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RESEARCH ARTICLE

Age differences in broader autism phenotype traits from young adulthood to older adulthood

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Abstract

Much of past research has been dedicated to refining the operationalization and correlates of the broader autism phenotype (BAP) and less on how the BAP differs by socio-demographic characteristics, like age—particularly after midlife. This gap is important because other nonclinical trait-like characteristics (e.g., personality) have shown considerable age differences, leading to work assessing the malleability of psychological characteristics and improving outcomes for individuals and their significant others. In the current study, we examined cross-sectional age differences in the BAP in a large sample of adults ranging in age from 18 to 85. We recruited a sample of 2966 adults ranging in age from 18 to 85 (M_{age} = 36.53, SD = 12.61; 58.9% Female; 1.1% with an ASD diagnosis) recruited from an online survey service. We found that total BAP scores were higher in younger adults and lower among older adults. These differences were particularly true for pragmatic language difficulties, with this component of the BAP showing the most dramatic age differences. Aloofness showed similar negative associations with age, albeit much smaller. Rigidity was not significantly associated with age. The results are consistent with other research showing an abatement of symptoms among individuals with autism spectrum disorders (ASDs) across early life and theories predicting changes in other psychological characteristics (e.g., personality). The results are discussed in the context of the malleability of ASD and BAP traits across life, the clinical implications of these changes, and the origins and consequences for lifespan differences in BAP.

Lay Summary: Little is known about how subclinical autistic-like traits among middle-aged and older adults compare to younger adults. We found that these subclinical traits were highest in young adults and lowest in older adults. Knowing how these traits differ by age can provide researchers and clinicians with a sense of how much these traits might change across life, if the traits might be sensitive to interventions, and when in development it might be best to intervene.

KEYWORDS
age differences, autism spectrum disorders, broader autism phenotype, lifespan development, personality

INTRODUCTION

Evidence from twin and family studies suggests a significant genetic and heritable component to autism spectrum disorders (ASDs; Bailey et al., 1995; Folstein & Rutter, 1977). There is substantial evidence that the characteristics of ASD extend to a subclinical behavioral phenotype. These traits—collectively known as the broader autism phenotype (BAP)—are continuously distributed in the population; although they are most prominent in first-degree family members of individuals with ASD (Bolton et al., 1994; Piven et al., 1997). Much of

past research has been dedicated to refining the measurement, operationalization, and correlates of the BAP (e.g., Hurley et al., 2007; Ingersoll et al., 2011; Riccio et al., 2020; Wainer et al., 2011). However, there is a relative dearth of research on how the BAP differs by sociodemographic characteristics, like age—particularly after adolescence. This gap is important because other nonclinical trait-like characteristics (e.g., personality) have shown considerable age differences (Roberts et al., 2006; Soto et al., 2010). These age differences in other traits have led to a proliferation of studies assessing the malleability of psychological characteristics and interventions aimed at improving outcomes for individuals and their significant others (Hudson et al., 2020; Stieger et al., 2020). In the current study, we examined cross-sectional age differences in the BAP in a large sample of nearly 3000 adults ranging in age from 18 to 85.

The broader autism phenotype

A great deal of attention has been paid to the development and operationalization of the BAP. Early self- and observer-report measures (e.g., the Autism-Spectrum Quotient and the Social Responsiveness Scale) were primarily developed to distinguish children and adults with ASD from typically developing children and adults (Baron-Cohen et al., 2001; Constantino & Todd, 2005; Dawson et al., 2007; Ingersoll et al., 2011; Ingersoll & Wainer, 2014). The Broader Autism Phenotype Questionnaire (BAPQ; Hurley et al., 2007), in contrast, was developed more specifically to identify and characterize individuals with the BAP and is suitable for both relatives of individuals with ASD and the general population. Further refinements and validations of the BAPQ have reached a consensus that the BAP is generally comprised of three traits—aloofness, pragmatic language difficulties, and rigidity (Sasson et al., 2013; Wainer et al., 2011). Aloofness characterizes people with a lack of awareness of, and interest in, others during social interactions. Pragmatic language difficulties characterize people who have difficulty communicating, particularly with the social use of verbal and nonverbal communication. Rigidity characterizes people with a strong preference for routine and difficulty adjusting to change. Finally, a summary score for a more general BAP can also be calculated.

Since the development of validated measures of the BAP, research has focused on the correlates and consequences of BAP-related traits. Higher scores on measures of the BAP have been linked to fewer and fledgling romantic and friendship relationships and higher levels of loneliness and depression (Ingersoll & Hambrick, 2011; Jobe & White, 2007). These relational struggles are often attributable to deficits in responsiveness, empathy, social support, closeness, and a disinterest in starting and maintaining relationships (Beffel et al., 2021; Lamport & Turner, 2014; Pollmann et al., 2010; Wainer et al., 2013; Wallace et al., 2016). More specifically, each of the facets of the BAP—aloofness, pragmatic language difficulties, and rigidity—have each been linked to important outcomes. For example, higher levels of aloofness are associated with lower interpersonal sensitivity and less interest in social networking and socializing—all prerequisites for maintaining meaningful social relationships (Harris et al., 2017; Reis & Shaver, 1988; Wainer et al., 2011). Pragmatic language difficulties have most consistently been linked to early language delays and fewer social-communicative behaviors in childhood (Chuthapisith et al., 2007; Toth et al., 2007). However, language difficulties continue to predict deficits into adulthood—they are also associated with educational, occupational, and social difficulties in adulthood. This link possibly exists through compromised executive functioning as such abilities—working memory, inhibition, planning—are thought to be crucial for goal-directed activity in a variety of domains, although such deficits are not consistently found in every sample (Carpita et al., 2019; DeBrabander et al., 2020; see Gerdts & Bernier, 2011, for a review; Losh et al., 2008; Rodger et al., 2008; Swineford et al., 2014; Whitehouse et al., 2010). Finally, behavioral rigidity is associated with higher rates of social phobias, obsessive–compulsive personality disorder, less warmth in interpersonal interactions, an inflexibility in altering behavior to optimize outcomes, and a lower likelihood of exploring new environments and activities (Boyd et al., 2012; Faso et al., 2016; Ingersoll & Wainer, 2014; Thakkar et al., 2008; Wainer et al., 2011). Altogether, the BAP—and each of its components—are uniquely associated with poorer emotion regulation (McDonnell & Nuttall, 2018), social interactions (Wainer et al., 2013), and well-being (Ingersoll & Hambrick, 2011).

The BAP across the lifespan

Although researchers are beginning to grasp the etiology and correlates of the BAP, it is worth acknowledging that the vast majority of this work has been conducted on children and adolescents with ASD, college students, and middle-aged parents of children with ASD, although there have been calls to study ASD and ASD-related traits across the lifespan and among the general population (Happé & Charlton, 2012; Howlin & Moss, 2012; Murphy et al., 2016; Orsmond & Seltzer, 2007; Piven et al., 2011). The few studies examining these issues among middle-aged and older adults that do exist often focus on the presence of clinical problems or ASD-related traits among parents of children with ASD, and less on comparing younger and older adults in their levels of BAP in the general population (Kats et al., 2013; Lever & Geurts, 2016). That is not to say that some efforts have not been undertaken (see Perkins & Berkman, 2012; Stewart et al., 2018; Stewart et al., 2020; Wallace et al., 2016). Although ASD diagnoses are very stable

(Beadle-Brown et al., 2006), cross-sectional and longitudinal studies of individuals with autism suggest that there might be an abatement of ASD symptoms across life (Bal et al., 2019; Chowdhury et al., 2010; Esbensen et al., 2009; Helles et al., 2015; Magiati et al., 2014; Seltzer et al., 2003; Shattuck et al., 2007; Taylor & Seltzer, 2010). Although it is important to know that ASD symptoms likely decrease across life, the samples from these studies are also very young. No studies have formally examined age differences in the BAP among the general population. For example, the mean ages of each of the adult-aged samples (some of which overlap; range: 19.6–22 years old) suggest that even basic information on normative age differences in BAP traits among the general population is still elusive. By reviewing lifespan perspectives on how psychological characteristics change over time, we will be able to make firmer predictions about how BAP might differ across the adult lifespan.

There is a consensus that psychological characteristics are somewhat stable and trait-like across life but nevertheless change over time, even in adulthood (Roberts & DelVecchio, 2000). For example, there have been efforts to characterize how Big Five personality traits (i.e., extraversion, agreeableness, conscientiousness, neuroticism, openness to experience; McCrae & Costa, 2008) differ by age and how these differences might be derived from broader lifespan developmental processes. For example, the maturity principle states that, over time, the direction of change in psychological traits is toward positivity and social and psychological maturity (Bleidorn, 2015; Roberts et al., 2007; Roberts & Mroczek, 2008). In this context, social and psychological maturity are conceptualized as the ability to be a productive and involved member and contributor to society. The successful development of this maturity (e.g., higher conscientiousness) is associated with the achievement of milestones across personal, occupational, and health domains (Nickel et al., 2017; Roberts et al., 2007; Roberts & Wood, 2006). Cross-sectional research on age differences in personality also supports the general conclusion of shifts toward maturity across life. For example, in a large sample of over 1 million participants aged 10 to 65, Soto et al. (2010) found that older adults were higher in conscientiousness, agreeableness, and emotional stability compared to younger adults. These differences reflect that older adults have the achieved psychological maturity of a life lived. Worth noting, many of the Big Five traits share conceptual and empirical overlap with autistic-like traits: a recent meta-analysis revealed that higher levels of ASD symptomology were associated with lower extraversion, agreeableness, emotional stability (i.e., the inverse of neuroticism), conscientiousness, and openness to experience (Lodi-Smith et al., 2019). To date, however, there has been little theoretical or empirical work regarding age-related differences in BAP-traits, thus rendering inferences about age differences in the BAP based on age differences in related Big Five traits premature.

Having said that, basic principles from this aforementioned literature might lead to the prediction that BAP-related traits would be higher among younger adults and lower among older adults. The exact ways these characteristics change and differ by age can be partially explained by lifespan models of trait development (Roberts & Nickel, 2017). For example, the Social Investment Theory provides one such account of why and how psychological characteristics might change over time—emphasizing that investment in social institutions shapes people's characteristics in line with the roles they play (Roberts et al., 2005; Wood & Roberts, 2006). These investments often occur when people transition in and out of roles across life, such as joining the workforce, forming long-term romantic relationships, or becoming a parent or a member of a broader community (e.g., religious community). The social expectations and responsibilities of these roles necessarily require individuals to modulate their behavior. Carrying out these social roles as an employee, partner, or parent ultimately rewards people to act more socially mature—being more conscientious and agreeable, and less neurotic—and behave in ways that help them to be successful in their roles (e.g., lending additional support to the maturity principle; Lodi-Smith & Roberts, 2007; Roberts et al., 2006). Importantly, the occurrence of non-normative life events and transitions also holds a place in the personality development literature (Helson & Mitchell, 2020). For example, potentially traumatic and adverse life events are thought about to spur psychological change, often in positive, more mature ways as well (Chopik et al., 2021; Jayawickreme et al., 2021; Jayawickreme & Blackie, 2014). Because more normative roles often follow an age-graded schedule, many of the most dramatic changes and age differences in psychological traits occur in young adulthood when many of these transitions occur. However, lifespan changes in psychological characteristics continue to occur beyond young adulthood (Specht et al., 2014; Srivastava et al., 2003).

People investing in social institutions that drive them toward individual and relational maturity might also lower BAP-related traits that interfere with this process. Across adulthood, people increasingly behave in ways that maximize positive social experiences and avoid conflict with others which is one reason why social relationships become "better" with age (Luong et al., 2011). The accompanying shift toward interpersonal harmony and maturity is seen across a variety of traits that share some empirical overlap with the BAP (Lamport & Turner, 2014; Wainer et al., 2011). For example, people tend to become more agreeable, conscientious, empathetic, and secure in their relationships while also declining in neuroticism and social anxiety over time (Atherton et al., 2020; Chopik et al., 2019; Oh et al., 2019). Such changes in prosocial traits and characteristics likely have implications for the BAP. Even among clinical samples with ASD, emotional and conduct symptoms and

behaviors decline longitudinally over time, likewise suggesting a shift toward social maturity and communication improvements (Stringer et al., 2020). In this particular study, the emotional and conduct symptoms included things like caring about other people's feelings, sharing with others, being around other people more, being nice to others, and not fighting with other people (Goodman, 1997; Goodman et al., 2000). Lifespan shifts toward in these more prosocial traits, seen among both clinical and nonclinical samples, would also lead to the prediction that BAP-related traits (e.g., aloofness, pragmatic language difficulties) might be higher among younger adults and lower among older adults. Thus, we predicted that BAP-related traits would be highest among young adults and lower among older adults.

The current study

Much of the existing knowledge on ASD and BAP focuses on children and adolescents with ASD, college students, and the parents of children with ASD. Very little research examines BAP from a lifespan perspective (Bal et al., 2015). Indeed, there is a relative lack of basic descriptive information on how BAP differs across age groups. In the current study, we hypothesized that BAP traits would be highest among younger adults and lower among middle-aged and older adults. This hypothesis was formed based on research demonstrating an abatement of clinical ASD symptoms in other cross-sectional samples (Seltzer et al., 2003) and age differences in other ostensibly related personality traits (Chopik et al., 2013; Ingersoll et al., 2011; Lamport & Turner, 2014; Srivastava et al., 2003).

METHODS

Participants

Participants were 2966 adults ranging in age from 18 to 85 (M_{age} = 36.53, SD = 12.61; 58.9% Female) recruited from Amazon Mechanical Turk (MTurk; Buhrmester et al., 2011). Participants were compensated $.40, which is comparable to other studies implemented on MTurk (Paolacci & Chandler, 2014). There were relatively healthy sample sizes for individuals aged 18–29 (n = 1105), 30–49 (n = 1323), and over 50 (n = 536). Self-reported race/ethnicity was 75.5% Caucasian, 7.6% African American, 5.5% Hispanic/Latino, 6.7% Asian, and 4.6% Mixed/Other ethnicities. Thirty-three participants (1.1%) reported that they had been diagnosed with an autism-related condition, and 1188 (40.1%) participants reported knowing someone with autism, matching similar rates of ASD in the population (Maenner et al., 2020). Four hundred and seven participants (13.58%) reported a genetic relationship to someone with autism; genetic relatedness, coded as related versus not (rs <0.03, ps >0.15) and degree of genetic relatedness (e.g., brother = 0.50; rs <0.02, ps >0.24), were unrelated to BAPQ and its subscales.

Comparing the sample characteristics according to Census distinctions of young (18–44), middle-aged (45–64), and older adults (65+) revealed some sample-based selection effects. Specifically, the middle-aged (66.3%) and older adult (65.1%) groups had relatively more women than men compared to the younger adult group (56.4%). Likewise, the younger adult group was a little more diverse (72.8% Caucasian) compared to the middle-aged (83.6%) and older adult group (85.5%). Because of these differences, we checked for gender and race differences in all subsequent analyses.

This research was approved by the Michigan State University Institutional Review Board (IRB#16-1291e). This research was not the result of a clinical trial. Regarding data collection, we recruited as many participants as we could with the resources we had available. With a sample size of 2966 and at $\alpha = 0.05$, we were able to estimate effect sizes as small as $f^2 = 0.003$ at 80% power and $f^2 = 0.005$ at 95% power, respectively. The study hypotheses and analyses were not preregistered. Data and syntax for the analyses below, and a copy of the survey, can be found on our OSF site (https://osf.io/9jfvx/). In addition to the variables mentioned below, a measure of social support was also collected (Sarason et al., 1983), but its consideration was beyond the scope of the current study.

Measures

Broader autism phenotype

The BAP was measured with the BAPQ (Hurley et al., 2007). The 36-item BAPQ measures the overall BAP as well as three subscales: aloofness, pragmatic language deficits, and rigidity. The 12-item aloofness subscale (α = 0.91) reflects a limited interest in and reduced enjoyment from social interaction (e.g., "I would rather talk to people to get information than to socialize."). The 12-item pragmatic language deficits subscale (α = 0.82) reflects a difficulty in the social use of language, particularly for communicating effectively and reciprocating appropriately (e.g., "It's hard for me to avoid getting sidetracked in conversation."). The 12-item rigidity subscale (α = 0.85) reflects a strong preference for routine and difficulty adjusting to change (e.g., "People have to talk me into trying something new."). Participants rated the extent to which each statement characterized their thoughts and behaviors on a six-point scale ranging from 1 (*very rarely*) to 6 (*very often*). An omnibus scale for the BAP was also computed by averaging all the items together (α = 0.92).[1]

Two efforts were undertaken to examine whether age group differences reflected genuine differences between

the groups. First, extreme positive and extreme negative responding on the BAPQ (i.e., the probability or likelihood of choosing the two most extreme positive and negative anchors) were not significantly associated with age (rs <|0.04|, ps >0.06).

Second, we tested measurement invariance across age groups. We compared groups of young (18–34, n = 1598), middle-aged (35–49; n = 830), and older adults (50+; n = 536) to ensure enough participants per age group could be examined. Specifically, we tested for configural, metric (are factor loadings similar across groups?), strong (are the factor means similar across groups?), and strict invariance (are residual variances similar across groups?) of the BAPQ. We began by running a confirmatory factor analysis on a variant of the three-factor structure of the BAPQ—the Correlated Trait-Correlated Method Minus One Model (CT-C[M-1]; Eid et al., 2003). The CT-C(M-1) model allows for the specification of a confirmatory factor structure while enabling for the modeling of a method factor (i.e., negatively worded items). Doing so for the BAPQ was paramount given the strong response patterns to negatively worded items that sometimes produces several additional trait-method factors across the BAPQ when exploratory factor analyses are run (see Ingersoll et al., 2011). We employed these analyses in MPlus version 8 (Muthén & Muthén, 2017) and considered good fit as a CFA and TLI greater than 0.95, and a RMSEA and SRMR less than 0.08 (Hu & Bentler, 1999; Little, 2013). As seen in Table S1, the fit statistics of this configural model were mixed, suggesting somewhat acceptable fit, χ^2 (1728) = 9166.67, p < 0.001, CFI = 0.84, TLI = 0.82, RMSEA = 0.07, SRMR = 0.07), but resembled the characteristics of other BAP-type scales (i.e., the Autism-Spectrum Quotient Scale; Lodi-Smith et al., 2021). Model fit did not substantially change when testing for metric (ΔCFI = 0.004, ΔTLI = −0.006, ΔRMSEA = 0.001, ΔSRMR = 0.003), strong (ΔCFI = 0.006, ΔTLI = 0.001, ΔRMSEA < 0.001, ΔSRMR = 0.001), or strict invariance (ΔCFI = 0.02, ΔTLI = 0.009, ΔRMSEA = −0.002, ΔSRMR = 0.006), in a sequential manner.

From these two analyses, we can reasonably assume that age differences in the BAPQ represent genuine mean-level differences between the age groups.[2]

RESULTS

Preliminary results

Means, standard deviations, and zero-order correlations are presented in Table 1. Age was negatively associated with the total BAP score, pragmatic language difficulties, and aloofness, such that older adults were lower in each relative to younger adults. Age was not associated with rigidity. Women reported lower levels of the total BAP score, aloofness, and pragmatic language deficits compared to men. As expected, individuals with an autism-related diagnosis reported higher total BAP scores and each of its facets. Race was unrelated to the total BAP and the subscales. The subscales and total BAP were all significantly intercorrelated ($0.42 \le r \le 0.85$).

Cross-sectional age differences

To formally model age differences in the overall BAP and its subcomponents, hierarchical regression analyses were conducted in which the overall BAP and each subcomponent were predicted from the linear, quadratic (age^2), and cubic (age^3) effects of age. Similar to previous research on cross-sectional age differences, we limited our investigation to cubic effects as more complex terms are often difficult to meaningfully interpret (Chopik, 2016; Terracciano et al., 2005). Age was centered prior to analysis, and this centered age term was used to compute the higher-order terms. We tested each model progressively by adding a more complex age term in each step. If an additional predictor did not significantly explain additional variance (indexed via ΔR^2 and F_{change}), the simpler model was retained. Because autism-related diagnoses and gender were significantly associated with most BAPQ subscales, we included both as covariates in each analysis. Because race/ethnicity was unrelated to the BAP and its subscales (see Table 1), it was not considered further (small and nonsignificant effects were also seen when it was included in the regressions reported below; βs <|0.03|). Gender did not moderate any of the age terms for the total BAP score (ps >0.51), aloofness (ps >0.08), pragmatic language difficulties (ps >0.28), or rigidity (ps >0.50), consistent with the results from a recent systematic review (Pender et al., 2020).

BAP total

As seen in the first panel of Table 2, the cubic effect best described variation in the overall BAP. As seen in Figure 1, the BAP was highest among young adults and lower in middle-aged and older adults. The eldest participants were lowest in BAP. The linear and quadratic effects of age were also significant. Age differences in the overall BAP were most dramatic earlier in life, and age was relatively unrelated to the overall BAP after middle age, mirroring effects seen in the personality literature (Srivastava et al., 2003). Specifically, the BAP total scale was negatively associated with age among 18–29 year olds (β = −0.09, p = 0.01), unrelated to age among 30–49 year olds (β = 0.003, p = 0.92), and negatively associated with age among those over the age of 50 (β = −0.07, p = 0.04). Men and those with an ASD diagnosis had higher scores on the overall BAP.

TABLE 1 Correlations and descriptive statistics for primary study variables

	1	2	3	4	5	6	7	M (%)	*SD*
1. Gender								58.9%[a]	
2. Race	−0.02							24.5%[b]	
3. Autism Diagnosis	−0.02	−0.02						1.1%[c]	
4. Age	0.09***	−0.15***	−0.02					36.53	12.61
5. Broader Autism Phenotype	−0.05**	−0.02	0.09***	−0.12***				3.15	0.64
6. Aloofness	−0.05*	−0.03	0.05**	−0.04*	0.85***			3.31	0.84
7. Pragmatic Language	−0.09***	0.02	0.10***	−0.23***	0.76***	0.48***		2.79	0.72
8. Rigidity	0.01	−0.03	0.08***	−0.03	0.79***	0.52***	0.42***	3.35	0.76

Note: *N*s range from 2931 to 2966.
[a]Percentage female.
[b]Percentage of participants of color.
[c]Percentage with an autism diagnosis.
Gender: −1, men; 1, women. Race: −1, White; 1, person of color. Autism diagnosis: −1, no; 1, yes.
*p <0.05.
**p <0.01.
***p <0.001.

TABLE 2 Age differences in the broader autism phenotype

Broader autism phenotype total							
Regression term[a]	***b***	***SE***	***β***	***t***	***p***	**95% CI LB**	**95% CI UB**
Intercept	3.36	0.06					
Age	−0.004	0.001	−0.08	−2.87	0.004	−0.007	−0.002
Age^2	<0.001	<0.001	0.10	2.57	0.01	0.0001	0.0005
Age^3	<0.001	<0.001	−0.12	−2.49	0.01	−0.00002	−0.000002
Autism diagnosis	0.24	0.06	0.08	4.29	<0.001	0.131	0.352
Gender	−0.03	0.01	−0.04	−2.37	0.02	−0.052	−0.005
Aloofness scale							
Regression term[b]	***b***	***SE***	***β***	***t***	***p***	**95% CI LB**	**95% CI UB**
Intercept	3.50	0.08					
Age	−0.003	0.001	−0.04	−2.13	0.03	−0.005	−0.0002
Autism diagnosis	0.19	0.08	0.04	2.37	0.02	0.033	0.347
Gender	−0.04	0.02	−0.05	−2.56	0.01	−0.077	−0.010
Pragmatic language difficulties scale							
Regression term[c]	***b***	***SE***	***β***	***t***	***p***	**95% CI LB**	**95% CI UB**
Intercept	3.01	0.06					
Age	−0.01	0.002	−0.23	−8.10	<0.001	−0.016	−0.010
Age^2	0.0005	0.0001	0.14	3.91	<0.001	0.0002	0.001
Age^3	−0.00001	0.000004	−0.10	−2.26	0.02	−0.00002	−0.000001
Autism diagnosis	0.29	0.06	0.08	4.69	<0.001	0.168	0.409
Gender	−0.05	0.01	−0.07	−3.97	<0.001	−0.077	−0.026
Rigidity scale							
Regression term[d]	***b***	***SE***	***β***	***t***	***p***	**95% CI LB**	**95% CI UB**
Intercept	3.60	0.06					
Age	−0.002	0.001	−0.03	−1.82	0.07	−0.004	−0.0002
Autism diagnosis	0.25	0.07	0.07	3.75	<0.001	0.126	0.385
Gender	0.01	0.01	0.02	0.91	0.36	−0.015	0.041

[a]N = 2928. $F_{(5,2923)}$ = 15.14, p < 0.001, R = 0.16. Gender: −1 = men, 1 = women. Autism diagnosis: −1 = no, 1 = yes.
[b]N = 2928. $F_{(3,2925)}$ = 6.05, p < 0.001, R = 0.08. Gender: −1 = men, 1 = women. Autism diagnosis: −1 = no, 1 = yes.
[c]N = 2928. $F_{(5,2923)}$ = 45.39, p < 0.001, R = 0.27. Gender: −1 = men, 1 = women. Autism diagnosis: −1 = no, 1 = yes.
[d]N = 2928. $F_{(3,2925)}$ = 6.06, p < 0.001, R = 0.08. Gender: −1 = men, 1 = women. Autism diagnosis: −1 = no, 1 = yes.

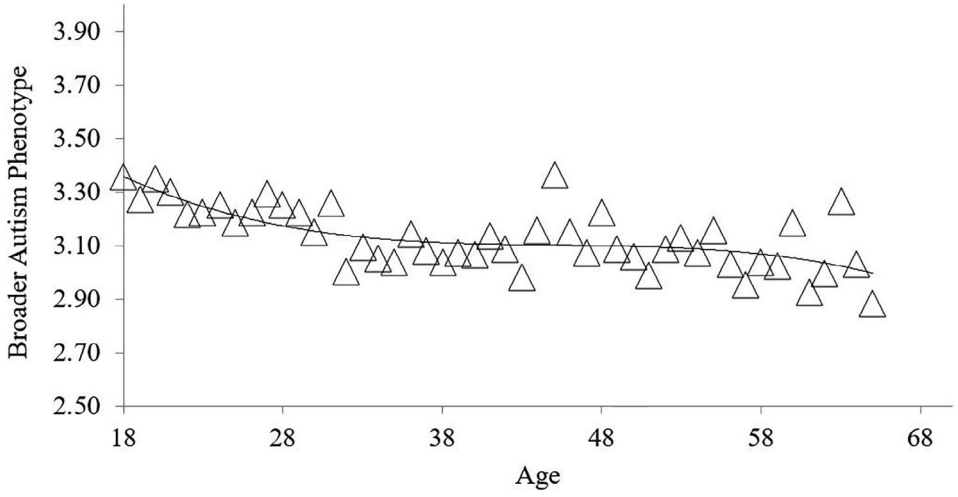

FIGURE 1 Age differences in the broader autism phenotype. Ages beyond 65 were collapsed due to small sample sizes

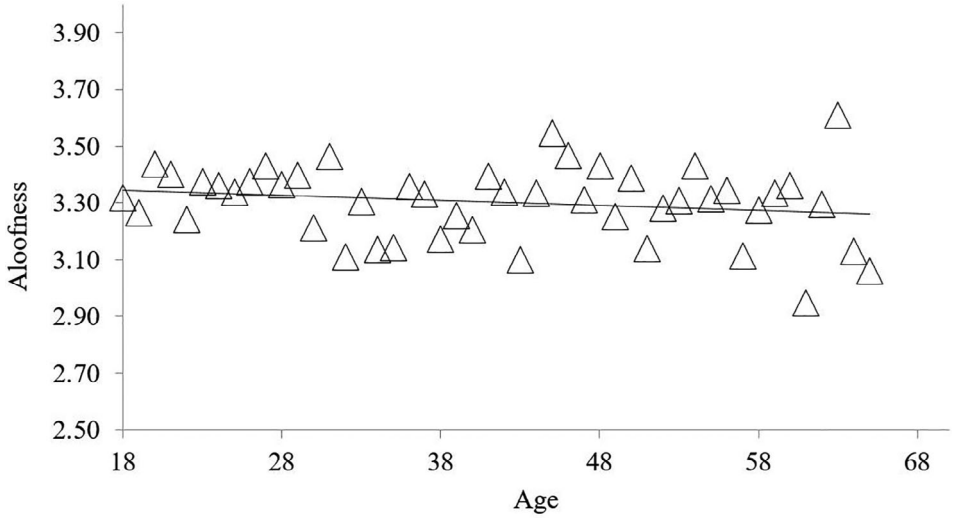

FIGURE 2 Age differences in aloofness. Ages beyond 65 were collapsed due to small sample sizes

Aloofness

As seen in the second panel of Table 2, the linear effect best described variation in the aloofness scale. The quadratic ($\Delta R^2 < 0.001$, $F_{change} = 0.53$) and cubic effects ($\Delta R^2 = 0.001$, $F_{change} = 3.68$) did not significantly contribute to the model, so only the linear effect was retained. As seen in Figure 2, aloofness was highest among younger adults and lowest among older adults. Men and those with an ASD diagnosis had higher aloofness scores.

Pragmatic language difficulties

As seen in the third panel of Table 2, the cubic effect best described variation in the pragmatic language difficulties scale. As seen in Figure 3, pragmatic language difficulties were higher among younger adults and lower among middle-aged and older adults. Mirroring the cubic results found for the overall BAP, the eldest participants reported the fewest pragmatic language difficulties. Again, the most dramatic differences in pragmatic language capabilities were among younger adults; age was less related to pragmatic language deficits in middle age. Specifically, pragmatic language difficulties were negatively associated with age among 18–29 year olds ($\beta = -0.10$, $p = 0.001$), less negatively associated with age among 30 to 49 year olds ($\beta = -0.06$, $p = 0.04$), and negatively associated with age among those over the age of 50 ($\beta = -0.09$, $p = 0.046$). Men and those with an ASD diagnosis had higher pragmatic language difficulty scores.

Rigidity

As seen in the fourth panel of Table 2, the linear effect best described variation in the rigidity scale. The quadratic ($\Delta R^2 < 0.001$, $F_{change} = 0.03$) and cubic effects ($\Delta R^2 = 0.001$, $F_{change} = 3.54$) did not significantly contribute to the model, so only the linear effect was

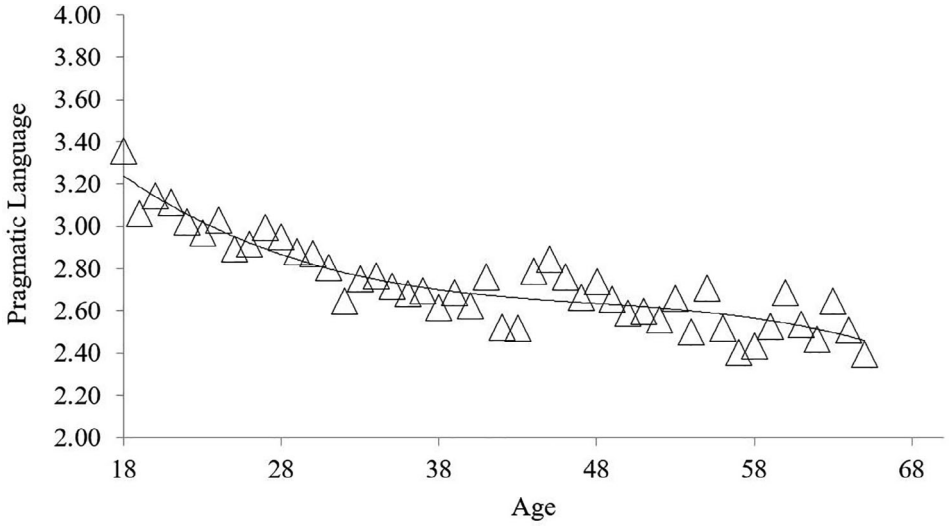

FIGURE 3 Age differences in pragmatic language difficulties. Ages beyond 65 were collapsed due to small sample sizes

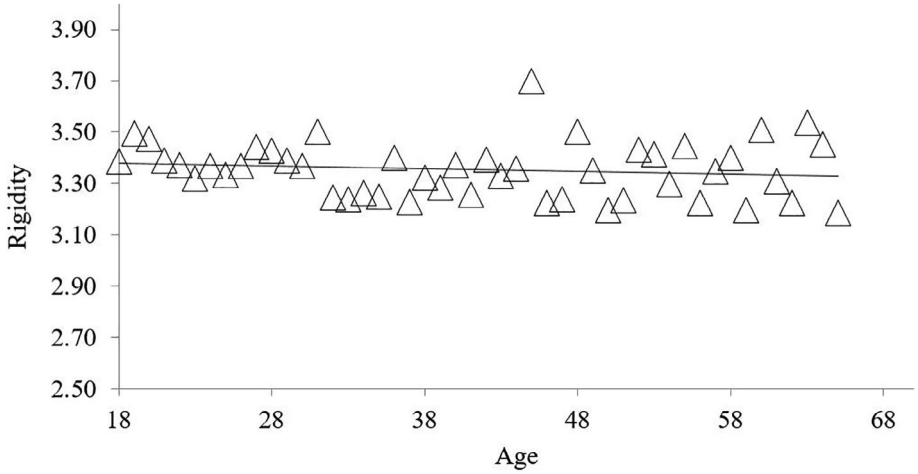

FIGURE 4 Age differences in rigidity. Ages beyond 65 were collapsed due to small sample sizes

retained. However, even this linear effect did not reach significance (p = 0.07). As seen in Figure 4, there were very few age differences in rigidity. Those with an ASD diagnosis had higher rigidity scores.

DISCUSSION

The current study examined age differences in the BAP in a large, cross-sectional study of 2966 adults. We found that the BAP was higher in younger adults and lower among older adults. These differences appeared to be driven by pragmatic language difficulties as this component of BAP showed the most dramatic age differences, with older adults reporting fewer pragmatic language difficulties. Aloofness showed similar negative associations with age, albeit much smaller. Rigidity was unrelated to age. These results are consistent with a recent systematic review showing lifespan declines in social ASD symptoms (e.g., analogous to aloofness and pragmatic language difficulties in the current study) but not nonsocial ASD symptoms (e.g., analogous to rigidity in the current study; Pender et al., 2020). However, this is one of the first and largest studies to examine lifespan differences (among younger, middle-aged, and older adults) in the BAP in the general population.

BAP from a lifespan perspective

The BAP had previously been linked to a variety of social and occupational deficits (e.g., Ingersoll & Hambrick, 2011; McDonnell & Nuttall, 2018; Wainer et al., 2013). However, there was a lack of research describing normative age differences in the BAP. Similar to other psychological characteristics, BAP age differences in the present study aligned well with existing models of maturity and personality change across life. Previous research on personality development has hypothesized that psychological changes closely match the investments that individuals make in social institutions (Roberts et al., 2005). These investments in social

institutions reward maturity, such that individuals advance and find success by selecting situations and altering their behavior to fit a situation that rewards maturity (Lodi-Smith & Roberts, 2007). Age differences in BAP might partially reflect this process. Reductions in pragmatic language difficulties likely make relational interactions and occupational efforts much more successful. Further, work on older adults shows that, even in the context of declines in specific language deficits (e.g., diminished vocabulary, compromised linguistic reasoning; Bourgeois, 1991), pragmatic functions of language (e.g., shared understanding) actually increase. This might be attributable to increases in nonverbal communication behavior that transmits their intentions and expectations in social contexts (Hubbard et al., 2002). Increases in behaviors that enhance the practical and pragmatic functions of communication likely also enhance relational interactions in ways consistent with the social investment and maturity principles, further improving social relations (Chopik, 2017). Lower aloofness likely enhances communication as well. Effective communication and responsiveness are some of the most powerful predictors of success in relationship and work contexts (Carletta et al., 1998; Guo & Sanchez, 2005; Reis et al., 2004). In other words, as increases in traits like agreeableness and conscientiousness (and declines in neuroticism) reflect social investment efforts, so too might age differences in BAP-related traits and behaviors.

Worth noting, other explanations for lifespan differences in ASD also exist, such as diagnostic practices varying over time and—consistent with the current report of individuals from the general population—environmental influences reducing symptomatology (Seltzer et al., 2003). Importantly, lifespan developmentalists often make distinctions between selection and socialization effects. For example, highly rigid people might select in or out of different situations across life—they might be less likely to venture out, depart from a routine, and expose themselves to new situations, missing the opportunities that might otherwise catalyze psychological change. Likewise, *among the rigid people who are able to find themselves in new environments outside of their routines*, there might be characteristics of these new environments that facilitate psychosocial change and ultimately reduce rigidity (Luhmann et al., 2020). The former effect—in which rigidity predicts the likelihood to be part of a new situation or not—is considered a selection effect. The latter effect—in which rigidity changes in response to a new situation—is considered a socialization effect. Together, they provide a useful distinction for why some people's psychosocial characteristics are more stable or malleable over time and across different situations (Caspi et al., 2005; Roberts & Caspi, 2003). Unfortunately, with just a cross-sectional snapshot of the general population, these two effects are confounded and obscured with each other in the current study. By examining the general population in one snapshot using a common measure of the BAP, we could more precisely examine age group differences and help guide future research about why BAP might differ by age.

Because there has been so little information published on demographic differences in the BAP, the closest analog to compare the current study's findings is with the ASD literature. Few long-term longitudinal studies exist examining changes in ASD symptoms across large stretches of the adult lifespan. However, the few longitudinal and cross-sectional studies show consistent lifespan declines in ASD symptoms. For example, throughout adolescence and early adulthood, improvements in language are somewhat common, reflecting a growing competence in the back-and-forth reciprocal nature of interpersonal interactions (Bal et al., 2015). From the perspective of adult relationship development, improvements in language norms also make sense—becoming a good conversational and relational partner at least somewhat depends on an understanding of relationship rules and a ceding of the conversation to a partner to voice their thoughts and opinions (Duncan, 1972; Stivers et al., 2009). Practice and exposure to relational contexts likely aid in reducing language difficulties. This interpretation also aligns with research showing that the largest longitudinal declines in pragmatic language difficulties occur among those with higher levels of education and supportive social relationships (Taylor & Seltzer, 2010; Woodman et al., 2016). Importantly, lifespan differences in ASD among clinical populations and the BAP among the general population are two separate questions, even if similar mechanisms might be driving both. Organizational (e.g., educational) and relational settings might provide the context through which BAP-related traits like language difficulties and aloofness are reduced through active engagement with social partners and reward-based contingencies (e.g., educational achievement and occupational attainment/advancement). Concurrent improvements in attachment security and empathy—constructs identified as correlates of the BAP (Lamport & Turner, 2014)—also likely play a role in why younger adults report higher BAP traits compared to older adults.

Our finding that rigidity was unrelated to age is also consistent with past research; in research on individuals with ASD, some studies find improvements in rigidity/repetitive behaviors (Chowdhury et al., 2010) and some studies do not (Hattier et al., 2011). In the general population, behavioral rigidity is highly stable, but stability in BAP-related rigidity over long periods of time has not been examined (Gruber-Baldini et al., 1995). This context underscores the importance of collecting longitudinal data on BAP-related traits over longer periods of time. Specifically, doing so would enable researchers to appropriately model individual differences in changes in BAP-rigidity (and the BAP more generally over time). In other words, there would be a greater understanding of why some people increase in BAP-rigidity and others decrease

in BAP-rigidity, even when, on average, there might appear to be little change when examining the overall mean-level change in a broader sample. Because there are individual differences in most psychological traits (Schwaba & Bleidorn, 2018), there are likely individual differences in changes in BAP-related rigidity as well. In addition to quantifying if there are individual differences in changes in the BAP, the antecedents and consequences will be important to study (a consideration we turn to in the next section). Unfortunately, with the cross-sectional nature of our data, we cannot definitively speak to this, despite a great deal of personality research suggesting it is likely. All told, future longitudinal studies should more thoroughly examine individual differences in changes in rigidity and the BAP to identify why some individuals become less rigid and why some individuals become more rigid across the lifespan.

Clinical implications

The current study provides largely descriptive information about how BAP differs across the adult lifespan in the general population. As a result, it was largely agnostic to exactly why different elements of BAP differ by age. Similar to the reasons provided for why ASD symptoms decline over time, the age differences in BAP could likely be attributable to environmental influences or intervening factors in individuals' social environments. Nevertheless, knowing how the BAP differs by age, even cross-sectionally, is useful in shaping people's expectations about which facets might naturally improve over time and which might be malleable to psychological interventions. In addition to merely being higher or lower in BAP-related traits and characteristics, *reductions* in these traits and characteristics might also be associated with quality of life gains among individuals and their close others. For example, declines in symptoms among individuals with ASD are associated with less compulsive and self-injurious behavior (Chowdhury et al., 2010). The cognitive, employment, independence, and social outcomes of individuals with ASD likewise improve with declining symptoms (Farley et al., 2009; Lounds et al., 2007). Although improvements are possible for individuals with ASD, there is some consensus that these gains likely do not result in fully normative outcomes in which they are on par with individuals without ASD (Howlin et al., 2013; Seltzer et al., 2004).

If the BAP shares some similarities with other psychological traits (e.g., personality), BAP traits may be malleable enough among the general population to make normative outcomes achievable. Worth noting, the most dramatic age differences in BAP were present among younger adults. This pattern is consistent with research on other psychological characteristics, like personality, which also shows that the most dramatic mean-level changes occur during young adulthood, followed by higher levels of stability with advanced age (Roberts et al., 2006; Roberts & DelVecchio, 2000).

The greater malleability of psychological characteristics among this age group explains why interventions to change personality have focused primarily on young adults (Hudson et al., 2019; Stieger et al., 2020). Although changes after young adulthood are certainly possible (Wagner & Mueller, 2020), efforts or interventions to reduce BAP-related traits may be more effective if they occur in young adulthood, before psychological characteristics become more stable (Srivastava et al., 2003). Some interventions have been developed to target BAP-related behavior or focus on child outcomes as a result of interventions with the parents (e.g., Parr et al., 2015). However, to our knowledge, no interventions designed to reduce BAP in adults in the general population have been developed and tested. Studies of volitional change and interventions to induce personality change might provide a useful roadmap for developing interventions for adults. For example, an important consideration in whether people's psychological characteristics change is if they *want* to change (Hudson et al., 2021; Hudson & Roberts, 2014). It is entirely possible that, in identifying as someone either with ASD or BAP traits, people may come to recognize the strengths of these characteristics and identity and ultimately resist contexts that might modify these traits (Caspi et al., 2005; Large & Serrano, 2018; Niemiec et al., 2017; Wong et al., 2018). Among those who do want to change, there have been positive examples of interventions that have proven effective at changing broader personality traits among younger adults. For example, gamifying personality and behavioral change through weekly challenges that target personality traits have spurred investment and psychological change over a four-month period (Hudson et al., 2019). There is also some evidence that interventions can be delivered through smartphone and mobile sensing technologies. Specifically, people can receive personality-focused micro-interventions that assign daily tasks, remind people about their goals, and provide resources to facilitate goal attainment for psychological change (Stieger et al., 2020). Finally, clinical interventions (e.g., forms of therapy) have also been shown to change people's personalities as a byproduct of their targeted efforts (Roberts et al., 2017). Such deliverable interventions might have promising effects on BAP-related traits as well.

Finally, this study also highlights the need to continue studying the incidence and manifestation of ASD and BAP among middle-aged and older adults. The focus of research to date has been disproportionally on children, adolescents, and younger adults (Murphy et al., 2016; Perkins & Berkman, 2012; Piven et al., 2011). In fact, because of changes in diagnostic criteria for ASD and a recent shift toward spectrum concepts, there is thought to be a "lost generation" of older adults who were previously excluded from a formal diagnosis of ASD (Lai &

Baron-Cohen, 2015). The use of a continuous, self-report subclinical measure of BAP-related traits is useful in this regard—it can capture a broader range of variation in BAP-related traits among individuals who are higher in autistic traits but nevertheless do not have a formal ASD diagnosis. However, the selection problem of older adults being historically excluded from this research is compounded by the fact that there are cognitive and language limitations that might prevent individuals from being able to accurately report on their own BAP traits (Hand et al., 2020; Lodi-Smith et al., 2021). In fact, executive and cognitive functioning deficits are some of the correlates of the BAP among older adults (Stewart et al., 2018, 2020; Wallace et al., 2016). Further, because people with ASD tend to have reduced longevity, studies of ASD and the BAP that do examine older adults might be restricted to a selected sample of abnormally healthy and cognitively intact older adults that might have lower BAP-related traits (Mouridsen et al., 2008; Shavelle et al., 2001; Smith DaWalt et al., 2019). Such concerns highlight the need to develop age-appropriate measures of BAP and ASD criteria as well as collect prospective longitudinal data on individuals prior to older adulthood to account for these selection effects.

The current study provides a useful starting point for researchers and clinicians by demonstrating that there is lifespan variation in the BAP. The next steps involve examining the origin and consequences of this variation for the lives of people and their close loved ones across the entire lifespan.

Limitations

The current study had many strengths. We examined age differences in BAP in a large sample of adults ranging in age from 18 to 85, a major effort to incorporate middle-aged and older adults from the general population into the study of BAP. Nevertheless, there are limitations to the study that are important to acknowledge.

First, the current study was a cross-sectional study of members of the general population. Because of the dearth of data on developmental differences on the BAP, our introduction and interpretation of the findings often had to rely on longitudinal studies of ASD individuals. The danger in interpreting cross-sectional age differences as indicative of how people longitudinally change over time is that it would neglect how different birth cohorts might differ on BAP-related traits (Stewart & Healy, 1989). This is particularly concerning when considering the limitations in assessing ASD and BAP-related characteristics in older adults more generally. For example, the aforementioned health, cognitive, language, and longevity limitations likely produce highly selective cohorts of older adults who did not have access to the same diagnostic criteria and measures when they were younger (Hand et al., 2020; Lai & Baron-Cohen, 2015; Smith DaWalt et al., 2019). Likewise, even among this highly selected group of older adults, there might be social norms and stigma around participating in ASD and BAP-related research (as answering affirmatively to these questions might affirm negative stereotypes about older adults; Chopik et al., 2018; Cuddy & Fiske, 2002). Some older adults might not participate because of these reasons and more. Such considerations would naturally have implications for comparing the BAP traits between individuals of different ages and further complicate whether the differences are attributable to cohort or developmental mechanisms. The question of whether cross-sectional results more closely resemble genuine developmental change or differences between people born at different times throughout history is a hotly debated topic in the adult development literature (Chopik & Grimm, 2019; Roberts et al., 2010; Trzesniewski et al., 2008; Wetzel et al., 2017). Unfortunately, due to the relatively recent introduction and measurement capabilities of the BAP, few longitudinal studies exist to quantify the amount of individual differences in changes in the BAP and whether these changes are related to disparate outcomes for individuals. To date, there is some converging evidence that cross-sectional results in these types of traits replicate when they are examined longitudinally (Roberts et al., 2006). However, only future longitudinal studies can truly describe the normative trajectory of BAP-related traits across the lifespan.

Second, and related to the first point, our study was relatively simple—it merely sought to describe how the BAP differed by age. As a result, we cannot be sure why younger and older adults might differ from one another. We proposed that these age differences partially reflect the degree to which individuals invest and find success in social institutions across the lifespan. However, several other plausible explanations exist. The lack of additional explanatory variables—paired with long-term longitudinal data—would strengthen our interpretation in this regard. Further, the sample composition also had its limitations. Specifically, the sample was relatively young and had fewer older adults, particularly those in their 80s and 90s. It is important to include a larger group of older adults in future studies. Given the aforementioned selection effects, we may be underestimating the presence of the BAP among older adults; studies with more older adults might reveal higher BAP traits among the oldest old. Likewise, the current sample was relatively homogenous with respect to its racial/ethnic breakdown. Historically, people from underrepresented backgrounds have been neglected in ASD research (Tincani et al., 2009; West et al., 2016). Future research should collect more diverse samples to examine if age differences in BAP are consistent across different racial/ethnic groups. Thus, we encourage future researchers to examine how and why the BAP might change across the lifespan and whether these changes benefit individuals and their close loved ones.

CONCLUSION

In closure, the current study examined age differences in the BAP in a large sample of 2966 adults. We found that the BAP—particularly pragmatic language deficits and aloofness—were higher among younger adults and lower among older adults. These age differences are consistent with theories related to social investment and psychological change as well as lifespan abatements in symptoms of individuals with ASD. Future research should examine changes in BAP in long-term longitudinal studies and the predictors and consequences of these changes. The current study provides several avenues for future directions in characterizing changes in BAP and more firmly situating middle-aged and older adults from the general population in the study of BAP and ASD.

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CONFLICT OF INTEREST

The authors report no conflicts of interest in the creation of this work.

ETHICS STATEMENT

This study was approved by the Michigan State University Institutional Review Board (application x16-1291e). This research was not the result of a clinical trial.

AUTHOR CONTRIBUTIONS

William J. Chopik: Conceptualization, data curation, formal analysis, investigation, methodology, project administration, resources, supervision, writing – original draft preparation, reviewing and editing. **Jeewon Oh:** formal analysis, validation, writing – review and editing. **Amy K. Nuttall:** writing – review and editing. **Katharine N. Thakkar:** writing – review and editing. **Brooke Ingersoll:** writing – review and editing. All authors approve of the version of this manuscript to be published and agree to be accountable for all aspects of the work.

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ENDNOTES

[1]An alternative way of scoring the BAPQ is with respect to cut-off scores provided by previous research (i.e., Hurley et al., 2007; Sasson et al., 2013). Using more the more liberal criteria of Hurley et al. (2007), the incidence of the BAP for the total scale (50.8%), aloofness (51.4%), rigidity (39.5%), and pragmatic language (47.1%) was relatively high. Using the more stringent (and gender-weighted) criteria of Sasson et al. (2013), the incidence rates were still substantial for the total scale (39.3%), aloofness (32.4%), rigidity (27.0%), and pragmatic language (33.5%). Consistent with the results reported in Table 1, age was negatively associated with the prevalence of the BAP.

[2]We had a large enough sample to run measurement invariance tests of the BAPQ across age. However, we did not have a large enough sample to do so among those with and without ASD. Piven and Sasson (2014) suggest that there are several conceptual and methodological concerns about administering the BAPQ to a sample of individuals with ASD. We view our inability to formally test measurement invariance and scale characteristics in the ASD subsample as a limitation of the current study. Worth noting, excluding participants with ASD led to nearly identical results as to what is presented in text. Nevertheless, we urge future researchers to think carefully about whether it makes sense to administer the BAPQ to individuals with ASD, the conclusions one can draw from doing so, and to formally examine the measurement characteristics of the BAPQ in a variety of samples.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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