RESEARCH ARTICLE

Cognitive Predictors of Self-Reported Camouflaging in Autistic Adolescents

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Camouflaging involves masking and/or compensating for autistic characteristics and has been identified in autistic individuals through a variety of different methods. Individual variation in the extent, processes and outcomes of camouflaging has been reported in autistic adults, and there has been some investigation of camouflaging by autistic adolescents. This study was conducted to better understand how some of these individual differences emerge, by examining potential mechanisms (theory of mind, executive function, intelligence quotient and age) involved in camouflaging by 58 autistic adolescents aged 13–18 years (29 females, 29 males). Fewer executive function difficulties predicted greater use of total camouflaging strategies and the compensation subscale, but not the masking or assimilation subscales; no other predictors reached statistical significance. These findings suggest that individual differences in executive function ability may underlie variation in the use of camouflaging by adolescents. The total variance explained in the model was small, suggesting the need to examine other factors which may underpin camouflaging. The implications of this finding for the relationship between camouflaging and well-being are discussed, along with the distinction between attempts to camouflage and the efficacy of those attempts. *Autism Res* 2020, 00: 1–10. © 2020 The Authors. *Autism Research* published by International Society for Autism Research and Wiley Periodicals LLC.

Lay Summary: Camouflaging involves hiding your autism or finding ways around difficulties in order to fit in during social situations. This study found that autistic teenagers with good executive function abilities camouflage their autism more than those who struggle with executive function (which includes planning, goal-direction and memory). This may have implications for teenagers' mental health and their social functioning.

Keywords: camouflaging; masking; compensation; adolescence; executive function

Introduction

Camouflaging—the use of strategies, whether consciously or not, to mask autistic characteristics and compensate for social difficulties associated with autism—has been extensively demonstrated in autistic adults. Three key components of camouflaging have been previously identified: compensation (the use of strategies to overcome specific social difficulties associated with autism), masking (the use of strategies to hide one's autism) and assimilation (the use of strategies to blend in with others in social situations) [Hull et al., 2018]. Although many autistic individuals camouflage in order to improve social relationships and gain opportunities, including employment, it has also been associated with significant negative outcomes including poor mental health [Hull et al., 2018; Lai et al., 2017], suicidal thoughts [Cassidy, Bradley, Shaw, & Baron-Cohen, 2018] and burnout [Raymaker et al., 2020].

Qualitative and quantitative research has shown that autistic adults have a range of different experiences of camouflaging. Some people report camouflaging in almost every social interaction, some that they are unable to camouflage even when they would like to and still others actively choose not to camouflage [Cage & Troxell-Whitman, 2019; Hull et al., 2017]. Self-reported camouflaging of autistic traits has been measured in adults with and without a diagnosis of autism, suggesting that non-autistic people may use some camouflaging techniques in social situations [Hull et al., 2018]. Although autistic adults on average report camouflaging at higher levels than non-autistic adults [Hull et al., 2020; Robinson, Hull, & Petrides, 2020], the distributions of scores on measures of camouflaging for autistic and non-autistic adults overlap. Some individuals also report that camouflaging is highly effortful and requires a lot of careful preparation, while others say they were

not even aware they were camouflaging until it was pointed out by others [Hull et al., 2017]. All of this suggests that the act of camouflaging, which is still little understood, varies extensively between different autistic individuals.

Individual differences in the cognitive abilities used in camouflaging may account for these differences in camouflaging experience and outcomes. However, to date there has been limited research identifying the cognitive processes involved in camouflaging. Some hypothesised predictors are discussed below.

Intelligence Quotient

Intellectual ability has been proposed as an important contributor to the ability to camouflage or compensate for autistic characteristics [Lehnhardt et al., 2015; Livingston & Happé, 2017].

Greater intellectual ability has been associated with a reduction in observable autistic characteristics, which may represent the development of successful camouflaging strategies [Black, Wallace, Sokoloff, & Kenworthy, 2009]; although this may also be due to genuine change in autistic characteristics over time. Intelligence quotient (IQ) was found to differentiate compensation ability in a study of adolescents [Livingston, Colvert, Bolton, & Happé, 2019], with high compensators having higher verbal and full-scale IQ than low compensators. However, another study did not find a relationship between verbal IQ and camouflaging ability [Lai et al., 2017]. One possible explanation for this discrepancy is that participants in the study by Lai and colleagues were adults with above-average IQ, whereas the adolescents in the study by Livingston and colleagues had below-average to average IQ. It may be that younger autistic individuals, and/or those with lower IQ, are more strongly influenced by variation in IQ compared to older, more intellectually able autistic people.

Executive Function

In addition to IQ, executive function abilities have been hypothesised to contribute to camouflaging in previous literature. High-level cognitive control, enabling flexibility of responses across situations, self-monitoring and inhibition of automatic behaviours and the planning of appropriate responses, has been proposed to enable the control of behaviours that underlie camouflaging [Lehnhardt et al., 2015; Livingston & Happé, 2017]. Lai et al. [2017] found an association between executive function and camouflaging in autistic women but not men, as well as evidence for an underlying neural mechanism, with greater cerebellum gray matter (associated with executive function abilities) correlated with greater camouflaging in women only. In a mostly male sample, high compensators were found to have greater executive function abilities than low compensators, suggesting that this relationship might not be limited to females [Livingston, Colvert, et al., 2019]. Some level of executive function capacity may be necessary for general camouflaging abilities and may be especially important for the compensation and masking components of camouflaging, as these involve the deliberate use of learned strategies and self-monitoring and inhibition of innate behaviours, respectively. However, no studies have yet examined the relationship between executive function and self-reported camouflaging.

Theory of Mind

Some researchers have also suggested that theory of mind or mentalising abilities may promote greater camouflaging. Camouflaging likely requires some level of understanding of what others expect from you (i.e. recognition of non-autistic social norms and expectations), and for a camouflaging attempt to be successful, an individual may also need to identify how others perceive them and adapt their behaviours accordingly. Livingston and Happé [2017] suggest that developing alternative neural routes to theory of mind may be a form of compensation which produces behaviours associated with camouflaging. For instance, autistic individuals with poor theory of mind may use cognitive strategies such as memorising facial expressions to enable them to respond appropriately to others' emotional states, and so score better on measures of theory of mind. It therefore stands to reason that greater theory of mind abilities (however, developed) are likely to be associated with greater overall camouflaging.

No association between the temporal parietal junction (an area traditionally associated with mentalising/theory of mind) and camouflaging has been found for autistic adults [Lai et al., 2019]. This may reflect the use of alternative neural mechanisms as proposed by Livingston and Happé [2017]; however, no cognitive measure of theory of mind was included in the study by Lai and colleagues, therefore it is unclear what participants' theory of mind abilities actually were. The only other study to empirically examine potential mechanisms of camouflaging [Livingston, Shah, & Happé, 2019] used theory of mind ability as part of the measure of camouflaging (operationalised as the discrepancy between Autism Diagnostic Observation Schedule (ADOS) score and theory of mind), therefore the role of theory of mind itself as a mechanism for camouflaging could not be evaluated due to confounding. No studies have yet examined cognitive theory of mind in relation to a separate measure of camouflaging. We suggest that theory of mind may play a particular role in promoting masking and assimilation strategies, as these rely on understanding how others perceive you.

Camouflaging in Adolescence

There has been limited research into camouflaging in non-adult samples; camouflaging has been observed in children [e.g. Dean, Harwood, & Kasari, 2017] and adolescents [e.g. Livingston, Shah, et al., 2019] through different methods, but self-reported camouflaging in particular has been previously examined just once in adolescents [Jorgenson, Lewis, Rose, & Kanne, 2020]. This suggests that autistic adolescents are able to report on their own camouflaging behaviours, although some individuals may be unaware of their camouflaging or unable to describe or identify it. However, it may still be possible for autistic adolescents to report on their use of specific strategies, even if they are not consciously aware of the reasons for using those strategies. Self-report methodologies capture only one aspect of camouflaging behaviours and should be used in combination with other methods, such as observation and informant report, for a fuller picture of both conscious and unconscious camouflaging processes [Hull et al., 2018].

Adolescence is a time when many people (autistic or not) are more aware of feeling different, and being autistic is likely to increase both the expectation and the difficulties associated with fitting [Tierney, Burns, & Kilbey, 2016]. Individual differences in cognitive characteristics, such as those described above, may therefore interact with greater expectation to camouflage during adolescence from peers, adults, or the individual themselves. These individual differences may influence how adolescents camouflage their autism and the impact it has on them as they develop into adulthood. As we know camouflaging is associated with poor mental health outcomes in adults [Hull et al., 2018], it is important to identify characteristics which may predict variation in the amount or the impact of camouflaging earlier in life. These findings could then be used to identify individuals who may be most at-risk of poor outcomes associated with camouflaging in adulthood.

The Present Study

This study is the first to examine proposed cognitive components of camouflaging in autistic adolescents, and, in particular, the first to examine the role of theory of mind in relation to self-reported camouflaging and its component parts. Age is also included as a predictor, as older adolescents are likely to have had more time to develop and practice their camouflaging abilities. The analyses also controlled for autism symptom severity.

Research Question

Which cognitive and individual characteristics (executive function, theory of mind, IQ, age) predict total and subscale self-reported camouflaging scores in autistic adolescents?

Methods
Participants

Participants included in this study were adolescents with a formal diagnosis of an autism spectrum disorder from the United Kingdom, recruited through local National Health Service services, social media, and word-of-mouth. Formal diagnosis was confirmed by checking medical records and educational statements (where families had given their consent), or by families providing details of the service or healthcare professional who had given the diagnosis. Participants were excluded if they had an intellectual disability (i.e. if they scored 70 or below on the Wechsler Abbreviated Scale of Intelligence, Second Edition [WASI-II]). A total of 58 participants aged 13–18 (29 female) were included in the present analyses. Participant characteristics are detailed in Table 1. Further demographic information about the participants, including ethnicity, whether they were in mainstream or specialist schooling, and socioeconomic status, was not available.

A posthoc sensitivity power analysis determined that our sample size of 58 would be able to detect moderate effects of $f^2 = 0.22$ (equivalent to standardised beta values of 0.42) with power = 0.80 for individual predictors in a linear multiple regression with four predictors of camouflaging.

Ethical Approval

Ethical approval for this study was obtained from the Health Research Authority and the Bloomsbury Research Ethics Committee (Reference 17/LO/2055).

Measures

Camouflaging Autistic Traits Questionnaire (CAT-Q) [Hull et al., 2018]. This is a 25-item self-report measure of camouflaging strategies, comprising a total score and three subscale scores, measuring Compensation (the use of strategies to compensate for social difficulties associated with autism), Masking (the use of strategies to hide autistic characteristics and/or present non-autistic characteristics), and Assimilation (the use of strategies to fit in with other, non-autistic people). The CAT-Q has demonstrated good test–retest reliability and measurement invariance in autistic and non-autistic adults [Hull et al., 2018]. The CAT-Q has not yet been validated with adolescent samples; however internal consistency for the total self-reported CAT-Q score in the present sample was $\alpha = 0.91$, while internal consistencies for the subscales were as follows: Compensation $\alpha = 0.89$, Masking $\alpha = 0.81$, Assimilation $\alpha = 0.87$.

Table 1. Means, SDs and Correlations (with 95% confidence intervals) Between All Variables ($N = 58$)

	Mean (SD)	Age	IQ	SRS	BRIEF	ToM	CAT-Q Total	CAT-Q Compensation	CAT-Q Masking
Age	14.48 (1.74)								
IQ	100.85 (15.98)	0.16 (−0.10, 0.40)							
SRS	79.95 (9.94)	−0.07 (−0.32, 0.19)	−0.30 (−0.52, −0.05)						
BRIEF	72.50 (10.58)	−0.02 (−0.28, 0.24)	−0.26 (−0.49, 0.00)	0.59 (0.39, 0.73)					
ToM	11.90 (2.97)	−0.03 (−0.29, 0.23)	0.50 (0.28, 0.67)	−0.21 (−0.44, −0.05)	−0.34 (−0.55, −0.09)				
CAT-Q Total	105.03 (25.22)	−0.14 (−0.38, 0.13)	0.10 (−0.16, 0.35)	0.03 (−0.23, 0.29)	−0.27 (−0.50, −0.01)	0.08 (−0.18, 0.33)			
CAT-Q Compensation	35.29 (12.47)	−0.13 (−0.37, 0.13)	0.01 (−0.25, 0.26)	0.00 (−0.26, 0.26)	−0.22 (−0.45, 0.04)	0.04 (−0.22, 0.29)	0.88 (0.80, 0.93)		
CAT-Q Masking	35.93 (9.48)	−0.16 (−0.40, 0.10)	0.11 (−0.15, 0.36)	−0.11 (−0.36, 0.15)	−0.31 (−0.52, −0.05)	0.04 (−0.22, 0.30)	0.70 (0.54, 0.81)	0.48 (0.26, 0.66)	
CAT-Q Assimilation	33.82 (10.43)	−0.03 (−0.29, 0.23)	0.14 (−0.12, 0.39)	0.18 (−0.08, 0.42)	−0.11 (−0.36, 0.15)	0.11 (−0.15, 0.36)	0.73 (0.59, 0.83)	0.48 (0.26, 0.66)	0.21 (−0.05, 0.45)

BRIEF: Behaviour Rating Inventory of Executive Function; CAT-Q: Camouflaging Autistic Traits Questionnaire; SRS: Social Reciprocity Scale; ToM: Theory of Mind scale of Strange Stories task.

Behaviour Rating Inventory of Executive Function, Second Edition (BRIEF-2) [Gioia, Isquith, Guy, & Kenworthy, 2015]. The BRIEF-2 is a 63-item informant-report measure of executive function difficulties, suitable for use with children aged 5–18 years, which has demonstrated good internal consistency, test–retest reliability, and concurrent validity [Hendrickson & McCrimmon, 2019]. It consists of nine subscales reflecting different aspects of executive function abilities, and yields an overall score representing general executive function impairment. The parent-report version was used for this study, and standardised total executive function difficulty scores (General Executive Composite [GEC]; with higher scores indicating great executive function impairment) were included in the analyses.

The BRIEF was selected instead of behavioural or self-report measures of executive function because this method has greater ecological validity in autistic populations [Demetriou et al., 2018]. The BRIEF has also demonstrated greater sensitivity to individual differences than behavioural measures of executive function [Demetriou et al., 2018].

Strange stories [Happé, 1994]. The Strange Stories task is a semi-naturalistic measure of theory of mind, which aims to measure participants' ability to understand the mental states of others in the context of everyday situations described in short stories. The original task was reported to have adequate reliability, but poor internal consistency [Devine & Hughes, 2016; Hayward & Homer, 2017]. Following previous studies from the original author which have adapted the original Strange Stories task [Happé, Brownell, & Winner, 1999; Happé, Winner, & Brownell, 1998], a subsample of 16 stories was included in the battery for the present study, which takes around 10 min to complete. Eight 'social' stories testing theory of mind, and eight control stories of similar conceptual complexity, but without theory of mind components, were shown to participants, who were then asked to read the story and turn the page when finished. They were subsequently asked a structured question designed to elicit understanding of underlying mental states (for the social stories) or understanding of the events that were described (for the control stories). Correct answers are awarded two points, partially correct answers one point, and incorrect answers no points according to the standardised scoring protocol [Happé, 1994]. For the current analyses, a total 'theory of mind' accuracy score was calculated from the sum of all scores for social stories, following previous procedures [Murray et al., 2017]. Our use of the Strange Stories task followed the adapted procedure described in previous studies from the original authors [Happé et al., 1998; Murray et al., 2017]. Internal consistency for control stories was acceptable ($\alpha = 0.76$), while

internal consistency for social stories was lower at $\alpha = 0.61$.

WASI-II [Wechsler, 2011]. The WASI-II is a standardised measure of intellectual ability suitable for children and adults aged 6–90 years. The WASI-II has demonstrated good-to-excellent internal consistency in both child and adult populations [McCrimmon & Smith, 2013], although has not, to our knowledge, been specifically validated in autistic populations. However, the WASI-II has been previously used in studies with autistic participants [e.g. Gardner, Campbell, Keisling, & Murphy, 2018; Morrison, DeBrabander, Faso, & Sasson, 2019]. Full-scale IQ scores were calculated for each participant.

Social Reciprocity Scale (SRS) [Constantino & Gruber, 2007]. A standardised parent-report measure of a child's autistic symptoms, consisting of 65 items. Acceptable levels of reliability and validity have been found in a general population sample of British children [Wigham, McConachie, Tandos, & Le Couteur, 2012]; and the SRS has demonstrated good sensitivity, specificity, and high correlations with other measures of autistic symptoms [Bruni, 2014]. A standardised *T* score is calculated for each child, with a mean of 50 and a SD of 10. Total scores of 60 and above are indicative of clinically significant social difficulties and restricted and repetitive behaviours associated with autism. Total scores were used for these analyses, with higher scores representing more autistic symptoms.

Procedure

Assessments took place at participants' home or school, or at private testing rooms at the university. All measures were administered by trained doctoral students (PhD and DClinPsych), and participants were referred to by numerical pseudonyms on all paper and electronic copies of measures. Informed consent was obtained from all participants prior to data collection; parents of all participants completed informed consent forms on behalf of themselves and their children, and adolescents confirmed their assent to take part in writing and verbally at the start of each data collection session.

Adolescents completed the WASI-II (unless a WASI-II or WISC-IV measure of IQ had already been recorded in the participant's medical notes, and the family had given consent for this to be accessed), the Strange Stories task, and the self-report CAT-Q. Parents completed the BRIEF-2 and the SRS concurrently with the other measures. The total study, with additional measures not included in the current analyses, took between 1.5 and 3 hr on average, depending on the number of assessments required and the number of breaks requested by the participant.

Analyses

All analyses were performed in R [R Core Team, 2013].

As several participants had one or more missing variables, multiple imputation was performed to replace missing data with plausible values using the Hmisc function in R. Data were missing completely at random, as there was no association between the presence of missing data and scores on any other variables. All variables included in the dataset were used to calculate imputed values, and five imputed data sets were pooled to produce estimates (as approximately 5% of the total data was missing, following White, Royston, and Wood [2011]. One participant (1.7% of total sample) was missing BRIEF-GEC, two (3.4%) were missing full-scale WASI scores, two (3.4%) were missing total CAT-Q and/or subscale scores, four (6.9%) were missing SRS scores, and six (10.3%) were missing scores on the Strange Stories Theory of Mind task.

Correlations between all variables were calculated (Table 1), with reported correlations adjusted for multiple comparisons. Four multiple regressions predicting self-reported camouflaging (total CAT-Q and Compensation, Masking, and Assimilation subscales) from cognitive characteristics were run, with autistic traits included as a covariate in each model.

Results

Mean scores and correlations between all variables are displayed in Table 1. 95% Confidence intervals are reported under all correlations. Significant correlations are in bold.

Age, IQ, and theory of mind were not correlated with any self-reported camouflaging scores. Executive function difficulties were negatively correlated with self-reported total and masking scores on the CAT-Q, although the observed effect was small, while the correlation between executive function difficulties and self-reported compensation strategies approached significance.

Results of the four multiple regressions are summarised in Table 2. Assumptions of independence of errors and no multicollinearity were met.

None of the overall regression models were significant (although Model 1 approached significance); however, in light of the small sample size, individual predictor parameters are reported as preliminary findings. The only significant predictor of camouflaging was executive function difficulties, which negatively predicted total camouflaging strategies and the compensation subscale.

Table 2. Summary of Results From Multiple Regression Analyses

	B	β	95% CI B	P
Model 1: Total self-report CAT-Q; R^2 Adj = 0.08, $F(5, 52)$ = 1.99, P = 0.09				
Intercept	136.83		38.59, 235.08	0.007
SRS	0.79	0.31	−0.03, 1.61	0.058
Age	−2.22	−0.15	−5.99, 1.56	0.244
IQ	0.23	0.15	−0.25, 0.72	0.337
BRIEF-2	−1.07	−0.45	−1.85, −0.29	0.008
ToM	−0.75	−0.09	−3.35, 1.86	0.568
Model 2: Self-report compensation; R^2 Adj = 0.01, $F(5,52)$ = 1.05, P = 0.39				
Intercept	60.80		10.30, 111.30	0.019
SRS	0.24	0.19	−0.18, 0.66	0.265
Age	−0.92	−0.13	−2.86, 1.02	0.345
IQ	0.02	0.02	−0.23, 0.27	0.900
BRIEF-2	−0.41	−0.35	−0.81, −0.01	0.045
ToM	−0.23	−0.06	−1.57, 1.11	0.730
Model 3: Self-report masking; R^2 Adj = 0.07, $F(5,52)$ = 1.84, P = 0.12				
Intercept	63.89		26.71, 101.06	0.001
SRS	0.12	0.12	−0.19, 0.43	0.446
Age	−1.04	−0.19	−2.47, 0.39	0.151
IQ	0.09	0.15	−0.09, 0.27	0.331
BRIEF-2	−0.36	−0.40	−0.65, 0.06	0.190
ToM	−0.48	−0.15	−1.46, 0.51	0.336
Model 4: Self-report assimilation; R^2 Adj = 0.05, $F(5,52)$ = 1.66, P = 0.16				
Intercept	11.93		−29.27, 53.13	0.564
SRS	0.44	0.42	0.09, 0.78	0.014
Age	−0.27	−0.04	−1.85, 1.32	0.736
IQ	−0.13	−0.20	−0.07, 0.34	0.203
BRIEF-2	−0.30	−0.31	−0.63, 0.02	0.069
ToM	0.04	0.01	−1.13, 1.06	0.947

Note. Statistics from each full model are presented, followed by coefficients (B), standardised beta values (β), 95% confidence intervals (95% CI) for coefficients, and significance values (P).

BRIEF-2: Behavioural Inventory of Executive Function, second edition; SRS: Social Reciprocity Scale; ToM: Theory of Mind scale of Strange Stories task.

Discussion

This study examined potential predictors of self-reported camouflaging in autistic adolescents. Results relating to each predictor will be discussed in turn below.

Age

Mean camouflaging scores (mean = 105.73, range = 62–169) were slightly lower in this adolescent sample than have been reported in previous adult samples (mean = 118.66 in Hull et al. [2018]; mean = 116.12 in Cage & Troxell-Whitman [2019]), and were slightly higher than those reported by the only other study to use the CAT-Q with adolescents (mean = 99.46) [Jorgenson et al., 2020]. It is not clear whether this reflects a small increase in the extent of camouflaging during adulthood, or changes in the ability to identify and report one's camouflaging strategies after adolescence. Nevertheless, these findings suggest that camouflaging does not develop solely in

adulthood, although it may increase from adolescence to adulthood. Examination of camouflaging in earlier childhood is therefore warranted, to identify when camouflaging begins to develop. It should be noted, however, that these comparisons are cross-sectional and that to properly examine changes in camouflaging across development, a longitudinal design will be needed.

Within our sample of young autistic people aged 13–18 years, there was no significant association between age and self-reported camouflaging, in contrast to our hypotheses. This suggests that younger adolescents may already camouflage at relatively high levels, and the extent of camouflaging may not increase during adolescence. Although there are many differences in the cognitive abilities and social experiences of teenagers aged 13 and 18 (the youngest and oldest ages included in this study), self-reported camouflaging appears to remain relatively constant. However, it is important to emphasise that the CAT-Q only measures self-identified attempts to camouflage one's autism. There may be developmental or social factors that impact the effectiveness of camouflaging during adolescence, as adolescents are able to refine and practice their camouflaging techniques in different situations.

The finding of no significant association between camouflaging and age suggests that early identification of camouflaging is especially important, as camouflaging may occur at relatively high levels even in younger adolescents. It is still unclear to what extent camouflaging has a negative impact on overall wellbeing, although the association between camouflaging and mental health difficulties, exhaustion, and burnout has been strongly and consistently documented [Cage, Di Monaco, & Newell, 2018; Hull et al., 2017]. If younger adolescents are camouflaging at similar levels to older adolescents, the impact of these camouflaging strategies should be assessed as early as possible, so the young person can be assisted in developing healthy coping strategies or, if preferred, minimising their use of camouflaging strategies.

Intelligence Quotient

IQ was not significantly correlated with any measure of camouflaging nor did it predict any measure of camouflaging in this sample. Overall, the findings suggest that higher full-scale IQ is not necessary to promote overall camouflaging in autistic adolescents. This supports some previous research findings [Lai et al., 2017], and suggests that particular subdomains of IQ (such as verbal IQ) may play a greater role than general cognitive ability [Livingston, Colvert, et al., 2019]. Participants in our study included a broad range of intellectual abilities (the lowest score was 71 and the highest 130), suggesting that there is no 'cutoff' within typical intellectual abilities at which camouflaging is more common. Future research

should therefore examine camouflaging in autistic individuals with intellectual disability to determine if similar results can be found in this population.

Executive Function

Better executive function, as measured by the BRIEF-2, predicted higher total camouflaging scores, and the compensation subscale. Negative predictive relationships between executive function difficulties and the masking and assimilation subscales were also found, although these did not reach statistical significance. There are several possible implications of these findings. Greater executive function abilities may underlie all aspects of camouflaging to some extent, although the relationship may be strongest with the compensation subscale. For instance, it may be necessary to use executive function when compensating for social difficulties, by identifying specific skills to develop, practice, and refine. These high-level cognitive abilities are also likely to be important for using specific masking strategies, such as mimicking others' facial expressions. Finally, executive function may be required when forcing oneself to assimilate with others, by identifying support strategies or comparing similarities between oneself and others. As the sample was underpowered to detect smaller effects, it is possible that the associations with the additional subscales might become significant in a larger sample.

The association between executive function abilities and camouflaging suggests that individuals with executive function impairments might find it harder to camouflage their autism. Interventions to improve executive function might increase ability to camouflage, although it is important to stress that this is not a desirable outcome for many autistic adults, who have stated that they do not want to camouflage at all [Hull et al., 2017]. However, some autistic individuals have said that camouflaging helps them to achieve certain aims, such as making friends [Cage & Troxell-Whitman, 2019]. If autistic teenagers would also like to improve some of their camouflaging strategies for these aims, they may require support with executive function skills. This should only be done where the individual themselves requests such support, and should be carefully monitored to minimise the risk of negative impact on mental health or well-being.

Theory of Mind

Theory of mind did not predict any aspect of camouflaging. This contradicts our hypothesis that adolescents with greater theory of mind abilities would camouflage more, due to being better able to think of how other people perceive them. Instead, theory of mind may be a necessary but not sufficient factor for camouflaging. Camouflaging—at least for adolescents—may be influenced more strongly

by factors related to the internal processes involved, rather than consideration of others' minds or perceptions. This finding may be related to the measurement of camouflaging in this study; the CAT-Q reports self-identified camouflaging strategies, rather than the success of such strategies during interaction. Good theory of mind abilities may be needed to camouflage in ways that are more successful or that produce more positive impressions for others, which was not measured in this study.

On the other hand, it may be that the Strange Stories was not an accurate measure of theory of mind for these individuals; the measure had mediocre internal consistency for social stories, but not for control stories. As most participants were of average or above average intellectual ability, they may have used alternative cognitive routes to answer some of the Strange Stories questions, and so compensated for any potential theory of mind difficulties on some, but not all questions [Livingston & Happé, 2017]. Score on the Strange Stories was positively correlated with IQ, suggesting that this may have been the case.

More ecologically valid measures of theory of mind (as distinct from emotion recognition ability) have been developed recently (e.g. the Strange Stories Film task) [Murray et al., 2017]; however, these were not available at the time this study was conducted. As such, we are cautious in our conclusions regarding the association between theory of mind and camouflaging and suggest these are further examined using different tests of theory of mind ability, across gender, cognitive ability, and age groups. It has been previously noted that there are many limitations in measuring cognitive characteristics behaviourally, and in using these measures to predict self-reported mechanisms, for instance in the field of cognitive flexibility [Geurts, Corbett, & Solomon, 2009].

Another explanation is that, due to underpowered analyses, any existing effects were not identified in the current analyses. However, associations were very small in addition to being non-significant, suggesting that any existing relationship may not have a meaningful impact on real-life camouflaging.

Other Potential Predictors of Camouflaging

Despite the significant predictive relationships between executive function and camouflaging reported here, it is important to note that the models presented only account for a very small proportion of variance in camouflaging. In other words, executive function itself only predicts a small amount of variation in individual camouflaging scores, and therefore there must be other factors contributing more strongly to how much autistic adolescents camouflage. In addition, individual differences in characteristics such as motivation and self-awareness may have influenced how much camouflaging

was reported by autistic teenagers; these may account for variation in how much specific camouflaging strategies were endorsed.

There may also be interactions between individual predictors which might account for the small amount of variance predicted by each variable individually. For instance, executive function ability may not be fully developed in adolescence, and so may reduce the impact of other cognitive factors, such as theory of mind, on camouflaging ability until later in development. In addition, some factors such as theory of mind may influence both ability to camouflage and underlying need to camouflage (as theory of mind difficulties are often associated with autistic characteristics).

Other possible predictors of camouflaging, which were not included here, may be the presence of additional conditions and identities which also produce an expectation to camouflage. For instance, there has been a consistent association between camouflaging and poor mental health in autistic adults [Hull et al., 2018; Lai et al., 2017]; no causal relationships have been demonstrated, and so it may be that autistic individuals who have additional mental health problems feel greater expectation to camouflage, perhaps in order to access support.

Similarly, autistic individuals who are non-heterosexual, transgender, or have a non-binary gender identity may also feel greater expectation to camouflage, perhaps due to the intersection of multiple stigmatised identities [Botha & Frost, 2018]. Adult studies have shown that camouflaging in non-binary people is at similar or even greater levels than in males and females [Hull et al., 2020]. It is important that future research explores these and other potential predictors of camouflaging in adolescent samples so we can better understand individual variation in camouflaging. Camouflaging likely reflects the fit between an individual and the environment they are in [Mandy & Lai, 2016], and so it is also important to measure environmental factors which may influence camouflaging, such as acceptance from non-autistic people [Cage et al., 2018].

Strengths and Limitations

A key strength of this study is that it was the first to empirically examine the relationship between cognitive factors and self-reported camouflaging in autistic adolescents, testing hypotheses that have mostly been proposed and examined in adult samples. Age, IQ and autism symptom severity were controlled for in our analyses, although the findings cannot be generalised to autistic adolescents with intellectual disability, or those with limited spoken language.

The sample was well balanced across males and females, although the sample was not large enough to allow for adequately powered examination of sex/gender differences. The sample was underpowered to identify small effects, and several results were marginally significant limiting the conclusions that can be drawn. As several participants were missing data, imputation was used to maximise the usable sample; ideally, these analyses would be replicated in an adequate sample with no missing data to take into account the full impact of individual variation. The extensive time and effort requirements for participants may have discouraged families from taking part, especially adolescent participants who may have felt under pressure from school, exam and extracurricular demands. In addition, the data collection period was limited by the lead author's funds and timing, as one part of a doctoral degree. These findings would therefore benefit from being further tested in a larger sample, as part of a study designed to take into account the lower rate of participation which may occur with adolescent participants as opposed to adults and younger children.

Another limitation is that only correlational relationships between cognitive predictors and camouflaging were investigated. It is imperative to conduct longitudinal studies to examine the causal relationships between camouflaging and cognitive abilities, for instance to identify if any additional factors contribute to the development of both camouflaging and executive function. Finally, the task used to measure theory of mind had poor internal consistency, suggesting it was not a reliable measure of autistic adolescents' theory of mind. Replication of the present analyses with more reliable measures of theory of mind would strengthen the current findings.

Future Research

As mentioned above, future research should use longitudinal designs to identify the causal relationships between camouflaging and associated cognitive mechanisms. Different social and cognitive factors may interact to produce different levels of camouflaging, and those camouflaging strategies may have varying degrees of success. It is important to compare self-reported camouflaging attempts (as measured by the CAT-Q) with objective measures of camouflaging success, such as the discrepancy between autistic characteristics and behavioural presentation. The relationship between camouflaging attempts and success may impact outcomes associated with camouflaging, including long-term wellbeing, in autistic individuals.

Larger samples should be recruited in order to examine interactive relationships between different predictors of camouflaging, and to compare potential predictors across genders, ages, and levels of ability with an appropriate level of statistical power. Looking at specific components within the predictors discussed here, and others, might reveal more nuanced mechanisms involved in camouflaging. For instance, components of executive function such

as shifting attention and flexible thinking may be particularly important in adapting camouflaging strategies across different situations.

Another important area of future research is to examine the neural mechanisms and structures associated with these cognitive predictors. The prefrontal cortex is most strongly associated with executive function abilities and has already been proposed as a key neural site for camouflaging [Livingston & Happé, 2017]. Another potential cognitive mechanism not explored in the current study is self-representation, the neural correlates of which were found to be associated with camouflaging in autistic men, but not women [Lai et al., 2019]. Measuring neural activity, for instance using electroencephalogram (EEG), while an individual engages in camouflaging may reveal other, previously unconsidered neurocognitive mechanisms involved, including those which individuals may not be able to report on themselves.

Conclusions

This study examined cognitive and individual characteristics that influence self-reported camouflaging in adolescents. Specifically, camouflaging is associated with better executive function ability, although this only accounted for a small proportion of variance in the overall model. Age, IQ and theory of mind were not associated with camouflaging. These findings provide insights into some of the factors that may determine the extent of camouflaging and associated outcomes, including poor mental health; additional factors should be explored in future research to better explain individual variation in camouflaging behaviours.

Acknowledgments

Conflict of Interest

The authors declare no conflicts of interest.

References

Black, D. O., Wallace, G. L., Sokoloff, J. L., & Kenworthy, L. (2009). Brief report: IQ split predicts social symptoms and communication abilities in high-functioning children with autism spectrum disorders. Journal of Autism and Developmental Disorders, 39(11), 1613–1619. https://doi.org/10.1007/s10803-009-0795-3

Botha, M., & Frost, D. M. (2018). Extending the minority stress model to understand mental health problems experienced by the autistic population. Society and Mental Health, 10, 20–38. https://doi.org/10.1177/2156869318804297

Bruni, T. P. (2014). Test review: Social Responsiveness Scale—second edition (SRS-2). Journal of Psychoeducational Assessment, 32(4), 365–369. https://doi.org/10.1177/0734282913517525

Cage, E., Di Monaco, J., & Newell, V. (2018). Experiences of autism acceptance and mental health in autistic adults. Journal of Autism and Developmental Disorders, 48(2), 473–484. https://doi.org/10.1007/s10803-017-3342-7

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

Cassidy, S., Bradley, L., Shaw, R., & Baron-Cohen, S. (2018). Risk markers for suicidality in autistic adults. Molecular Autism, 9 (42), 1–14. https://doi.org/10.1186/s13229-018-0226-4

Constantino, J. N., & Gruber, C. P. (2007). Social Responsiveness Scale (SRS). Los Angeles, CA: Western Psychological Services.

Dean, M., Harwood, R., & Kasari, C. (2017). The art of camouflage: Gender differences in the social behaviors of girls and boys with autism spectrum disorder. Autism, 21(6), 678–689. https://doi.org/10.1177/1362361316671845

Demetriou, E. A., Lampit, A., Quintana, D. S., Naismith, S. L., Song, Y. J. C., Pye, J. E., … 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

Devine, R. T., & Hughes, C. (2016). Measuring theory of mind across middle childhood: Reliability and validity of the Silent Films and Strange Stories tasks. Journal of Experimental Child Psychology, 149, 23–40. https://doi.org/10.1016/j.jecp.2015.07.011

Gardner, L. M., Campbell, J. M., Keisling, B., & Murphy, L. (2018). Correlates of DSM-5 autism spectrum disorder levels of support ratings in a clinical sample. Journal of Autism and Developmental Disorders, 48(10), 1–11. https://doi.org/10.1007/s10803-018-3620-z

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. (2015). BRIEF-2: Behavior Rating Inventory of Executive Function: Professional manual. Lutz, FL: Psychological Assessment Resources.

Happé, F., Brownell, H., & Winner, E. (1999). Acquired 'theory of mind' impairments following stroke. Cognition, 70(3), 211–240. https://doi.org/10.1016/S0010-0277(99)00005-0

Happé, F. G., Winner, E., & Brownell, H. (1998). The getting of wisdom: theory of mind in old age. Developmental Psychology, 34(2), 358–362. https://doi.org/10.1037/0012-1649.34.2.358

Happé, F. G. E. (1994). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped, and normal children and adults. Journal of Autism and Developmental Disorders, 24(2), 129–154. https://doi.org/10.1007/BF02172093

Hayward, E. O., & Homer, B. D. (2017). Reliability and validity of advanced theory-of-mind measures in middle childhood and adolescence. British Journal of Developmental Psychology, 35(3), 454–462. https://doi.org/10.1111/bjdp.12186

Hendrickson, N. K., & McCrimmon, A. W. (2019). Test review: Behavior Rating Inventory of Executive Function®, second edition (BRIEF®2) by Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. Canadian Journal of School Psychology, 34(1), 73–78. https://doi.org/10.1177/0829573518797762

Hull, L., Lai, M.-C., Baron-Cohen, S., Allison, C., Smith, P., Petrides, K. V., & 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., Mandy, W., Lai, M. C., Baron-Cohen, S., Allison, C., Smith, P., & Petrides, K. V. (2018). 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

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. https://doi.org/10.1007/s10803-020-04491-7

Lai, M.-C., Lombardo, M. V., Chakrabarti, B., Ruigrok, A. N., Bullmore, E. T., Suckling, J., … Baron-Cohen, S. (2019). Neural self-representation in autistic women and association with 'compensatory camouflaging'. Autism, 23(5), 1210–1223. https://doi.org/10.1177/1362361318807159

Lai, M.-C., Lombardo, M. V., Ruigrok, A. N. V., Chakrabarti, B., Auyeung, B., Szatmari, P., … Consortium, M. A. (2017). Quantifying and exploring camouflaging in men and women with autism. Autism, 21(6), 690–702. https://doi.org/10.1177/1362361316671012

Lehnhardt, F.-G., Falter, C. M., Gawronski, A., Pfeiffer, K., Tepest, R., Franklin, J., & Vogeley, K. (2015). Sex-related cognitive profile in autism spectrum disorders diagnosed late in life: Implications for the female autistic phenotype. Journal of Autism and Developmental Disorders, 46(1), 139–154. https://doi.org/10.1007/s10803-015-2558-7

Livingston, L. A., Colvert, E., 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, 60(1), 102–110. https://doi.org/10.1111/jcpp.12886

Livingston, L. A., & Happé, F. (2017). Conceptualising compensation in neurodevelopmental disorders: Reflections from autism spectrum disorder. Neuroscience and Biobehavioral Reviews, 80, 729–742. https://doi.org/10.1016/j.neubiorev.2017.06.005

Livingston, L. A., Shah, P., & Happé, F. (2019). Compensatory strategies below the behavioural surface in autism: A qualitative study. Lancet Psychiatry, 0366(19), 1–12. https://doi.org/10.1016/S2215-0366(19)30224-X

Mandy, W., & Lai, M.-C. (2016). Annual research review: The role of the environment in the developmental psychopathology of autism spectrum condition. Journal of Child Psychology and Psychiatry, and Allied Disciplines, 57(3), 271–292. https://doi.org/10.1111/jcpp.12501

McCrimmon, A. W., & Smith, A. D. (2013). Review of the Wechsler Abbreviated Scale of Intelligence, second edition (WASI-II). Journal of Psychoeducational Assessment, 31(3), 337–341. https://doi.org/10.1177/0734282912467756

Morrison, K. E., DeBrabander, K. M., Faso, D. J., & Sasson, N. J. (2019). Variability in first impressions of autistic adults made by neurotypical raters is driven more by characteristics of the rater than by characteristics of autistic adults. Autism, 23, 1817–1829. https://doi.org/10.1177/1362361318824104

Murray, K., Johnston, K., Cunnane, H., Kerr, C., Spain, D., Gillan, N., … Happé, F. (2017). A new test of advanced theory of mind: The 'Strange Stories Film Task' captures social processing differences in adults with autism spectrum disorders. Autism Research, 10(6), 1120–1132. https://doi.org/10.1002/aur.1744

R Core Team. (2013). R: A language and environment for statistical processing. Retrieved from http://www.r-project.org/

Raymaker, D. M., Teo, A. R., Steckler, N. A., Lentz, B., Scharer, M., Santos, A. D., … Nicolaidis, C. (2020). 'Having all of your internal resources exhausted beyond measure and being left with no clean-up crew': Defining autistic burnout. Autism in Adulthood, 2(2), 1–12. https://doi.org/10.1089/aut.2019.0079

Robinson, E., Hull, L., & Petrides, K. V. (2020). Big Five model and trait emotional intelligence in camouflaging behaviours in autism. Personality and Individual Differences, 152, 109565. https://doi.org/10.1016/j.paid.2019.109565

Tierney, S., Burns, J., & Kilbey, E. (2016). Looking behind the mask: Social coping strategies of girls on the autistic spectrum. Research in Autism Spectrum Disorders, 23, 73–83. https://doi.org/10.1016/j.rasd.2015.11.013

Wechsler, D. (2011). WASI-II: Wechsler Abbreviated Scale of Intelligence. Bloomington, MN: Psychological Corporation.

White, I. R., Royston, P., & Wood, A. M. (2011). Multiple imputation using chained equations: Issues and guidance for practice. Statistics in Medicine, 30(4), 377–399. https://doi.org/10.1002/sim.4067

Wigham, S., McConachie, H., Tandos, J., & Le Couteur, A. S. (2012). The reliability and validity of the Social Responsiveness Scale in a UKgeneral child population. Research in Developmental Disabilities, 33(3), 944–950. https://doi.org/10.1016/j.ridd.2011.12.017