Understanding Oneself to Understand Others: The Role of Alexithymia and Anxiety in the Relationships between Autistic Trait Dimensions and Empathy

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Abstract

People on the autism spectrum may have difficulty inferring others' emotions (cognitive empathy), but may share another's emotions (affective empathy) and exhibit heightened personal distress. The present study examined independent autistic trait dimensions (social difficulties and restricted/repetitive behaviours) and the roles alexithymia and trait anxiety have in explaining this profile of empathy. Results from the general population (*n*=301) revealed that pronounced social difficulties and not restricted/repetitive behaviours related to reduced cognitive and affective empathy, and heightened personal distress. However, both dimensions, through alexithymia and anxiety, indirectly influenced empathy. Surprisingly, while the dimensions indirectly improved affective empathy, pronounced social difficulties directly reduced affective empathy. This study motivates a nuanced model of empathy by including autistic trait dimensions, anxiety, and alexithymia.

Keywords: Autism, alexithymia, anxiety, empathy

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Understanding Oneself to Understand Others: The Role of Alexithymia and Anxiety in the Relationships between Autistic Trait Dimensions and Empathy

People on the autism spectrum present with social and communication difficulties, and restricted and repetitive behaviours (American Psychiatric Association, 2013). These clinically pronounced autistic traits can cause significant life challenges such as in maintaining friendships (Kasari et al., 2011), and obtaining and maintaining employment (Nord et al., 2016). In the past, researchers believed that many interpersonal challenges resulted from reduced empathy in autism (Frith, 1989). However, this view may be too simplistic, with empathy involving multiple facets, not all of which are reduced in autism (Smith, 2006).

Empathy is multidimensional, comprising of a cognitive component—an ability to infer others' emotional states and understand how and why others' feel an emotion—and an affective component—an ability to vicariously experience and share the emotions of others (Decety & Meyer, 2008). If not acknowledging the distinction between cognitive and affective empathy, studies may not provide a comprehensive account of the empathic abilities of people on the autism spectrum. Studies differentiating between the two components of empathy have found that autistic traits are related to reduced cognitive empathy, but intact or even heightened affective empathy (Dziobek et al., 2008; Jones et al., 2010; Rogers et al., 2007; Smith, 2006, 2009), although some studies have found reduced affective empathy (e.g., Aaron et al., 2015; Svedholm-Häkkinen et al., 2018).

Smith (2006) proposed the empathy imbalance hypothesis of autism, whereby deficits in cognitive empathy and intact affective empathy characterize the disorder. In a later study, Smith (2009) suggested that people on the spectrum show heightened affective empathy due to an increase in personal distress. Personal distress is the negative self-oriented feelings resulting from tense interpersonal situations (Davis, 1980). There has been debate as to whether personal

distress is a form of affective empathy or a secondary response related to empathy that focusses on the self and not others (Batson et al., 1987; Jolliffe & Farrington, 2006; Lawrence et al., 2004; Smith, 2009). Nonetheless, it is still a vital construct that highlights how people on the autism spectrum react in difficult interpersonal situations. Furthermore, elevated personal distress has been reported for autistic people compared to non-autistic people (Dziobek et al., 2008; Rogers et al., 2007).

Mediation

To better understand the empathy imbalance and heightened personal distress related to autistic traits, possible causal links should be investigated. This investigation may have practical as well as theoretical significance in informing the development of therapies that identify and subsequently target key causal variables. Research has found that alexithymia and anxiety may mediate the relationships between autistic traits and the empathy profile described above (Bird & Cook, 2013; Grynberg et al., 2010).

Alexithymia is a multidimensional trait characterized by difficulties in identifying, describing and focussing on one's own emotional state (Preece et al., 2017). Alexithymia is common for people on the spectrum, being present at pronounced levels in 50% of the autistic population as opposed to 5% in the general population (Kinnaird et al., 2019).

Alexithymia may be a trans-diagnostic precursor to empathic difficulties (Valdespino et al., 2017). The introspection-centric simulation theory predicts that an inability to understand one's own emotions accurately may lead to empathic difficulties (Goldman, 2006). In line with this theory, increased alexithymia traits predict difficulties in cognitive empathy and heightened personal distress (Banzhaf et al., 2018). Additionally, this pattern of association is seen in relation to autism. Bird et al. (2010) revealed that empathic brain activation (in the

anterior insula) did not differ between individuals with or without autism, after controlling for the effects of alexithymia. Other research, using self-report questionnaires, suggests that alexithymia can explain the deficits in empathy associated with autism (Grynberg et al., 2010; Silani et al., 2008). From these studies, Bird and Cook (2013) introduced the alexithymia hypothesis. Under this hypothesis, many socio-cognitive challenges in autism, like empathy, are explained by alexithymia.

Trait anxiety is the tendency for an individual to experience negative emotions, such as worry and fear (Gidron, 2013). Individuals with more pronounced autistic traits often show higher trait anxiety (Kanne et al., 2009). In fact, during their lifetime, 42% of people on the autism spectrum will be diagnosed with an anxiety disorder (Hollocks et al., 2019).

Personal distress is closely related to trait anxiety (Cheetham et al., 2009). As such, researchers have suggested that the heightened personal distress seen in people on the spectrum may be due to the pronounced anxiety experienced by this group (Dziobek et al., 2008; Rogers et al., 2007). Furthermore, Grynberg et al. (2010) reported that the association between alexithymia and personal distress was primarily due to trait anxiety. However, Grynberg et al. (2010) also reported that trait anxiety did not explain the relationships alexithymia had with cognitive and affective empathy. These findings provide evidence that trait anxiety, perhaps in series with alexithymia, may mediate the relationship between autistic traits and heightened personal distress, but not cognitive and affective empathy.

Thus past research suggests that alexithymia and trait anxiety may mediate relationships that more pronounced autistic traits have with reduced cognitive empathy and heightened personal distress. However, alexithymia and trait anxiety are not independent. Alexithymia may play a vital role in the development of trait anxiety in both the general population (Berthoz et al., 1999; Mennin & Fresco, 2010; Taylor et al., 1999) and people on the autism spectrum

(Maisel et al., 2016; Morie et al., 2019; Rogers & Ofield, 2018; South & Rodgers, 2017). As greater alexithymia increases anxiety, the heightened personal distress associated with autistic traits may be due to alexithymia and trait anxiety working in series. However, no study has investigated whether this serial mediation is present.

Independent Autistic Trait Dimensions

The studies considered so far have not accounted for the independence of the autistic trait dimensions. As stated earlier, autistic traits present as both (1) social and communication difficulties, and (2) restricted and repetitive behaviours (American Psychiatric Association, 2013). However, both behavioural and genetic studies suggest that these two social and non-social dimensions are distinct and arise through different mechanisms (Brunsdon & Happé, 2014; Happé et al., 2006; Happé & Ronald, 2008; Warrier et al., 2019). Furthermore, factor analytical studies assessing autism assessments in clinical samples (Shuster et al., 2014) and questionnaires assessing autistic traits in the general population (English et al., 2020) reveal a consistent finding that the social dimension bears little covariation with the non-social dimension.

From findings such as these, Happé and Ronald (2008) recommended investigating these dimensions independently to help capture the heterogeneity seen within the autism spectrum. In some preliminary research on empathy, higher scores on a social difficulties dimension were found to relate to reduced cognitive and affective empathy, and to increased personal distress, whereas higher scores on a non-social dimension, interest in numbers and patterns, related only to reduced affective empathy (Svedholm-Häkkinen et al., 2018). However, Svedholm-Häkkinen et al. (2018) used the numbers and patterns factor from the short version of the AQ (Hoekstra et al., 2011) which showed low reliability (Cronbach's α = .57; Svedholm-Häkkinen et al., 2018). Liss et al. (2008) explored the relationships of social

and non-social autistic trait dimensions with alexithymia and found that only social difficulties showed a significant positive relationship. As such, past research suggests that social difficulties, and not necessarily non-social autistic traits (e.g., restricted and repetitive behaviours), are likely responsible for difficulties in alexithymia and empathy.

The Present Study

From the literature reviewed, there is evidence for an empathy imbalance associated with autism (Domes et al., 2016; Dziobek et al., 2008; Jones et al., 2010; Rogers et al., 2007; Schwenck et al., 2012; Smith, 2006, 2009), with some inconsistencies present (e.g., Aaron, 2015; Svedholm-Häkkinen et al., 2018). According to the imbalance hypothesis, autism is associated with restricted cognitive empathy, relatively intact affective empathy, and greater expression of personal distress. Past research has suggested that atypical empathy associated with autism may be due to alexithymia (Bird & Cook, 2013) and/or trait anxiety (Grynberg, 2010). Lastly, social and non-social dimensions of autism have been shown to be reasonably independent (English et al., 2020; Warrier et al., 2019). Accordingly, the present study will investigate the empathy imbalance hypothesis by examining the unique contributions of autistic trait dimensions and the possible mediating roles of alexithymia and trait anxiety in these relationships.

While atypical patterns of empathy and personal distress are likely to be more exaggerated in autistic individuals than in individuals with pronounced but subclinical levels of autistic traits, there are significant advantages in investigating relationships between autistic traits and empathy in a general, nonclinical sample. A major advantage of this approach is that the social and non-social dimensions of autistic traits are essentially independent in the general population, enabling assessment of their separate contributions to empathy. In contrast,

pronounced levels of both autistic trait dimensions are necessarily present in all individuals with autism, where separation of their influence is therefore difficult.

Studies that investigate subclinical levels of autistic traits in the general population complement clinical studies in ASD (Landry & Chouinard, 2016). For instance, behavioural genetics studies have demonstrated a similar aetiology for autistic traits in the general population as for the diagnosed ASD condition (Robinson et al., 2016; Warrier et al., 2019) and pronounced autistic traits in the general population have been associated with similar social, emotional, and cognitive characteristics to the characteristics identified for the autistic population (De Groot & Van Strien, 2017; Cribb et al., 2016; Kanne et al., 2009). Thus, given the potential informativeness of investigating individual differences in separable autistic-trait dimensions, a large sample of adults was recruited from the general population for the present study.

The present study tested three predictions. Extending on the empathy imbalance hypothesis (Smith, 2009), when taking into account the independence of the autistic trait dimensions, it was predicted that (1) only the social difficulties dimension would relate to reduced cognitive empathy, and heightened personal distress, with no relationships evident for affective empathy. Extending on the alexithymia hypothesis (Bird & Cook, 2015), it was expected that (2) alexithymia alone would mediate any relationships between autistic trait dimensions and cognitive empathy, and (3) alexithymia and trait anxiety would work in series to mediate any relationships with personal distress. Lastly, for completeness, the potential roles of alexithymia and trait anxiety in mediating relationships between autistic trait dimensions and affective empathy were also investigated—however, significant indirect effects from the autistic trait dimensions were not expected.

Method

Participants, Measures, and Procedure

The participants were 301 adults (67.1% female), with a mean age of 20.72 years (SD = 5.42 years, range: 16-56 years), recruited from an undergraduate population or through social media. Participants either volunteered their time freely, received a $10 payment, or completed the study to fulfil a course component. The present study was approved by the Human Research Ethics Committee at the University of Western Australia.

Participants completed self-report measures of social difficulties (13-item social difficulties factor of the Autism-Spectrum Quotient, AQ; Baron-Cohen et al., 2001), restricted and repetitive behaviours (20-item Adult Repetitive Behaviours Questionnaire-2, RBQ-2A; Barret et al., 2015), alexithymia (20-item Toronto Alexithymia Scale, TAS-20; Bagby et al., 1994), trait anxiety (trait version of the 21-item State-Trait Inventory for Cognitive and Somatic Anxiety, STICSA; Ree et al., 2008), cognitive and affective empathy (31-item questionnaire of Cognitive and Affective Empathy, QCAE; Reniers et al., 2011), and personal distress (7-item personal distress scale from the Interpersonal Reactivity Index, IRI; Davis, 1980).

The social difficulties factor of the AQ identified in Russell-Smith et al.'s (2011) three-factor model, measuring (dis)agreement with statements on social difficulties on a 4-point Likert scale, has shown good reliability and validity for both autistic and non-autistic samples (English et al., 2020); higher scores indicate more pronounced social difficulties. The RBQ-2A, measuring the frequency of an individual to partake in restricted and repetitive behaviours (i.e., insistence on sameness and repetitive motor behaviours) on a 3-point scale, has shown good reliability and validity (Barrett et al., 2015). The RBQ-2A was used in preference to other

non-social dimensions from the AQ, which have shown low reliability in past studies (e.g., Austin, 2005; English et al., 2020; Liss et al., 2008).

The TAS-20, measuring (dis)agreement with statements about difficulties identifying, describing, and orienting away from one's emotions, on a 5-point Likert scale, is widely used in autism research on empathy (e.g., Aaron et al., 2015; Bird et al., 2010; Grynberg et al., 2010; Liss et al., 2008; Silani et al., 2008). However, for the present study we excluded the third subscale (externally-oriented thinking) because it has problematic reliability and validity (e.g., Gignac et al., 2007; Preece et al., 2018a, 2020). As such we used the remaining 12 items, measuring difficulty identifying and describing one's emotions to quantify alexithymia; these items have, demonstrated good reliability and validity (Müller et al., 2003).

The STICSA, measuring the tendency to experience cognitive and somatic anxiety on a 4-point Likert scale, was chosen over the more popular State-Trait Anxiety Inventory (Spielberger, 1983) to measure trait anxiety, as the STICSA is a more pure measure of anxiety (Grös et al., 2007).

The QCAE, measuring agreement with statements about understanding and feeling others' emotions on a 4-point Likert scale, was used to measure cognitive and affective empathy; higher scores indicate greater empathizing ability. The QCAE was used as it can adequately distinguish between cognitive and affective empathy (Reniers et al., 2011), unlike the IRI (Chrysikou & Thompson, 2016; Murphy et al., 2020). However, the personal distress subscale from the IRI, measuring individuals' self-oriented feelings of personal anxiety and unease during interpersonal settings on a 5-point Likert scale, was used in the present study. This IRI subscale has shown good reliability and validity for measuring personal distress (Chrysikou & Thompson, 2016; Murphy et al., 2020). All measures produced good reliability in the current study (Table 1). Participants completed the questionnaires in a random order

through an online survey platform, Qualtrics. Demographic information and a self-report data-validity question were also included.

Statistical Analyses

IBM SPSS Statistics Version 25 was used to conduct all analyses. In addition to Pearson correlations, multiple regression analyses were used to examine the unique contribution that the two autistic trait dimensions had on empathy, controlling for the effects of age and sex. To test the hypothesized serial mediation models, three path analyses were conducted using the PROCESS macro for SPSS (model 6), developed by Hayes (2012). The three analyses differed in which dependent variable was being assessed (cognitive empathy, affective empathy, or personal distress). For all models, alexithymia and anxiety were inputted as serial mediators. Both autistic-trait dimensions (social difficulties and restricted and repetitive behaviours) were placed as independent variables within each model to assess their unique effects (following recommendations from Hayes & Preacher, 2014). Past research has linked the study variables with age (Lai et al., 2015; Mattila et al., 2006; Richter & Kunzmann, 2011) and sex (McLean & Anderson, 2009; Schulte-Rüther et al., 2008). As such, age and sex were included as covariates. To assess the significance of the indirect effects, 95^{th} percentile bootstrap confidence intervals (CIs) based on 10,000 bootstrap samples were used. If the CIs included zero, the effect was deemed not significant. The direct paths in the models were evaluated using *p* values and 95% CIs. To control for the family-wise error elicited from conducting three mediation model analyses, a Bonferroni correction was implemented so that a significant alpha level would be indicated by values below 0.017 (.05 divided by 3) and 98.3% confidence intervals were used in the mediation analyses.

Results

Data Screening

Participants were asked whether they believed their data to be valid (responses were either ‘yes’ or ‘no’) at the end of the questionnaires; eight participants reported invalid data and were removed. One case completed the questionnaires in under 10 mins and was removed as the responses were the same for every item throughout the questionnaires. No multivariate outliers were detected for the seven study variables using Mahalanobis distance, a chi-square test and a critical alpha level recommended by Becker and Gather (1999). Accordingly, the remaining 292 participants were included in the rest of the statistical analyses. Skew and kurtosis were checked for all variables and found to be within the recommended limits of |2| and |7|, respectively (Byrne, 2010). Additionally, the assumptions of normally distributed residuals, homoscedasticity, and multi-collinearity were tested and revealed that only the homoscedasticity assumption was violated when predicting anxiety. Therefore, the heteroscedasticity-consistent standard error estimator “HC3” in PROCESS was used to determine reliable standard errors for the serial mediation models, as recommended by Hayes and Cai (2007).

Contributions of the Autistic Trait Dimensions to Empathy

Pearson correlations and descriptive statistics for the study variables are shown in Table 1. The mean scores are similar to those found in past studies using a similar sample (e.g., general population & university students; see Aaron et al., 2015; Barrett et al., 2015; English et al., 2020; Grös et al., 2007; Reniers et al., 2010). The correlation results showed a significant, but small in magnitude, positive relationship between the two autistic trait dimensions. Concerning how the autistic trait dimensions relate to empathy, higher levels of social difficulties were associated with lower cognitive empathy (medium effect), and lower affective

empathy (small effect), and with elevated personal distress (medium effect). The restricted and repetitive behaviours dimension showed only a small negative relationship with cognitive empathy, while no statistically significant relationship was found with affective empathy and personal distress. Table 2 provides the results of the multiple regression analyses that examined the unique contributions of the autistic trait dimensions to empathy. These results showed that after controlling for the influence of the alternative autistic trait dimension, only social difficulties maintained a statistically significant relationship with the empathy factors, whereas the restricted and repetitive behaviours variable showed no statistically significant relationship to any empathy factors.

[Insert Table 1 here]

[Insert Table 2 here]

Serial Mediation Analyses

Cognitive empathy

The first serial mediation model investigated the roles of alexithymia and trait anxiety in the reduced cognitive empathy associated with autistic traits. Results from this analysis are shown in Figure 1 and Table 3. The model accounted for 20% of the variance in cognitive empathy, $R = .45$, $F(6, 285) = 9.99$, $p < .001$. More prominent social difficulties and restricted and repetitive behaviours were associated with heightened alexithymia and anxiety. Greater alexithymia predicted increases in anxiety and reductions in cognitive empathy. However, trait anxiety was not associated with cognitive empathy. Further, more pronounced social difficulties had a negative direct effect on cognitive empathy. No direct effect was found between restricted and repetitive behaviours and cognitive empathy.

Further analysis of the indirect effects of the two autistic trait dimensions on cognitive empathy indicated that alexithymia mediated the relationships between cognitive empathy and

social difficulties (B = -.096, CI = [-.177, -.023], β = -.09), and restricted and repetitive behaviours (B = -.082, CI = [-.164, -.019], β = -.07). Anxiety, alone, did not significantly mediate any indirect effect on cognitive empathy for social difficulties (B = .020, CI = [-.004, .062], β = .02), nor for restricted and repetitive behaviours (B = .065, CI = [-.013, .149], β = .05). Also, there was no evidence for serial mediation of cognitive empathy as the indirect effects through alexithymia and anxiety were not statistically significant for social difficulties (B = .020, CI = [-.004, .051], β = .02) or restricted and repetitive behaviours (B = .017, CI = [-.003, .046], β = .01). These results revealed that alexithymia alone mediated the negative relationships between both autistic trait dimensions and cognitive empathy and that social difficulties still directly reduced cognitive empathy.

[Insert Figure 1 here]

[Insert Table 3 here]

Affective empathy

The second serial mediation analysis investigated whether autistic trait dimensions predicted affective empathy and if alexithymia and trait anxiety had any role in these relationships. The results are shown in Figure 2 and Table 4. The model accounted for 17% of the variance in affective empathy, $R = .42$, $F(6, 285) = 11.44$, $p < .001$. The relationships between the autistic trait dimensions, alexithymia, and trait anxiety are the same as for the above model. Alexithymia did not significantly predict affective empathy, whereas elevated trait anxiety predicted improved affective empathy. In contrast, social difficulties directly reduced affective empathy. No direct effect was found between restricted and repetitive behaviours and affective empathy.

Further analysis of the indirect effects on affective empathy indicated that alexithymia by itself was not a statistically significant mediator, with indirect effects not reaching significance for social difficulties (B = -.034, CI = [-.079, .014], β = -.05), and restricted and repetitive behaviours (B = -.029, CI = [-.072, .011], β = -.04). In contrast, anxiety mediated positive indirect effects on affective empathy of both social difficulties (B = .031, CI = [.003, .069], β = .04) and restricted and repetitive behaviours (B = .101, CI = [.040, .171], β = .12). Furthermore, alexithymia and anxiety worked in series in mediating indirect effects on affective empathy from social difficulties (B = .031, CI = [.012, .056], β = .04) and restricted and repetitive behaviours (B = .026, CI = [.010, .051], β = .03).

These results suggest that both autistic trait dimensions indirectly increase affective empathy through alexithymia and anxiety. However, the direct effect of social difficulties is to decrease affective empathy. These opposing positive indirect and negative direct effects are known as an inconsistent mediation (MacKinnon et al., 2010). An inconsistent mediation can be thought of as a suppression where the positive indirect effects and the negative direct effect reduce the total effect.

[Insert Figure 2 here]

[Insert Table 4 here]

Personal distress

The third serial mediation analysis investigated the role of alexithymia and trait anxiety in explaining the heightened personal distress associated with more pronounced autistic traits. The results are shown in Figure 3 and Table 5. The model accounted for 21% of the variance in personal distress, $R = .45$, $F(6, 285) = 9.40$, $p < .001$. The relationships between the autistic trait dimensions, alexithymia, and anxiety are the same as for the previous models. Alexithymia did not significantly predict personal distress, whereas, more elevated trait anxiety predicted heightened personal distress. Further, more pronounced social difficulties directly predicted

heightened personal distress. No direct effect was found between restricted and repetitive behaviours and personal distress.

Alexithymia alone showed no significant indirect effects between the autistic trait dimensions and personal distress, that is, for social difficulties (B = .011, CI = [-.029, .052], β = .02) and restricted and repetitive behaviours (B = .009, CI = [-.025, .046], β = .01). Anxiety alone showed support of mediation as the results indicated significant indirect effects to heightened personal distress from the autistic dimensions, that is, social difficulties (B = .021, CI = [.002, .047], β = .03) and restricted and repetitive behaviours (B = .067, CI = [.018, .122], β = .10). Lastly, serial mediation was present as the indirect effects of alexithymia and anxiety working in series reached significance for the indirect path from social difficulties (B = .021, CI = [.005, .039], β = .03) and restricted and repetitive behaviours (B = .017, CI = [.004, .039], β = .02). Overall, these results suggest that anxiety, either alone or with alexithymia, mediated the positive relationship between the autistic-trait dimensions and personal distress, with an additional positive direct effect present between social difficulties and personal distress.

[Insert Figure 3 here]

[Insert Table 5 here]

Discussion

The present study investigated the unique contributions that social and non-social autistic trait dimensions had on empathy and examined the roles of alexithymia and trait anxiety using three serial mediation models. Consistent with the hypothesis, social difficulties was the only autistic trait dimension to show unique contributions on empathy. However, when including alexithymia and trait anxiety, both autistic trait dimensions showed an indirect effect

that contributed to the profile of empathy. Nevertheless, social difficulties still directly influenced empathy, highlighting its overarching involvement in empathy.

Empathy Imbalance

The finding that more pronounced social difficulties uniquely contributed to reduced cognitive empathy and heightened personal distress is consistent with previous reports of the same pattern of results for a general autistic trait measure (Dziobek et al., 2008; Rogers et al., 2007; Smith 2009). Additionally, this finding is consistent with Svedholm-Häkkinen et al. (2018), who found that only social autistic-trait dimensions related to self-reported cognitive empathy and personal distress. Overall, these results suggest that individuals with more pronounced social difficulties may find it more difficult to understand others' emotions and are more likely to become personally distressed during tense interpersonal situations.

Past research assessing empathy in autism typically used a general measure of autistic traits, and when doing so, no relationship was found between autistic traits and affective empathy (Dziobek et al., 2008; Rogers et al., 2007; Smith, 2009). In contrast, by separating social and non-social dimensions of autistic traits, we were able to demonstrate a more nuanced pattern of relationships in that more pronounced social difficulties were associated with reduced affective empathy. In contrast, restricted and repetitive behaviours were not associated with affective empathy. This finding is inconsistent with the empathy imbalance hypothesis and suggests that pronounced autistic traits (primarily social difficulties) relate to reduced affective as well as cognitive empathy.

Alexithymia Hypothesis

The finding that alexithymia, either alone or with trait anxiety, mediated the relationships between both of the autistic trait dimensions and cognitive empathy, affective empathy and personal distress is consistent with the alexithymia hypothesis and previous

research measuring a general autistic trait (Aaron et al., 2015; Bird & Cook, 2010). However, the fact that both social difficulties and restricted and repetitive behaviours related to alexithymia was inconsistent with our hypotheses and with results reported by Liss et al. (2008). Liss et al. (2008) reported that only the social dimension of autistic traits related to alexithymia, although their study used the attention to detail factors from the AQ to assess non-social traits, a factor which has shown low reliability (Austin, 2005; English et al., 2020), whereas the present study used a more reliable measure, the RBQ-2A, to measure restricted and repetitive behaviours. As such, the present findings provide more robust evidence that both social and non-social autistic traits uniquely impact alexithymia.

The finding that alexithymia alone mediated the relationships between the autistic trait dimensions and cognitive empathy suggests that alexithymia is a likely mechanism of reduced cognitive empathy for individuals with more pronounced autistic traits. The results suggest that individuals exhibiting more pronounced social and non-social traits of autism show increased problems with identifying and describing their own emotions, leading to greater difficulty understanding others' emotions. Lastly, social difficulties still directly reduced cognitive empathy, beyond the effects of alexithymia, perhaps due to additional challenges with Theory of Mind (Mathersul et al., 2013).

The finding that alexithymia and trait anxiety worked in series to mediate the relationships between the autistic trait dimensions and heightened personal distress extended on past research (e.g., Grynberg et al., 2010; South & Rodgers, 2017) by investigating the mediating role of alexithymia through trait anxiety. The results suggest that alexithymia is a mechanism that increases personal distress via trait anxiety for individuals with pronounced social and non-social autistic trait dimensions. Additionally, more pronounced social difficulties directly predicted heightened personal distress, suggesting that individuals with these difficulties are at a higher risk of becoming distressed during interpersonal situations,

regardless of alexithymia or trait anxiety. These results provide evidence that both alexithymia and trait anxiety may increase the tendency for individuals with pronounced autistic traits to become overwhelmed and experience negative self-oriented feelings resulting from tense interpersonal situations.

The finding of an inconsistent serial mediation in the relationships between autistic trait dimensions and affective empathy was unexpected. The mediation analysis for affective empathy showed that both autistic trait dimensions had positive indirect effects through alexithymia and trait anxiety working in series, and through trait anxiety alone. Simultaneously, social difficulties were shown to reduce affective empathy directly.

These two opposite effects may occur due to different external and internal processes. The positive indirect effect may arise due to an internal process whereby highly anxious individuals have a fear of being negatively evaluated by peers, and so tend to be more attentive to others' signals (Tibi-Elhanany & Shamay-Tsoory, 2011). On the other hand, the negative direct effect from social difficulties may arise due to an external process whereby individuals with these social difficulties are less likely to engage in social activities (Chevallier et al., 2012), and so have less exposure to and practice in affective empathy. Reduced practice through social activities may mean that individuals with more pronounced autistic traits are less accurate at recognizing facial expressions (Poljac et al., 2013) which impacts negatively on affective empathy (Besel & Yille, 2010; Lawrence et al., 2004).

The serial mediation models provide an in-depth picture of the relationships between autistic traits and the different facets of empathy. Our findings imply that, although restricted and repetitive behaviours show no total effect with empathy, this trait dimension does indirectly influence empathy through alexithymia and anxiety. Additionally, the results suggest that the empathy imbalance hypothesis of autism is not as simple as first hypothesized. Instead, the

presence of alexithymia and anxiety complicate the relationships, indicating the need for a more nuanced model. This added complexity may be a cause for some of the inconsistencies in the literature regarding affective empathy and autism (e.g., Aaron et al., 2015; Dziobek et al., 2008; Jones et al., 2010; Rogers et al., 2007; Schwenck et al., 2012; Smith, 2006, 2009). The present study examined autistic traits in the general population, yet, as people on the autism spectrum commonly show heightened alexithymia (Kinnaird et al., 2019) and trait anxiety (Hollocks et al., 2019), future studies should see if these nuanced relationships are present within the autistic population. While these findings provide preliminary evidence that therapies targeting alexithymia and anxiety may improve cognitive empathy and reduce personal distress for individuals with pronounced autistic traits, further research is still needed to ascertain whether these results will generalise to a clinical population. However, before doing so, research should be undertaken to ensure the measures used are appropriate in this clinical group. While often used in this population (e.g., Kinnaird et al., 2019), some measures (e.g., TAS-20 and QCAE) have not undergone comprehensive psychometric assessment within this clinical population.

Nonetheless, as expected, the results provide preliminary evidence that therapies should focus more on improving social skills rather than restricted and repetitive behaviours to improve cognitive and affective empathy and reduce personal distress. Furthermore, therapies targeting alexithymia and anxiety may be beneficial to improve cognitive empathy and reduce personal distress for those with pronounced autistic traits. However, pronounced alexithymia and anxiety seem to increase affective empathy; so, alleviating alexithymia and anxiety may see some deficits in affective empathy. Therefore, the present study provides preliminary evidence to suggest that therapies targeting alexithymia may be beneficial, although, future research should be undertaken on clinical samples to assess generalizability and should investigate the inconsistent mediation to guide such therapies.

Limitations and Future Research

The present study excluded the externally-oriented thinking subscale of the Toronto Alexithymia Scale (Bagby et al., 1994) because of its poor psychometric properties (see Gignac et al., 2007; Preece et al., 2018a, 2020). Nonetheless, by excluding this subscale, the present study did not assess the full scope of alexithymia. As such, the full effect of alexithymia may have been underestimated in the present study. Preece et al. (2017) conceptualized externally-oriented thinking as a difficulty in attending to one's emotions, whereas difficulties describing and identifying feelings (used in the present study) represent difficulties accurately appraising what an emotional response is and what it means. With reference to this conceptualization, the present study would suggest that individuals with pronounced autistic traits show difficulties in appraising their emotions, which leads to challenges to understand others' emotions, while increasing their ability to share another's emotions, and to experience distress during tense interpersonal situations. However, the present study did not investigate the role of attending to one's own emotional responses. A newly developed Perth Alexithymia Questionnaire (Preece et al., 2018b, 2020) has shown promising signs for validly and reliably measuring externally-oriented thinking, as well as difficulties identifying and describing feelings. Future studies could use this measure to assess the full breadth of alexithymia.

A further limitation is the use of cross-sectional data. Some researchers suggest that mediation should not suggest any causal processes from correlational data (Maxwell et al., 2011). However, the present study provides possible causal links between the variables, steeped in support from previous research. As such, the statistically significant mediation effects found in the current paper provide one possible causal explanation; however, others may be viable. Nonetheless, the present findings show sound statistical modelling of relationships which can be used to understand empathy associated with autism and test theoretical propositions and

hypotheses. In order to provide more causal support, future studies should attempt to build on the present findings by utilizing an experimental design.

A significant obstacle for conducting experimental designs, however, is a difficulty in manipulating these variables. Alexithymia is a trait with relative stability, although it can be modified through therapy (Cameron et al., 2014; Cooper et al., 2018; Norman et al., 2019). This difficulty manipulating alexithymia limits the feasibility of a simple experimental design. Instead, future research may need to be integrated with therapy programs that target alexithymia to investigate the possible causal relations further.

Closing Comments

To date, no research had investigated the profile of empathy associated with autism by looking at separate autistic trait dimensions, and how alexithymia and trait anxiety work together to mediate these relationships. The current study provided evidence that a more nuanced model should be used to examine the influence of social and non-social autistic trait dimensions on cognitive and affective empathy, and personal distress. This nuanced model suggests that social difficulties are largely responsible for reduced empathy and increased personal distress, that alexithymia plays a role in the reduced cognitive empathy associated with autistic traits and that both alexithymia and trait anxiety are partly responsible for the heightened personal distress. Lastly, social autistic traits may predict reduced affective empathy, although the presence of alexithymia and trait anxiety may counteract this effect by improving affective empathy. Findings from the current study enhance our knowledge of empathic responses associated with autism.

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Figure Captions

Figure 1. Serial mediation model with cognitive empathy as the dependent variable. Including sex and age as covariates. Solid lines indicate significant effects (green = positive; red = negative) and dotted lines indicate non-significant effects. Regression paths are labelled 1 – 9, corresponding to numbering in Table 3.

Figure 2. Serial mediation model with affective empathy as the dependent variable. Including sex and age as covariates. Solid lines indicate significant effects (green = positive; red = negative) and dotted lines indicate non-significant effects. Regression paths are labelled 1 – 9, corresponding to numbering in Table 4.

Figure 3. Serial mediation model with personal distress as the dependent variable. Including sex and age as covariates. Solid lines indicate significant effects (green = positive; red = negative) and dotted lines indicate non-significant effects. Regression paths are labelled 1 – 9, corresponding to numbering in Table 5.

Figure 1 top

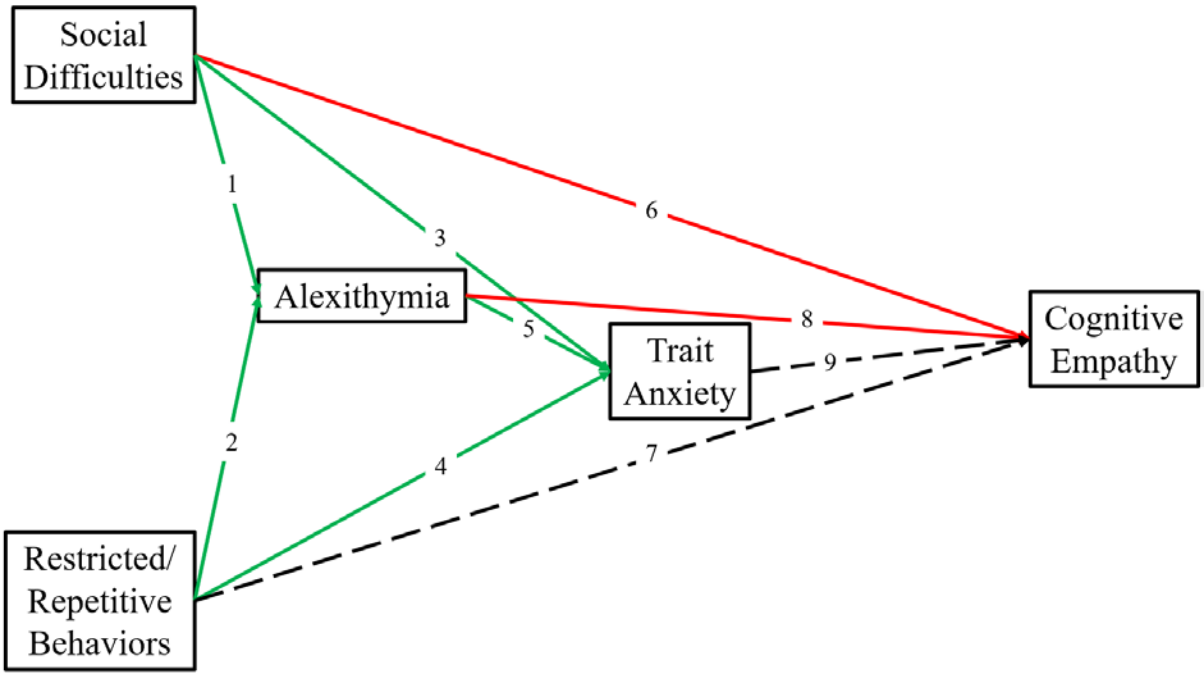

Figure 1. Serial mediation model with cognitive empathy as the dependent variable. Including sex and age as covariates. Solid lines indicate significant effects (green = positive; red = negative) and dotted lines indicate non-significant effects. Regression paths are labelled 1 – 9, corresponding to numbering in Table 3.

Figure 2 Top

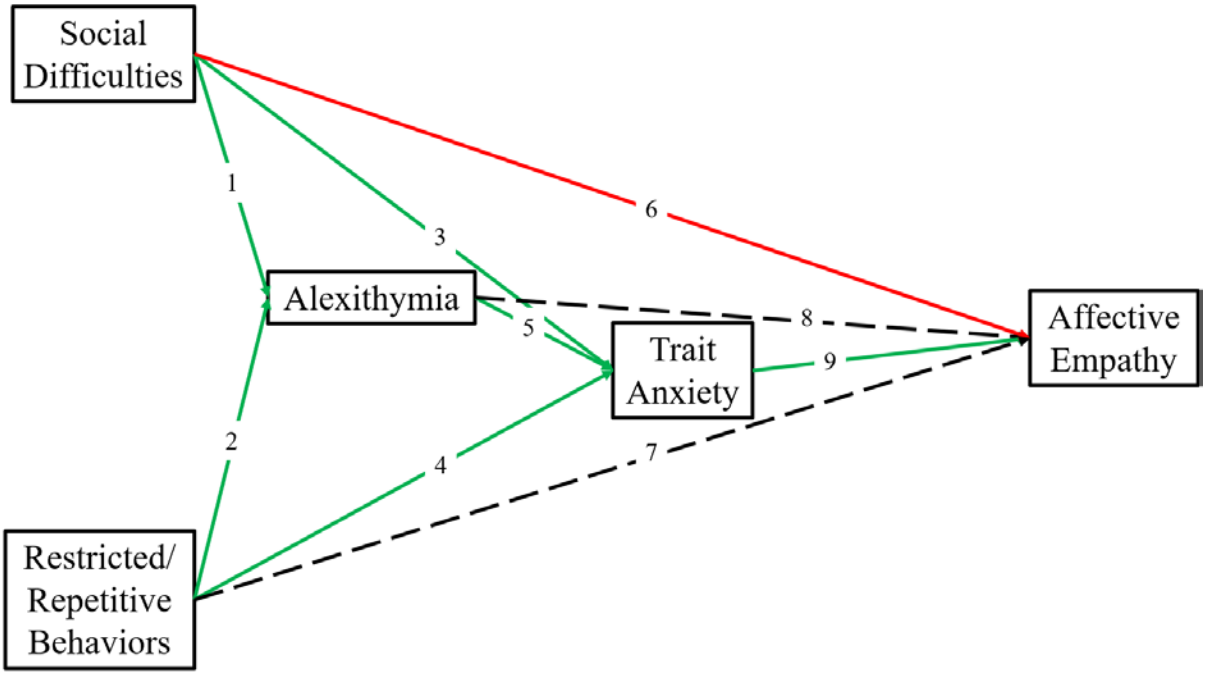

Figure 2. Serial mediation model with affective empathy as the dependent variable. Including sex and age as covariates. Solid lines indicate significant effects (green = positive; red = negative) and dotted lines indicate non-significant effects. Regression paths are labelled 1 – 9, corresponding to numbering in Table 4.

Figure 3 Top

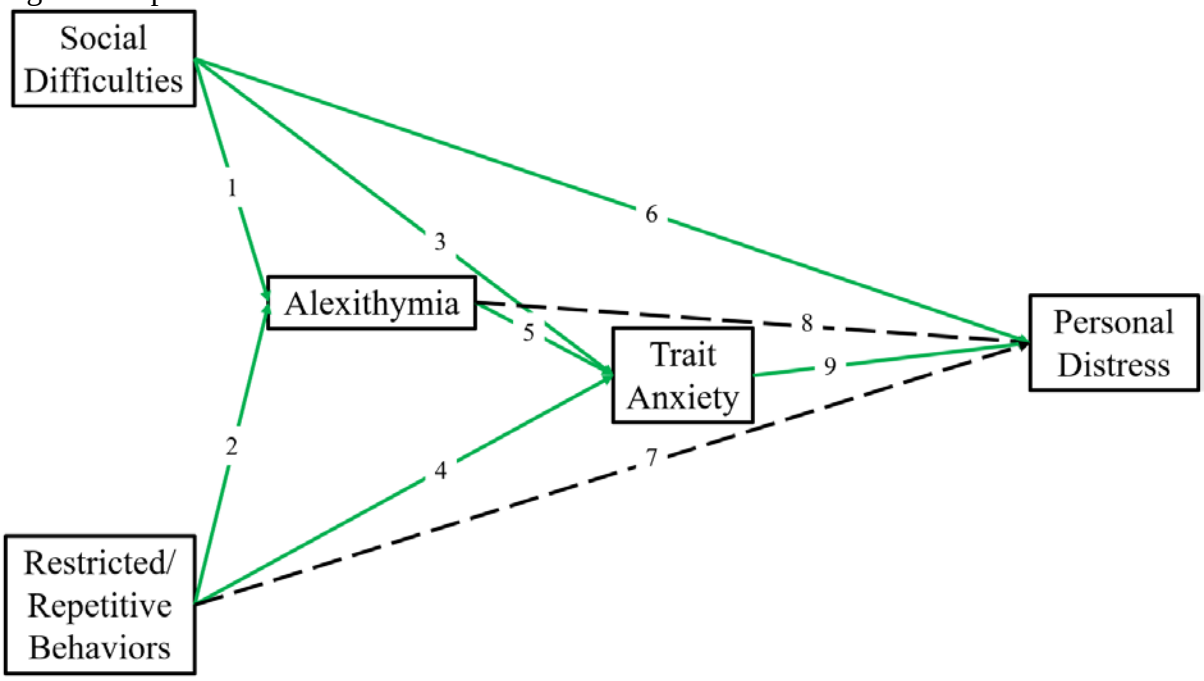

Figure 3. Serial mediation model with personal distress as the dependent variable. Including sex and age as covariates. Solid lines indicate significant effects (green = positive; red = negative) and dotted lines indicate non-significant effects. Regression paths are labelled 1 – 9, corresponding to numbering in Table 5.

Table 1

Pearson Correlations and Descriptive Statistics of the Study Variables. Zero-order Pearson Correlations are Shown Above the Diagonal and Partial Correlations Controlling for Sex and Age are Shown Below the Diagonal.

	Pearson Correlations							Descriptive Statistics		
	Soc	RRB	Alex	Anx	CE	AE	PD	Mean (SD)	Mean Item Responses	Cronbach's α
Soc		.18**	.44**	.37**	-.39**	-.14*	.32**	28.74 (7.67)	2.21	.90
RRB	.19**		.34**	.46**	-.17**	-.10	.06	32.59 (6.77)	1.63	.85
Alex	.44**	.35**		.54**	-.32**	-.06	.27**	31.96 (10.29)	2.66	.90
Anx	.36**	.51**	.53**		-.13*	.17*	.35**	42.80 (11.11)	2.04	.92
CE	-.39**	-.16**	-.33**	-.14*		.33**	-.16**	59.19 (8.33)	3.12	.89
AE	-.16**	-.02	-.08	.14*	.32**		.31**	35.02 (5.59)	2.92	.80
PD	.32**	.11	.25**	.32**	-.18**	.26**		12.70 (4.73)	1.72	.78

Note: Soc = social difficulties; RRB = restricted & repetitive behavior; Alex = alexithymia; Anx = trait anxiety; CE = cognitive empathy; AE = affective empathy; PD = personal distress; SD = standard deviation.
* p <.05. **p<.01.

Table 2

Standardized Beta-weights from Multiple Regression Analyses with Each Autistic Trait Dimension Predicting Empathy Factors, with and without Controlling for the Effects of the Other Autistic Trait Dimension.

	Cognitive Empathy		Affective Empathy		Personal Distress	
	Uncontrolled	Controlled	Uncontrolled	Controlled	Uncontrolled	Controlled
Social Difficulties	-.39**	-.37**	-.16**	-.16**	.30**	.29**
Restricted & Repetitive Behaviours	-.18 **	-.10	-.04	.00	.12*	.06

*Indicates $p < .05$.
**Indicates $p < .01$.

Table 3

Unstandardized and Standardized Regression Beta Weights, Standard Errors, Probability Values, and Confidence Intervals for the Mediation Model Represented in Figure 1

Regression Paths	B (SE)	β	*p* value	Confidence Intervals	
				Lower Bound	Upper Bound
1	.51 (.07) *	.38	<.001	.34	.67
2	.43 (.08) *	.28	<.001	.24	.63
3	.19 (.07) *	.13	.011	.01	.37
4	.62 (.09) *	.38	<.001	.40	.83
5	.37 (.06) *	.34	<.001	.22	.52
6	-.35 (.07) *	-.33	<.001	-.51	-.19
7	-.11 (.09)	-.09	.225	-.31	.10
8	-.19 (.06) *	-.23	.002	-.33	-.05
9	.11 (.05)	.14	.052	-.02	.24

Note: B = unstandardized beta weight, SE = standard error, β = standardized beta weight.
* p <.017. 98.3% Confidence Intervals are used.

Table 4

Unstandardized and Standardized Regression Beta Weights, Standard Errors, Probability Values, and Confidence Intervals for the Mediation Model Represented in Figure 2

Regression Paths	B (SE)	β	*p* value	Confidence Intervals	
				Lower Bound	Upper Bound
1	.51 (.07) *	.38	<.001	.34	.67
2	.43 (.08) *	.28	<.001	.24	.63
3	.19 (.07) *	.13	.011	.01	.37
4	.62 (.09) *	.38	<.001	.40	.83
5	.37 (.06) *	.34	<.001	.22	.52
6	-.14 (.05) *	-.19	.004	-.25	-.02
7	-.09 (.06)	-.11	.103	-.22	.04
8	-.07 (.04)	-.12	.075	-.16	.02
9	.16 (.04) *	.33	<.001	.08	.25

Note: B = unstandardized beta weight, SE = standard error, β = standardized beta weight.
* p <.017. 98.3% Confidence Intervals are used.

Table 5

Unstandardized and Standardized Regression Beta Weights, Standard Error, Probability Values, and Confidence Intervals for the Mediation Model Represented in Figure 3

Regression Paths	B (SE)	β	*p* value	Confidence Intervals	
				Lower Bound	Upper Bound
1	.51 (.07) *	.38	<.001	.34	.67
2	.43 (.08) *	.28	<.001	.24	.63
3	.19 (.07) *	.13	.011	.01	.37
4	.62 (.09) *	.38	<.001	.40	.83
5	.37 (.06) *	.34	<.001	.22	.52
6	.13 (.04) *	.21	<.001	.04	.22
7	-.06 (.05)	-.08	.266	-.18	.06
8	.02 (.03)	.05	.519	-.06	.10
9	.11 (.03) *	.26	.001	.03	.19

Note: B = unstandardized beta weight, SE = standard error, β = standardized beta weight.
* p <.017. 98.3% Confidence Intervals are used.