you are encountering any difficulties or have any concerns related to your mental wellbeing, and would like to find support, here are a list of resources for you to contact.

1) Try to tell a trusted adult (such as your GP, teacher, school nurse/counsellor, parent/carer, other family member) about your mental health difficulties and experiences.

2) If you would like to seek support from outside your family and/or school, below are a few resources and charities that you may find helpful:

    a. List of resources on Child and Adolescent Mental Health Services (NHS): https://www.slam.nhs.uk/our-services/camhs/

    b. Young Minds: https://youngminds.org.uk/

    c. Samaritans for young people: https://www.samaritans.org/how-we-can-help/schools/young-people/

I am worried about keeping myself safe

Please note, we are not able to offer you any medical advice or treatment as part of this research study.

If you think you need support, you should speak to your GP or other healthcare provider, or call NHS 111, as soon as possible. If you need urgent medical care, please go to a local hospital Emergency Department or call 999. You will find details for other helpful resources and information about young people's mental health on this website: https://www.slam.nhs.uk/our-services/camhs/ .

IRAS ID: 300879

I want to find out more about autism and/or support for autistic young people

If you have been diagnosed with (or suspect a diagnosis of) a specific learning disability, and/or Autism Spectrum Disorder, and would like to find additional support services, below are a few resources that you may find helpful:

National Autistic Society (National charity for Autism):
http://www.autism.org.uk/

Autistica (charity for Autism):
https://www.autistica.org.uk

Scope about disability (website with lots of support resources for learning and physical impairments/disabilities):
https://www.scope.org.uk/support

What if I have further questions, or if something goes wrong?

If you have a concern about any part of this study, first you should contact us and we will do our best to answer your question. If you remain unhappy, you can contact the South London and Maudsley NHS Foundation Trust Patient Advice and Liaison Service using the freephone 0800 731 2864 (option 2) or by email at pals@slam.nhs.uk .

If you have a complaint, you can contact the Director of Research Quality:

Dr. Gill Dale, Director of Research Quality
South London and Maudsley NHS Foundation Trust, R&D Department,
Room W1.08, Institute of Psychiatry, Psychology & Neuroscience (IoPPN)
De Crespigny Park, London SE5 8AF
Tel: 020 7848 0339

Who should I contact for further information?

If you have any questions or require more information about this project, please contact the research team using the following contact details:

Principal Investigator: Dr Jiedi Lei
Address: Institute of Psychiatry, Psychology & Neuroscience,
King's College London. De Crespigny Park, SE5 8AF.
Email: jiedi.lei@kcl.ac.uk

Thank you for reading this debrief sheet and for taking part in this research. Please ask us if you have any questions.

Appendix 5: Young Person Questionnaires

1. Demographic Questionnaires

Version 1 – 28/06/2021 (300879)

Young person demographic information questionnaire

1. What is your FULL NAME?

(BLANK TEXT BOX)

2. What is your email address? (*Note: Please put down the email address you check most regularly, personal email preferred (instead of school email) if possible)*

(BLANK TEXT BOX)

3. What is the name of the parent/carer whom we can contact to complete some online questionnaires as part of this study? Please type FULL NAME below.

(BLANK TEXT BOX)

4. What is your parent/carer (INSERT NAME FROM Q3)'s email address which we can use to contact them about completing some questionnaires as part of this study? (*Note: Please put down the email address you check most regularly, personal email preferred (instead of work email) if possible)*

(BLANK TEXT BOX)

5. How old are you?

- 14
- 15
- 16
- 17
- 18
- 19

6. What is your gender?

- Male
- Female
- Transgender female
- Transgender male
- Gender-variant/Non-conforming
- Prefer not to say
- Other (Blank Text Box)

7. Which year group are you in at school?

- Year 9 or equivalent
- Year 10 or equivalent
- Year 11 or equivalent
- Year 12 or equivalent (e.g., Lower Sixth)
- Year 13 or equivalent (e.g., Upper Sixth)
- No longer in school

8. What is your ethnicity?

- White – British
- White – Irish
- White – Any other White Background
- Mixed – White and Black Caribbean
- Mixed – White and Black African
- Mixed – White and Asian
- Mixed – Any other mixed background
- Asian or Asian British – Indian
- Asian or Asian British – Pakistani
- Asian or Asian British – Bangladeshi

- Asian or Asian British – Any other Asian background
- Black or Black British – Caribbean
- Black or Black British – African
- Black or Black British – Any other Black background
- Other Ethnic Groups – Chinese
- Other Ethnic Groups – Any other ethnic group
- Other Ethnic Groups – Traveller
- Other Ethnic Groups – Arab
- Prefer not to say

The next few questions will ask you about any mental health, physical health, or neurodevelopmental conditions that you may have. Please report as accurately as you can, and only share this information if you feel comfortable doing so.

9. Have you ever received a formal diagnosis of Autism Spectrum Disorder or equivalent? (For example – Asperger's Syndrome, Autism Spectrum Condition, Pervasive Developmental Disorder – Not Otherwise Specified?
- Yes
- No
- Unsure
- Prefer not to say

10. (If YES to Q9): Which diagnosis did you receive for Autism?
- Autism Spectrum Disorder
- Autism Spectrum Condition
- Asperger's Syndrome
- Pervasive Developmental Disorder – Not Otherwise Specified (PDD-NOS)

11. Have you ever received a formal diagnosis of any other mental health related conditions?
- Yes
- No
- Unsure
- Prefer not to say

12. (If YES to Q11): Which mental health diagnosis/diagnoses have you received?
(Blank Text Box)

13. Have you ever been diagnosed with Social Anxiety Disorder by a healthcare professional?
- Yes
- No
- Unsure
- Prefer not to say

14. Do you have any chronic or long-standing physical health conditions?
- Yes
- No
- Unsure
- Prefer not to say

15. (If YES to Q14) – Which chronic/long-standing physical health condition(s) do you have?
(BLANK TEXT BOX)

16. Do you have any disability/disabilities?
- Yes

- No
- Unsure
- Prefer not to say

17. (If Yes to Q12) – Which disability/disabilities do you have?
(BLANK TEXT BOX)

18. Are you currently living away from your parents and in care?
- Yes
- No
- Prefer not to say

The next few questions will ask you about your family's circumstances. Please only answer what you feel comfortable with and answer as accurately as you can.

19. Have any of your parent(s)/carer(s) completed a university degree course or equivalent (e.g., Bachelor of Arts (BA), Bachelor of Science (BSc) or higher)?
- Yes
- No
- I don't know
- Prefer not to say

20. Do you have at least one parent(s)/carer(s) who is currently employed either part time or full time?
- Yes
- No
- I don't know
- Prefer not to say

21. What type of school have you been attending mostly since the age of 11?
- State-run and state-funded school that was not selective (e.g., local comprehensive, Scottish High School/Secondary School/Academy)
- A state-run or funded school that selected on the basis of academic ability, faith or other grounds
- An independent or fee-paying school but my fees are paid in part or full by a bursary
- An independent school, and my fees are not paid in part by a bursary
- Attended school mostly outside of the UK
- Home schooled
- Prefer not to say

22. Are you eligible for Free School Meals at any point during your school years?
- Yes
- No
- Unsure
- Prefer not to say

2. Autism Quotient - 28

The Autism Spectrum Quotient (AQ) - Short

SPECIMEN, FOR RESEARCH USE ONLY.

For full details, please see:

R. A. Hoekstra, A.A.E. Vinkhuuyzen, S. Wheelwright, M. Bartels, D.I. Boomsma, S. Barcon-Cohen, D. Posthuma, S. van der Sluis, (2011). **The construction and validation of an abridged version of the Autism-Spectrum Quotient (AQ-Short).** Journal of Autism and Developmental Disorders. 41: 589-596.

Name:..... Sex:.....

Date of birth:..... Today's Date.....

How to fill out the questionnaire

Below are a list of statements. Please read each statement very carefully and rate how strongly you agree or disagree with it by circling your answer.

DO NOT MISS ANY STATEMENT OUT.

Examples

E1. I am willing to take risks.	definitely agree	slightly agree	slightly disagree	definitely disagree
E2. I like playing board games.	definitely agree	slightly agree	slightly disagree	definitely disagree
E3. I find learning to play musical instruments easy.	definitely agree	slightly agree	slightly disagree	definitely disagree
E4. I am fascinated by other cultures.	definitely agree	slightly agree	slightly disagree	definitely disagree

1. I prefer to do things with others rather than on my own. (1)	definitely agree	slightly agree	slightly disagree	definitely disagree
2. I prefer to do things the same way over and over again. (2)	definitely agree	slightly agree	slightly disagree	definitely disagree
3. If I try to imagine something, I find it very easy to create a picture in my mind. (3)	definitely agree	slightly agree	slightly disagree	definitely disagree
4. I frequently get so strongly absorbed in one thing that I lose sight of other things. (4)	definitely agree	slightly agree	slightly disagree	definitely disagree
5. I usually notice car number plates or similar strings of information. (6)	definitely agree	slightly agree	slightly disagree	definitely disagree
6. When I'm reading a story, I can easily imagine what the characters might look like. (8)	definitely agree	slightly agree	slightly disagree	definitely disagree
7. I am fascinated by dates. (9)	definitely agree	slightly agree	slightly disagree	definitely disagree
8. In a social group, I can easily keep track of several different people's conversations. (10)	definitely agree	slightly agree	slightly disagree	definitely disagree
9. I find social situations easy. (11)	definitely agree	slightly agree	slightly disagree	definitely disagree
10. I would rather go to a library than a party. (13)	definitely agree	slightly agree	slightly disagree	definitely disagree
11. I find making up stories easy. (14)	definitely agree	slightly agree	slightly disagree	definitely disagree
12. I find myself drawn more strongly to people than to things. (15)	definitely agree	slightly agree	slightly disagree	definitely disagree
13. I am fascinated by numbers. (19)	definitely agree	slightly agree	slightly disagree	definitely disagree
14. When I'm reading a story, I find it difficult to work out the characters' intentions. (20)	definitely agree	slightly agree	slightly disagree	definitely disagree
15. I find it hard to make new friends. (22)	definitely agree	slightly agree	slightly disagree	definitely disagree
16. I notice patterns in things all the time. (23)	definitely agree	slightly agree	slightly disagree	definitely disagree
17. It does not upset me if my daily routine is disturbed. (25)	definitely agree	slightly agree	slightly disagree	definitely disagree
18. I find it easy to do more than one thing at once. (32)	definitely agree	slightly agree	slightly disagree	definitely disagree

19. I enjoy doing things spontaneously. (34)	definitely agree	slightly agree	slightly disagree	definitely disagree
20. I find it easy to work out what someone is thinking or feeling just by looking at their face. (36)	definitely agree	slightly agree	slightly disagree	definitely disagree
21. If there is an interruption, I can switch back to what I was doing very quickly. (37)	definitely agree	slightly agree	slightly disagree	definitely disagree
22. I like to collect information about categories of things (e.g. types of car, types of bird, types of train, types of plant, etc.). (41)	definitely agree	slightly agree	slightly disagree	definitely disagree
23. I find it difficult to imagine what it would be like to be someone else. (42)	definitely agree	slightly agree	slightly disagree	definitely disagree
24. I enjoy social occasions. (44)	definitely agree	slightly agree	slightly disagree	definitely disagree
25. I find it difficult to work out people's intentions. (45)	definitely agree	slightly agree	slightly disagree	definitely disagree
26. New situations make me anxious. (46)	definitely agree	slightly agree	slightly disagree	definitely disagree
27. I enjoy meeting new people. (47)	definitely agree	slightly agree	slightly disagree	definitely disagree
28. I find it very easy to play games with children that involve pretending. (50)	definitely agree	slightly agree	slightly disagree	definitely disagree

3. Social Phobia Inventory (SPIN)

*Social Phobia Inventory (SPIN)**

Patient Name: _____ Date: _____

Please indicate how much the following problems have bothered you **during the past week**. Mark only one box for each problem, and be sure to answer all items.

	NOT AT ALL	A LITTLE BIT	SOME-WHAT	VERY MUCH	EXTREMELY
1. I am afraid of people in authority.	☐	☐	☐	☐	☐
2. I am bothered by blushing in front of people.	☐	☐	☐	☐	☐
3. Parties and social events scare me.	☐	☐	☐	☐	☐
4. I avoid talking to people I don't know.	☐	☐	☐	☐	☐
5. Being criticized scares me a lot.	☐	☐	☐	☐	☐
6. Fear of embarrassment causes me to avoid doing things or speaking to people.	☐	☐	☐	☐	☐
7. Sweating in front of people causes me distress.	☐	☐	☐	☐	☐
8. I avoid going to parties.	☐	☐	☐	☐	☐
9. I avoid activities in which I am the center of attention.	☐	☐	☐	☐	☐
10. Talking to strangers scares me.	☐	☐	☐	☐	☐
11. I avoid having to give speeches.	☐	☐	☐	☐	☐
12. I would do anything to avoid being criticized.	☐	☐	☐	☐	☐
13. Heart palpitations bother me when I am around people.	☐	☐	☐	☐	☐
14. I am afraid of doing things when people might be watching.	☐	☐	☐	☐	☐
15. Being embarrassed or looking stupid is among my worst fears.	☐	☐	☐	☐	☐
16. I avoid speaking to anyone in authority.	☐	☐	☐	☐	☐
17. Trembling or shaking in front of others is distressing to me.	☐	☐	☐	☐	☐

4. Camouflaging Autistic Traits Questionnaire (CAT-Q)

Self-Report Camouflaging Autistic Traits Questionnaire

Please read each statement below and choose the answer that best fits your experiences during social interactions.

Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Neither Agree nor Disagree (4)	Somewhat Agree (5)	Agree (6)	Strongly Agree (7)

1. When I am interacting with someone, I deliberately copy their body language or facial expressions
2. I monitor my body language or facial expressions so that I appear relaxed
3. I rarely feel the need to put on an act in order to get through a social situation*
4. I have developed a script to follow in social situations (for example, a list of questions or topics of conversation)
5. I will repeat phrases that I have heard others say in the exact same way that I first heard them
6. I adjust my body language or facial expressions so that I appear interested by the person I am interacting with
7. In social situations, I feel like I'm 'performing' rather than being myself
8. In my own social interactions, I use behaviours that I have learned from watching other people interacting
9. I always think about the impression I make on other people
10. I need the support of other people in order to socialise
11. I practice my facial expressions and body language to make sure they look natural
12. I don't feel the need to make eye contact with other people if I don't want to*
13. I have to force myself to interact with people when I am in social situations
14. I have tried to improve my understanding of social skills by watching other people
15. I monitor my body language or facial expressions so that I appear interested by the person I am interacting with
16. When in social situations, I try to find ways to avoid interacting with others

Hull, L., Mandy, M., Lai, M-C., Baron-Cohen, S., Allison, C., Smith, P. & Petrides, KV. Development and Validation of the Camouflaging Autistic Traits Questionnaire (CAT-Q) (2018). *Journal of Autism & Developmental Disorders, 49*(3), 819-833.

17. I have researched the rules of social interactions (for example, by studying psychology or reading books on human behaviour) to improve my own social skills
18. I am always aware of the impression I make on other people
19. I feel free to be myself when I am with other people*
20. I learn how people use their bodies and faces to interact by watching television or films, or by reading fiction
21. I adjust my body language or facial expressions so that I appear relaxed
22. When talking to other people, I feel like the conversation flows naturally*
23. I have spent time learning social skills from television shows and films, and try to use these in my interactions
24. In social interactions, I do not pay attention to what my face or body are doing*
25. In social situations, I feel like I am pretending to be 'normal'

Scoring:

All items are scored 1-7, with higher scores reflecting greater camouflaging. Items with an asterisk (*) should be reverse scored.

Factors:

Compensation (behaviours used to compensate for autism-related difficulties in social situations) = 1, 4, 5, 8, 11, 14, 17, 20, 23

Masking (behaviours used to hide autistic characteristics or present a non-autistic personality) = 2, 6, 9, 12, 15, 18, 21, 24

Assimilation (behaviours used to fit in with others/not stand out from the crowd) = 3, 7, 10, 13, 16, 19, 22, 25

Hull, L., Mandy, M., Lai, M-C., Baron-Cohen, S., Allison, C., Smith, P. & Petrides, KV. Development and Validation of the Camouflaging Autistic Traits Questionnaire (CAT-Q) (2018). *Journal of Autism & Developmental Disorders, 49*(3), 819-833.

5. Adolescent Social Behaviours Questionnaire (ASBQ)

ADOLESCENT SOCIAL BEHAVIOUR QUESTIONNAIRE

Please circle the word which best describes how often you do the following things when you are anxious in, or before a social situation.

1.	Try not to attract attention	Never	Sometimes	Often	Always
2.	Make an effort to get your words right	Never	Sometimes	Often	Always
3.	Check that you are coming across well	Always	Often	Sometimes	Never
4.	Avoid eye contact	Never	Sometimes	Often	Always
5.	Talk less	Always	Often	Sometimes	Never
6.	Avoid asking questions	Always	Often	Sometimes	Never
7.	Try to picture how you appear to others	Never	Sometimes	Often	Always
8.	Grip cups or glasses tightly	Never	Sometimes	Often	Always
9.	Position yourself so as not to be noticed	Always	Often	Sometimes	Never
10.	Try to control shaking	Always	Often	Sometimes	Never
11.	Choose clothes that will prevent or hide sweating	Never	Sometimes	Often	Always
12.	Wear clothes or makeup to hide blushing	Never	Sometimes	Often	Always
13.	Rehearse sentences in your mind	Always	Often	Sometimes	Never
14.	Check what you are going to say	Always	Often	Sometimes	Never
15.	Blank out or switch off mentally	Never	Sometimes	Often	Always
16.	Avoid talking about yourself	Never	Sometimes	Often	Always
17.	Keep still	Always	Often	Sometimes	Never
18.	Ask lots of questions	Always	Often	Sometimes	Never
19.	Stay on the edge of groups	Never	Sometimes	Often	Always
20.	Avoid pauses in speech	Always	Often	Sometimes	Never
21.	Hide your face	Never	Sometimes	Often	Always
22.	Try to think about other things	Always	Often	Sometimes	Never
23.	Use alcohol/drugs to manage anxiety	Always	Often	Sometimes	Never
24.	Talk more	Always	Often	Sometimes	Never
25.	Try to fit in and ‘act normal’	Always	Often	Sometimes	Never
26.	Try to stay in control of your behaviour	Never	Sometimes	Often	Always
27.	Make an effort to come across well	Always	Often	Sometimes	Never
28.	Planning things to talk about before a conversation	Never	Sometimes	Often	Always

6. Adolescent Social Cognitions Questionnaire (ASCQ)

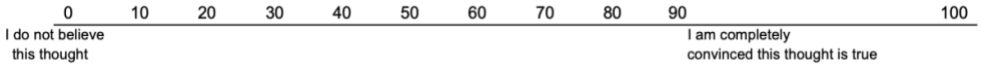
ADOLESCENT SOCIAL COGNITIONS QUESTIONNAIRE

Listed below are some thoughts that go through people's minds when they are nervous or frightened. Indicate, on the **LEFT** hand side of the form, how often in the last week each thought has occurred; rate each thought from 1-5 using the following scale:

1. Thought never occurs
2. Thought rarely occurs
3. Thought occurs during half of the times when I am nervous
4. Thought usually occurs
5. Thought always occurs when I am nervous

How often do you have this thought (Rate from 1-5)		**How much do you believe this thought?** (Rate from 0-100)
___	I will be unable to speak	___
___	I am unlikeable	___
___	I am going to tremble or shake uncontrollably	___
___	People will stare at me	___
___	I am being an idiot	___
___	People won't want to be friends with me	___
___	I will be frozen with fear	___
___	I will drop or spill things	___
___	I am going to be sick	___
___	I am not good enough	___
___	I will babble or talk funny	___
___	I am not as good as others	___
___	I will be unable to concentrate	___
___	I will be unable to write properly	___
___	People are not interested in me	___
___	People won't like me	___
___	People will make fun of me	___
___	I will sweat/perspire	___
___	I am going red	___
___	I am weird/different	___
___	People will see I am nervous	___
___	People think I am boring	___
___	I will embarrass myself	___
___	People will be angry with me	___
___	I will wet myself/have diarrhoea	___
___	I will look stupid	___
___	I will be forced to do things I don't want to do	___
___	People will laugh at me	___
	Other thoughts not listed (please specify)	
___	_____	___
___	_____	___

When you feel anxious how much do you believe each thought to be true. Please rate each thought by choosing a number from the scale below, and put the number which applies on the **RIGHT** hand side of the form.



7. Penn-State Worry Questionnaire - Child (PSWQ – C)

PSWQ-C

Directions. This form is about worrying. Worrying happens when you are scared about something and you think about it a lot. People sometimes worry about school, their family, their health, things coming up future, or other kinds of things. For each sentence that you read, circle the answer that best tells how true that sentence is about you.

1.	My worries really bother me.	never true	sometimes true	most times true	always true
2.	I don't really worry about things.	never true	sometimes true	most times true	always true
3.	Many things make me worry.	never true	sometimes true	most times true	always true
4.	I know I shouldn't worry about things, but I just can't help it.	never true	sometimes true	most times true	always true
5.	When I am under pressure, I worry a lot.	never true	sometimes true	most times true	always true
6.	I am always worrying about something.	never true	sometimes true	most times true	always true
7.	I find it easy to stop worrying when I want.	never true	sometimes true	most times true	always true
8.	When I finish one thing, I start to worry about everything else.	never true	sometimes true	most times true	always true
9.	I never worry about anything.	never true	sometimes true	most times true	always true
10.	I've been a worrier all my life.	never true	sometimes true	most times true	always true
11.	I notice that I have been worrying about things.	never true	sometimes true	most times true	always true
12.	Once I start worrying, I can't stop.	never true	sometimes true	most times true	always true
13.	I worry all the time.	never true	sometimes true	most times true	always true
14.	I worry about things until they are all done.	never true	sometimes true	most times true	always true

8. Revised Children's Anxiety and Depression Scales – Young Person Depression Scale

How are things?

Date: ☐☐/☐☐/20☐☐ Time: ☐☐h☐☐m

Please put a circle around the word that shows how often each of these things happen to you.
There are no right or wrong answers.

		0	1	2	3
1	I feel sad or empty	Never	Sometimes	Often	Always
2	Nothing is much fun anymore	Never	Sometimes	Often	Always
3	I have trouble sleeping	Never	Sometimes	Often	Always
4	I have problems with my appetite	Never	Sometimes	Often	Always
5	I have no energy for things	Never	Sometimes	Often	Always
6	I am tired a lot	Never	Sometimes	Often	Always
7	I cannot think clearly	Never	Sometimes	Often	Always
8	I feel worthless	Never	Sometimes	Often	Always
9	I feel like I don't want to move	Never	Sometimes	Often	Always
10	I feel restless	Never	Sometimes	Often	Always

NHS ID: .....

Service allocated case ID .....

SUM: ☐

9. Revised Children's Anxiety and Depression Scales – Young Person Generalised Anxiety Scale

How are things?

Date: ☐☐/☐☐/20☐☐ Time: ☐☐h☐☐m

Please put a circle around the word that shows how often each of these things happen to you.
There are no right or wrong answers.

		0	1	2	3
1	I worry about things	Never	Sometimes	Often	Always
2	I worry that something awful will happen to someone in my family	Never	Sometimes	Often	Always
3	I worry that bad things will happen to me	Never	Sometimes	Often	Always
4	I worry that something bad will happen to me	Never	Sometimes	Often	Always
5	I worry about what is going to happen	Never	Sometimes	Often	Always
6	I think about death	Never	Sometimes	Often	Always

.....

NHS ID: .....

Service allocated case ID .....

SUM: ☐

Appendix 6. Ethics Approval Letters

1. Health Research Authority

Dr Matthew Hollocks
Institute of Psychiatry, Psychology & Neuroscience
King's College London
16 De Crespigny Park
SE5 8AB

Email: approvals@hra.nhs.uk
HCRW.approvals@wales.nhs.uk

13 December 2021

Dear Dr Hollocks

HRA and Health and Care Research Wales (HCRW) Approval Letter

Study title:	**Understanding the relationship between social camouflaging in autism and safety behaviours in social anxiety in autistic and neurotypical adolescents**
IRAS project ID:	**300879**
Protocol number:	**N/A**
REC reference:	**21/LO/0750**
Sponsor	**King's College London**

I am pleased to confirm that **HRA and Health and Care Research Wales (HCRW) Approval** has been given for the above referenced study, on the basis described in the application form, protocol, supporting documentation and any clarifications received. You should not expect to receive anything further relating to this application.

Please now work with participating NHS organisations to confirm capacity and capability, in line with the instructions provided in the "Information to support study set up" section towards the end of this letter.

How should I work with participating NHS/HSC organisations in Northern Ireland and Scotland?
HRA and HCRW Approval does not apply to NHS/HSC organisations within Northern Ireland and Scotland.

If you indicated in your IRAS form that you do have participating organisations in either of these devolved administrations, the final document set and the study wide governance report (including this letter) have been sent to the coordinating centre of each participating nation. The relevant national coordinating function/s will contact you as appropriate.

Please see IRAS Help for information on working with NHS/HSC organisations in Northern Ireland and Scotland.

How should I work with participating non-NHS organisations?
HRA and HCRW Approval does not apply to non-NHS organisations. You should work with your non-NHS organisations to obtain local agreement in accordance with their procedures.

What are my notification responsibilities during the study?

The standard conditions document "*After Ethical Review – guidance for sponsors and investigators*", issued with your REC favourable opinion, gives detailed guidance on reporting expectations for studies, including:

- Registration of research
- Notifying amendments
- Notifying the end of the study

The HRA website also provides guidance on these topics, and is updated in the light of changes in reporting expectations or procedures.

Who should I contact for further information?
Please do not hesitate to contact me for assistance with this application. My contact details are below.

Your IRAS project ID is **300879**. Please quote this on all correspondence.

Yours sincerely,
Kathryn Davies

Approvals Specialist

Email: approvals@hra.nhs.uk

Copy to: *Mr Dunstan Nicol-Wilson, South London and Maudsley NHS Foundation Trust*

List of Documents

The final document set assessed and approved by HRA and HCRW Approval is listed below.

Document	*Version*	*Date*
Confirmation of any other Regulatory Approvals (e.g. CAG) and all correspondence [SLaM Sponsorship v1 300879]	1	08 September 2021
Contract/Study Agreement template [IRAS 300879 PIC Agreement v1 Bath]	1	01 January 2021
Copies of materials calling attention of potential participants to the research [Recruitment poster v2 300879]	v2	12 November 2021
Copies of materials calling attention of potential participants to the research [Recruitment emails v2.1 300879]	v2.1	13 December 2021
Copies of materials calling attention of potential participants to the research [Recruitment video link v1 300879]	1	26 July 2021
IRAS Application Form [IRAS_Form_16092021]		16 September 2021
Letter from funder [IoPPN DClinPsy Research Funding Letter v1 300879]	1	23 June 2021
Letter from sponsor [Sponsorship v1 300879]	1	08 September 2021
Non-validated questionnaire [Parent Q1 Parent Demographic Qs v1 300879]	1	28 June 2021
Non-validated questionnaire [YP Q1 YP Demographic Qs v1 300879]	1	28 June 2021
Other [IRAS Amendment Response - 121121]	v1	12 November 2021
Other [IRAS Amendment Response - 131221]	1	13 December 2021
Participant consent form [Parent consent for child v2 300879]	v2	12 November 2021
Participant consent form [Parent Self Consent v2 300879]	v2	12 November 2021
Participant consent form [Child Assent v2 300879]	v2	12 November 2021
Participant consent form [Adult (16-19 yrs) Consent v2 300879]	v2	12 November 2021
Participant information sheet (PIS) [Child PIS v2 300879]	v2	12 November 2021
Participant information sheet (PIS) [Adult PIS v2 300879]	v2	12 November 2021
Participant information sheet (PIS) [Parent Child PIS v2 300879]	v2	12 November 2021
Participant information sheet (PIS) [Parent Self PIS v2 300879]	v2	12 November 2021
Participant information sheet (PIS) [Parent Debrief v2 300879]	v2	12 November 2021
Participant information sheet (PIS) [Young Person Debrief v2 300879]	v2	12 November 2021
Referee's report or other scientific critique report [DClinPsy Project Review v1 300879]	1	20 April 2021
Research protocol or project proposal [Protocol v2 300879]	v2	12 November 2021
Summary CV for student [Jiedi Lei (Student) - CV]	1	18 June 2021
Summary CV for supervisor (student research) [Tony Charman (Supervisor 1) CV 2021 v1 300879]	1	21 June 2021
Summary CV for supervisor (student research) [Eleanor Leigh (Supervisor 3) - CV]	1	05 July 2021
Summary CV for supervisor (student research) [Ailsa Russell (Supervisor 4) - CV]	1	05 July 2021
Summary, synopsis or diagram (flowchart) of protocol in non technical language [IRAS Appendix v1 300879]	1	14 June 2021
Validated questionnaire [Parent Q2 AQ-Adolescent v1 300879]	1	
Validated questionnaire [Parent Q3 RCADS-Parent v1 300879]	1	
Validated questionnaire [YP Q2 AQ-Short v1 300879]	1	

Validated questionnaire [YP Q3 SPIN v1 300879]	1	
Validated questionnaire [YP Q4 CAT-Q v1 300879]	1	
Validated questionnaire [YP Q5 ASBQ-28 v1 300879]	1	
Validated questionnaire [YP Q6 ASCQ v1 300879]	1	
Validated questionnaire [YP Q7 PSWQ-C v1 300879]	1	
Validated questionnaire [YP Q8 RCADS-C (Depression) v1 300879]	1	
Validated questionnaire [YP Q9 RCADS-C (GAD) v1 300879]	1	

IRAS project ID	300879

Information to support study set up

The below provides all parties with information to support the arranging and confirming of capacity and capability with participating NHS organisations in England and Wales. This is intended to be an accurate reflection of the study at the time of issue of this letter.

Types of participating NHS organisation	Expectations related to confirmation of capacity and capability	Agreement to be used	Funding arrangements	Oversight expectations	HR Good Practice Resource Pack expectations
This is a single site study sponsored by the participating NHS organisation therefore there is only one site type.	This is a single site study sponsored by the participating NHS organisation. You should work with your sponsor R&D office to make arrangements to set up the study. The sponsor R&D office will confirm to you when the study can start following issue of HRA and HCRW Approval.	This is a single site study sponsored by the participating NHS organisation therefore no agreements are expected.	No external study funding has been sought.	A Principal Investigator should be appointed at the study site.	The sponsor has confirmed that local staff in participating organisations in England who have a contractual relationship with the organisation will undertake the expected activities. Therefore, no honorary research contracts or letters of access are expected for this study.

Other information to aid study set-up and delivery

This details any other information that may be helpful to sponsors and participating NHS organisations in England and Wales in study set-up.
The applicant has indicated that they do not intend to apply for inclusion on the NIHR CRN Portfolio.

2. South London and Maudsley - Capacity and Capability approval

IRAS: 300879- Confirmation of SLaM Capacity and Capability (C&C)

Armoogum, Christina <christina.armoogum@kcl.ac.uk>
Mon 14/02/2022 15:32

To: Lei, Jiedi <jiedi.lei@kcl.ac.uk>; Hollocks, Matthew <matthew.hollocks@kcl.ac.uk>

Cc: kcl - slam-ioppn.research <slam-ioppn.research@kcl.ac.uk>; KCL SLaM EDGE Support <slam.edge@kcl.ac.uk>; CAMHS.Governance@slam.nhs.uk <CAMHS.Governance@slam.nhs.uk>

4 attachments (962 KB)

Reporting_SLaM_Participants_Recruitment.pdf; Study team responsibilities v3.0 20.12.2021.pdf; IRAS_Form_16092021.pdf; PI Declaration v1.0 30.09.2020.docx;

Dear Dr Hollocks,

IRAS ID: 300879
Study Title: Social camouflaging and safety behaviours in autism and social anxiety
Sponsor: South London and Maudsley NHS Foundation Trust & King's College London
CI: Dr Matthew Hollocks
Trust R&D Ref: R&D 2022/004

Please take this e-mail as confirmation that South London and Maudsley NHS Foundation Trust (SLaM) has the capacity and capability to host this research study. This study can therefore now commence at SLaM. Your Trust reference number has been quoted above and should be used at all times when contacting this office about this study. Please read the conditions outlined below and keep a copy of this email for future reference.

The confirmation of capacity and capability to host this research study relates to work in the **CAHMS CAG** and to the specific protocol and informed consent procedures described in approved by the REC and the HRA. Any deviation from this will be deemed to invalidate this confirmation.

You have committed to recruit	114 participants
Within the recruitment period	14/02/2022 and 28/02/2023
First participant is expected to be recruited by	16/03/2022 (30 days after C&C).

Should there be any issues with this please do not hesitate to contact the R&D office. There is a mandatory requirement that your study team provides monthly accrual / recruitment data as requests – completion of this is a condition of your continuation of SLaM approval of this study.

Please find attached guidance on reporting requirements, study management and PI declaration. Please let me know if you/ the study delegate wish to to go through the PI declaration and I can arrange a meeting for this.

Approved documents:

Document title:	Version:	Date:
Protocol v2 300879	2.0	12/11/2021
IRAS Appendix v1 300879	1.0	14/06/2021
Child PIS v2 300879	2.0	12/11/2021
Adult PIS v2 300879	2.0	12/11/2021
Parent Child PIS v2 300879	2.0	12/11/2021
Parent Self PIS v2 300879	2.0	12/11/2021
Parent Child Consent v2 300879	2.0	12/11/2021
Parent Self Consent v2 300879	2.0	12/11/2021
Child Assent v2 300879	2.0	12/11/2021
Adult Consent v2 300879	2.0	12/11/2021
Recruitment poster v2 300879	2.0	12/11/2021
Recruitment Emails v2.1 300879	2.1	13/12/2021

Recruitment video link v1 300879	1.0	(no date on document)
Parent Debrief v2 300879	2.0	12/11/2021
Young Person Debrief v2 300879	2.0	12/11/2021
Q1 Parent Demographic Qs v1 300879	1.0	28/06/2021
Q1 YP Demographic Qs v1 300879	1.0	28/06/2021
Q2 AQ-Adolescent v1 300879	1.0	-
Q3 RCADS-Parent v1 300879	1.0	-
Q2 AQ -Short v1 300879	1.0	-
Q3 SPIN v1 300879	1.0	-
Q4 CAT-Q v1 300879	1.0	-
Q5 ASBQ-28 v1 300879	1.0	-
Q6 ASCQ v1 300879	1.0	-
Q7 PSWQ-C v1 300879	1.0	-
Q8 RCADS-C (Depression) v1 300879	1.0	-
Q9 RCADS-C (GAD) v1 300879	1.0	-

Kind regards,

Christina

Christina Armoogum
Senior R&D Governance Facilitator, Joint R&D Office of SLaM and IoPPN
King's College London
W1.12, Institute of Psychiatry, Psychology & Neuroscience (IoPPN),
King's College London, De Crespigny Park, London SE5 8AF
Email: christina.armoogum@kcl.ac.uk

3. CRIS Application – 22-009 Approval

CRIS Application - 22-009 /Information Governance Training

Cummings, Debbie <Debbie.Cummings@slam.nhs.uk>
Wed 09/03/2022 11:27
To: Lei, Jiedi <Jiedi.Lei@slam.nhs.uk>

2 attachments (603 KB)
Welcome to CRIS_Active.pdf; Notes for C4C projects_active.pdf;

Dear Jiedi

Your CRIS application reference number: Project 22-009 ' Understanding the relationship between social camouflaging in autism and safety behaviours in social anxiety in autistic and neurotypical adolescents | C4C', is now approved.

Please find attached our Welcome to CRIS Guide for your reference, C4C Notes and the link to the BRC website. Please be aware that CRIS users are requested to provide feedback on the progress of their study. You will be contacted for this purpose, for a mid-year review, after project approval by the CRIS administrator, until project completion. If your study has experienced a delay of greater than 3 months in starting, the oversight committee may request the application is resubmitted

http://www.maudsleybrc.nihr.ac.uk/

CRIS is a service and the team is available to answer any queries and offer guidance throughout your time using CRIS. As a first step, please meet with Daisy Kornblum Information Analyst (daisy.kornblum@slam.nhs.uk), to discuss your search strategy.

We hold regular CRIS training sessions, if you are interested in attending a session please let either myself or Daisy know and we will keep you informed of the next session to take place. (**Please note we have no training dates currently planned**).

Information Governance Training

Please be aware that anyone accessing any data or systems need to have undertaken the SLaM IG training, via LEAP at the following link:

https://leap.slam.nhs.uk/course/view.php?id=179 or Kings https://internal.kcl.ac.uk/about/secretariat/business-assurance/compliance/gdpr/GDPR-training and provide relevant evidence.

Please note if your coming to us from an existing course or other institution, you should bring your GDPR training credentials which maybe accepted.

Kind regards Debbie

Debbie Cummings
BRC Nucleus Administrator

South London and Maudsley NHS Foundation Trust
SLaM Biomedical Research Centre Nucleus | Maudsley Site | Ground Floor | Mapother House | De Crespigny Park | Denmark Hill | London | SE5 8AF
Telephone: 020 3228 8553

020 3228 6000 The switchboard number for SLaM

For more information about CRIS, see our website: http://www.maudsleybrc.nihr.ac.uk/about-us/core-facilities/clinical-record-interactive-search-cris/

South London and Maudsley NHS Foundation Trust
Overall rating of 'good' - Care Quality Commission

Appendix 7. Statement regarding Parent/Carer Data Information

The current study proposal also included asking parent/carer for each young person to participate in the study by completing a set of questionnaires about their perception of the young person's autism traits and mental health difficulties. Data collected from parent/carers were used in a separate empirical study that examined the association between social camouflaging and self- versus caregiver-report discrepancies in anxiety and depressive symptoms in autistic and non-autistic adolescents. This manuscript is currently under peer review at the journal *Autism*.