Lost in Translation or Just Too Pragmatic?

Validation of the German Broader Autism Phenotype Questionnaire (BAPQ-G)

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Abstract. The Broader Autism Phenotype Questionnaire (BAPQ) is a measure to assess a set of personality and language characteristics reflecting the phenotypic expression of autistic traits in neurotypically developing individuals. This paper aims to evaluate the newly developed German version of the BAPQ (BAPQ-G) in terms of its factorial validity. We performed confirmatory factor analyses and correlations with other measures of the broader autism phenotype on three German samples ($N_1 = 248$, $N_2 = 289$, $N_3 = 255$). Associations with other constructs are in line with the assumptions, yet the anticipated factor structure of the BAPQ-G did not meet the cutoff criteria. These results are discussed along with recent findings regarding other cultural versions of the BAPQ.

Keywords: broader autism phenotype, autism, validation, confirmatory factor analysis, psychometrics

Autism spectrum condition (ASC) is characterized by difficulties in social communication and interaction as well as stereotyped, repetitive behaviors (American Psychiatric Association [APA], 2013). The autism spectrum varies between a lower-than-average IQ, oftentimes nonverbal individuals, and so-called high-functioning individuals with an average to above-average IQ (Wing, 1997).

Twin data suggest a genetic liability for autism (Folstein & Rutter, 1977), which can result in a milder form of autistic traits in neurotypical relatives of individuals on the autism spectrum (Ingersoll & Wainer, 2014). These subclinical differences, referred to as the broader autism phenotype (BAP), are in their domains, similar to the diagnostic criteria of ASC, but differ in their quality and severity (Piven, 2001). The BAP comprises a group of social and communication skills and personality features frequently found in neurotypical relatives of individuals on the autism spectrum (Ingersoll & Wainer, 2014). For example, parents of children on the spectrum report to be less attuned to solely social interactions and have fewer and lower quality friendships than control parents (Losh et al., 2008; Piven et al., 1997). Furthermore, Maxwell et al. (2013) found that parental BAP predicts child functioning in ASC. While the BAP is more frequently found in first-degree relatives of individuals on the autism spectrum (e.g., Sung et al., 2005), it also seems to exist within the general population (e.g., Baron-Cohen et al., 2001; Constantino & Todd, 2005), thus

supporting the idea of an autism spectrum. These findings emphasize the importance of more research on the BAP, both in relatives of autistic individuals and in the typically developing population, which might aid in gaining a better understanding of the developmental trajectories of autistic tendencies (Godoy-Giménez et al., 2018; Landry & Chouinard, 2016).

BAP Domains

While there are specific clinical diagnostic criteria for ASC (APA, 2013), this is not the case for the BAP, since it is a subclinical phenomenon. This lack of criteria has made comparisons across studies difficult, but scholars have described core features of the BAP (e.g., Losh et al., 2011), suggesting that ASC and the BAP share the same areas of difficulty, but differ in their degree of severity and quality (Wainer et al., 2011). These areas will be highlighted with regard to how they relate between ASC and the BAP.

Social Behavior and Personality

Difficulties regarding social behaviors such as anxiousness, difficulty maintaining close friendships, or difficulty

adjusting to change are considered core features of ASC (APA, 2013) and can be indicative of the BAP as well (Ingersoll & Wainer, 2014). Relatives of autistic individuals have been found more likely to display such traits, among them shyness, rigidity, anxious or eccentric behaviors, and aloofness or unresponsiveness (Murphy et al., 2000; Pickles et al., 2000). Nonautistic siblings of individuals on the autism spectrum have shown early developmental differences in terms of social behavior such as responding to one's name (Nadig et al., 2007) or social smiling (Toth et al., 2007). Jobe and Williams White (2007) found a relation between social functioning and BAP in a non-clinical sample. Individuals with higher BAP levels and a desire for social interaction were reporting more loneliness and had fewer and shorter friendships (Bauminger & Kasari, 2000). Pollmann et al. (2010) suggest that high levels of BAP could influence romantic relationships in both quality and satisfaction.

Wainer et al. (2011) assume that these respective individuals may strive to engage with others but fail due to the lack of socially expected skills, which leads to social rejection. The authors propose that social difficulties of individuals with high levels of BAP could be related to both the ability to communicate, that is, pragmatic language and said difficulties, and the actual interest in interaction, that is, aloofness.

Rigid Behaviors and Interests

Restricted, repetitive, and stereotyped behavioral patterns and interests are seen as characteristic for ASC but can also be found in siblings and parents of individuals on the autism spectrum (Christensen et al., 2010). Individuals with high levels of autistic traits display a preference for activities involving systematizing as well as a tendency to analyze, understand, or construct rule-based systems (Baron-Cohen, 2002; Ingersoll & Wainer, 2014). These behavioral and interest-related characteristics can be expressed more mildly in family members of individuals on the autism spectrum (Baron-Cohen, 2002).

Pragmatic Language and Communication

ASC is also characterized by difficulties in language and communication skills. Whereas evidence on structural language difficulties is mixed at best (Ingersoll & Wainer, 2014), there is a larger, more consistent body of research on pragmatic language, that is, difficulties with the social use of language. Pragmatics refer to such skills as taking turns in conversations or sticking to a conversational topic, but also relate to nonverbal elements such as gestures, eye

contact, vocal prosody, or facial expressions (Ingersoll & Wainer, 2014). In self-reports, difficulties with pragmatics appear to be more common in siblings and adult family members of individuals on the autism spectrum compared to control parents (e.g., Ruser et al., 2007). Ingersoll and Wainer (2014) state that research on pragmatic language difficulties in nonclinical samples is limited, yet findings do suggest a correlation between pragmatic language problems and the BAP. For example, there has been evidence of early language delay in younger siblings of individuals on the autism spectrum (Constantino et al., 2010) and less pronounced social communication, for example, gestures, pointing to objects, and social smiling (Toth et al., 2007).

Assessing the BAP

Previously, various methods were employed to assess characteristics of the BAP in parents of individuals on the autism spectrum, for example, family history interviews (Piven et al., 1997), as well as instruments originally meant to assess autistic traits, for example, the Social Responsiveness Scale (SRS; Constantino, 2002) and the Autism Quotient (AQ; Baron-Cohen et al., 2001). As these instruments are often used to assess the BAP without being developed for that purpose, we will give a brief overview to facilitate a better understanding of similarities and differences between them before proceeding to the Broader Autism Phenotype Questionnaire (BAPQ; Hurley et al., 2007), which was specifically developed to assess the BAP.

Social Responsiveness Scale

The SRS is a parent/teacher questionnaire aimed at distinguishing children on the spectrum from those with typical development based on the child's ability to engage in reciprocal social interactions (Constantino et al., 2003). The SRS has five theoretically defined subscales including reciprocal social behavior, communication, and stereotyped behaviors and interests, with symptoms ranging from what is referred to as *normal* to autistic behavior (Hurley et al., 2007). Originally developed to be used in children, an adapted version for adults has since been published (adult version of the SRS [SRS-A]; Bölte, 2012). Used for the assessment of the BAP, studies have shown that siblings of children on the autism spectrum score higher on the SRS than siblings of neurotypical children (Constantino et al., 2007). Subthreshold autistic traits assessed by the SRS appear to be continuously distributed in the general population (Constantino & Todd, 2005).

Autism Quotient

The AQ (Baron-Cohen et al., 2001) assesses core features of ASC on five subscales. It is a self-assessment questionnaire identifying the degree to which an adult of normal intelligence exhibits autistic traits (Wheelwright et al., 2010). Several scholars have employed the AQ to assess the BAP, although it was never intended to be used as a BAP measure. Wheelwright et al. (2010), for example, found that parents of children on the autism spectrum score higher on four out of five subscales of the AQ, compared to parents without children on the autism spectrum. Bishop et al. (2004) reported similar findings with higher scores of parents of children on the autism spectrum on two out of five subscales, *social skills* and *communication*, concluding that the AQ is sensitive to the BAP when attention is being restricted to these two areas.

Broader Autism Phenotype Questionnaire

The SRS is mainly used to assess social behavior, while the AQ assesses the three defining constructs of autism (that is, social skills, attention to detail, and communication) as well as attention switching and imagination. In contrast to the AQ and the SRS, the BAPQ was specifically designed to identify the BAP in nonautistic relatives of individuals on the autism spectrum, assessing the theoretically defined core features of the BAP on three subscales: *aloof personality*, *rigid personality*, and *pragmatic language problems* (Hurley et al., 2007). The BAPQ was developed to assess these three components because they correspond to the conceptually defining areas of autism (social, stereotyped-repetitive, and communication difficulties), suggesting a strong theoretical relevance (Hurley et al., 2007). Furthermore, Piven et al. (1997) showed that these areas of difficulties occur more frequently in parents of autistic individuals than other BAP features, such as untactful behavior. The main purpose of the BAPQ is to provide an efficient, valid, and reliable screening tool to detect individuals exhibiting the sub-clinical characteristics of the BAP that are below the clinical threshold targeted by the standard ASC assessment (Hurley et al., 2007).

Aloof Personality

Defined as *a lack of interest in or enjoyment of social interaction* (Hurley et al., 2007). Wainer et al. (2011) found aloofness to be correlated with specific personal interests: There was a negative relation with preferences for attending parties, social networking and music, while being positively associated with a preference for being alone.

Rigid Personality

Defined as *little interest in change or difficulty adjusting to change* (Hurley et al., 2007). Previous studies have found rigidity to be associated with lower agreeableness, higher neuroticism, and lower extraversion due to cognitive and behavioral inflexibility (Ingersoll & Wainer, 2014), as well as with a negative association with attending social events such as parties (Wainer et al., 2011).

Pragmatic Language Problems

Defined as *deficits in the social aspects of language resulting in difficulties communicating effectively or in holding a fluid, reciprocal conversation* (Hurley et al., 2007). Wainer et al. (2011) suggest that while persons scoring high on pragmatic language may not have a distinct aversion toward social relationships, these relationships may be made difficult due to the persons' language abilities.

Psychometric Properties of the BAPQ

In previous studies, the BAPQ has adequate internal consistency for both the total score ($\alpha > .90$) and each of its subscales ($\alpha > .70$). However, in recent validation studies using confirmatory factor analyses (CFAs), the BAPQ exhibited a questionable factor structure across cultures (e.g., Broderick et al., 2015; Godoy-Giménez et al., 2018). For example, in the CFA of the Spanish version of the BAPQ, Godoy-Giménez et al. (2018) reported a root mean square error of approximation (RMSEA) of .07, a comparative fit index (CFI) of .74, and moderate to low factor loadings (aloof personality: range = [.31, .80], rigid personality: range = [.29, .72], pragmatic language: range = [.03, .73]). Specifically, items of the pragmatic language factor seemed to be the main source of global misfit. Broderick et al. (2015) performed exploratory analyses to identify alternative models of the BAPQ after finding limited goodness-of-fit, testing a four-factor structure which included an anxiety factor that was part of the original BAPQ conceptualization (Piven et al., 1997). In the end, the authors rejected their adapted version because it did not yield evidence of model fit and returned to the originally proposed three-factor structure. However, Broderick et al. (2015) did not retest their measurement models with a second sample.

In the evaluation of psychometric properties of the Brazilian translation of the BAPQ, Prata et al. (2019) performed an exploratory factor analysis (EFA), a comparison between clinical and nonclinical groups, and determined internal consistency. In their EFA, a three-component structure emerged with factors that are in line with the original conceptualization of the BAPQ by Hurley et al. (2007). However, they also found that five items of the pragmatic language factor loaded higher on

aloof personality than on their theoretically ascribed factor, indicating again that the pragmatic language factor might not be well-designed. Finally, Sharma and Bhushan (2018) performed EFAs to validate the Hindi version of the BAPQ. They reported a loading pattern that indicated a different factor structure and suggested an adapted 18-item version of the questionnaire. Their suggested version only included three items on the pragmatic language factor (factor loadings range = .30–.38) and four items on the rigid factor (factor loadings range = .40–.58), thus further questioning the factorial validity of the BAPQ.

Aim of This Study

In light of these findings and the fact that the original BAPQ was never validated by means of a CFA, the purpose of this study is to validate the newly translated German version of the BAPQ (BAPQ-G) in a German sample. Ingersoll et al. (2011) have found strong positive correlations between different BAP instruments ranging from $r = .55$ to $.66$. Hence, a strong positive association is expected between the BAPQ-G and the full-length AQ, and the AQ-10 (Allison et al., 2012) and the SRS-A. We further expect a strong positive correlation between the BAPQ-G and the Social Phobia Inventory (SPIN; Stangier & Steffens, 2002), and the revised Obsessive Compulsive Inventory (OCI-R; Gönner et al., 2007) and the items of the socially avoidant subscale of the Inventory of Interpersonal Problems (Horowitz et al., 2016).

Among all three subscales of the BAPQ-G, there should be positive correlations with the Big Five Inventory (BFI; Schupp & Gerlitz, 2014) subscale neuroticism, and negative correlations with agreeableness and extraversion, as well as openness (Wainer et al., 2011). As for conscientiousness, negative correlations are expected with pragmatic language due to more interpersonal problems and aloof personality because of social detachment, as well as negative correlations with rigid personality based on findings of negative correlations between conscientiousness and high AQ scores by Wakabayashi et al. (2006). Furthermore, we aim to investigate the theoretical three-factor structure of the BAPQ in a German sample.

Method

Participants and Procedure

We included three data sets with a total of 792 participants ($N_1 = 248$, $N_2 = 289$, $N_3 = 255$). Eight individuals were removed from the total sample due to implausible

response behavior with no variance in their answers. Table 1 includes descriptive statistics of all three data sets.

Most of the participants (89.76%) were either employees ($n_1 = 136$, $n_2 = 107$, $n_3 = 83$) or students ($n_1 = 84$, $n_2 = 151$, $n_3 = 150$). The study was conducted in German and participation was voluntary; hence, no incentives were supplied. Participants were recruited on several online social media platforms. The study was approved by the ethics commission of the Medical School Berlin (MSB2019/08).

Instruments

Demographics

Participants were asked to state their age, gender, highest level of completed education, employment status, and sector of employment encoded with the classification of occupations 2010 (Bundesagentur für Arbeit, 2011).

BAPQ-G

On a rating scale ranging from 1 = *very rarely* to 6 = *very often*, participants rated 36 statements (see Electronic Supplementary Material 1 [ESM 1]). The new German version of this scale was developed using a standard translation-back-translation procedure with several native speakers familiar with cultural nuances (Guillemin et al., 1993). We used the BAPQ-G in all three data sets.

AQ

The AQ-10 (Allison et al., 2012) is the short version of the AQ-50 (Baron-Cohen et al., 2001). Each item is rated on a rating scale ranging from 1 = *definitely agree* to 4 = *definitely disagree*. The AQ-10 was used in Data set 1, and the AQ-50 in Data set 2.

SRS-A

The SRS-A (Bölte, 2012) was used to assess autistic traits. Its 65 items are rated on scale from 1 = *not true* to 4 = *almost always true*. For the purpose of this study, wording in the instructions was changed, adapting the SRS-A to a self-report format. The SRS-A was used in Data set 1.

Big Five

The BFI-S (Schupp & Gerlitz, 2014) with 15 items reflecting the personality traits openness, conscientiousness, agreeableness, extraversion, and neuroticism was assessed on a rating scale from 1 = *does not apply to me at all* to 7 = *applies to me perfectly*. The BFI-S was used in Data set 2.

Social Phobia Inventory

We used the SPIN (Stangier & Steffens, 2002) in Data set 2 with 17 items surveying the characteristic domains of social anxiety. On a rating scale from 1 = *not at all* to

Table 1. Descriptive statistics of all three data sets

	M_{age} (SD)	N_{female}	N_{male}	$N_{nonbinary}$	$N_{diagnosis}$
Data set 1	35.74 (3.90)	178 (71.77%)	68 (27.42%)	2 (0.81%)	5 (2.02%)
Data set 2	30.54 (10.83)	216 (74.74%)	69 (23.87%)	4 (1.40%)	3 (1.04%)
Data set 3	29.76 (11.03)	176 (69.02%)	76 (29.80%)	3 (1.18%)	0 (0.00%)

5 = *extremely*, participants rated the degree to which specific problems had affected them over the past week.

Revised Obsessive Compulsive Inventory

The OCI-R (Gönner et al., 2007) with 18 items was employed in Data set 2. Participants stated on a rating scale from 1 = *not at all* to 5 = *very much* the degree to which behaviors or experiences affected them in the past.

Inventory of Interpersonal Problems (IIP-D)

Participants rated the four items of the socially avoidant subscale of the Inventory of Interpersonal Problems (IIP-D; Horowitz et al., 2016) on a rating scale from 1 = *does not apply at all* to 5 = *fully applies*. We used the IIP-D in Data set 2.

ASC Diagnosis

All participants were asked to indicate whether they have ever received an official ASC diagnosis.

Statistical Analyses

Data analysis was performed using the package *lavaan* (version 0.6-7; Rosseel, 2012) of the statistical software R (version 3.6.1; R Core Team, 2020). We evaluated the factorial validity of the BAPQ-G (for the model visualization refer to ESM 2), with a confirmatory factor analysis, using the proposed criteria by Hu and Bentler (1999). To augment the overly conservative χ^2 test, those criteria include a standardized root mean square residual (SRMR) $\leq .08$ in combination with at least one of the following fit indices: a RMSEA $\leq .06$, a lower bound of the 90% CI of the RMSEA $\leq .06$, a comparative fit index (CFI) $\geq .95$, or a Tucker–Lewis index $\geq .95$. Furthermore, we also report individual cutoff values tailored to the empirical data using the R package *ezCutoffs* (Schmalbach et al., 2019). Traditional fit measure cutoffs, although having almost reached canonical status, should be regarded with caution. Hu and Bentler (1998) themselves warned that cutoffs resulting from simulation studies are only appropriate under the investigated conditions, and thus should neither be interpreted as rigid, nor be overgeneralized (McNeish & Wolf, 2020). Several methodological studies have scrutinized the use of fixed cutoff values and found that, given other conditions, that is, other empirical data, cutoff values might

fluctuate, for example, with changes in data and model characteristics, degrees of freedom (e.g., Kenny et al., 2015), or factor loading and factor reliability (e.g., Heene et al., 2011). This, in turn, makes it harder to identify cutoff values appropriate for the data set at hand. Contemporary approaches generate dynamic fit index cutoffs by simulating data sets with similar characteristics to the data set under consideration (McNeish & Wolf, 2020). In other words, they mimic the process used by Hu and Bentler (1999), with parameters corresponding to the empirical model, thus generating individual cutoff values, similar to the traditional ones that are applicable for the empirical model (McNeish & Wolf, 2020). Besides the global fit, we also analyzed local model fit by means of modification indices to guide future research to improve the questionnaire.

Estimators of CFA models, such as the maximum likelihood (ML), usually assume observed variables to be continuous and multivariate normally distributed. In the behavioral sciences, where it is common to use questionnaires with few answer categories, this assumption often does not hold. Consequently, robust estimators (e.g., maximum likelihood robust; MLR) have been developed to deal with violations of the normal distribution. Simulation studies showed that ML-based estimators tend to produce biased results with regard to factor loadings and *SEs* when non-normality was severe (e.g., Beauducel & Herzberg, 2006). Diagonally weighted least squares (WLSMV) on the other hand is an appropriate estimator when the sample is relatively small and the normality assumption is violated (Li, 2016). Thus, in this study, we used WLSMV to estimate the CFA models.

To test convergent and divergent validity of the BAPQ-G, bivariate correlation analyses were conducted with other BAP measures and personality scales. We report McDonald's ω_t as an estimate of the total reliability of a test since it is the appropriate measure for tests that do not meet the assumption of tau-equivalence (Revelle & Condon, 2019). To help facilitate comparison with earlier studies, we also report Cronbach's α . Analysis of the data set revealed seven missing values (= .03%). We used listwise deletion to deal with the missing data.

We fixed the scales of the latent variables by fixing factor loadings of the first indicator of a latent variable to 1. All the correlations between factors were freed, and all the cross-loadings were fixed to zero. If the current BAPQ-G model fits the data reasonably well, we would consider

Table 2. Model fits (CFA^a) and individual cutoff values^b of the BAPQ-G

	<i>N</i> factors	χ^2	<i>df</i>	<i>p</i>	SRMR	TLI	CFI	RMSEA	RMSEA 90% CI
Data set 1	3	1,450.43	591	<.001	.088	.839	.849	.077	[.072, .082]
Data set 2	3	1769.42	591	<.001	.093	.855	.864	.083	[.079, .088]
Data set 3	3	1,334.12	591	<.001	.082	.870	.878	.070	[.065, .075]
Individual cutoff values									
Data set 1	3	719.83	591		.052	.949	.953	.029	
Data set 2	3	712.11	591		.047	.962	.965	.026	
Data set 3	3	685.36	591		.050	.961	.963	.025	

Note. BAPQ = Broader Autism Phenotype Questionnaire, BAPQ-G = German version of the BAPQ, CFA = confirmatory factor analysis, CFI = comparative fit index, TLI = Tucker–Lewis index, WLSMV = weighted least square.

^aCFA calculated using the WLSMV estimator.

^bIndividual cutoff values for each data set using ezCutoffs ($\alpha = .05$).

retaining it. In case of a bad model fit, we analyzed local fit to provide further directions for the improvement of the scale. In both cases, we aim to replicate our previous findings in Data set 2 and 3.

Results

To investigate the three-factor structure of the BAPQ, a CFA model was fitted in each data set. Table 2 shows the results of the CFA (for item statistics refer to ESM 3). With reference to the fit criteria of Hu and Bentler (1999), the BAPQ-G displayed acceptable global model fit in Data set 1 and 3, with only SRMR and RMSEA marginally reaching the cutoff criteria. In Data set 2, the global model fit was poor. Individual cutoff values, as proposed by McNeish and Wolf (2020), also in Table 2, indicate that model fit in all data sets was not acceptable. As expected, the indicators showed significant positive factor loadings, with standardized coefficients for aloof personality ranging from .55 to .82 in Data set 1 (Data set 2: range = [.49, .82], Data set 3: range = [.57, .80]), pragmatic language ranging from .31 to .76 (Data set 2: range = [.17, .86], Data set 3: range = [.22, .80]), and rigid personality ranging from .37 to .80 (Data set 2: range = [.36, .78], Data set 3: range = [.27, .80]). For factor loadings and *SEs*, refer to Table 3.

Modification indices in all three samples were highest for the same items of the pragmatic language subscale, especially those related to potential error covariances – pragmatic language item 9 (“I can tell when someone is not interested in what I am saying”) and 12 (“I can tell when it is time to change topics in conversation”). Furthermore, several items of the pragmatic and the aloof personality subscale exhibited potential cross-loadings, especially item 5 of the pragmatic language subscale (“I feel disconnected or ‘out of sync’ in conversations with others”) loaded on the aloof personality factor in all three data sets (modification index range = [43.26, 125.71]).

Table 4 presents descriptive statistics and reliability measures. All external instruments, except the AQ-10 and the BFI facets conscientiousness and agreeableness, show acceptable scores for McDonald’s ω_t and Cronbach’s α . In all three data sets, McDonald’s ω_t was $> .90$ for the total scores of the BAPQ-G. The aloof personality and rigid personality subscales displayed acceptable reliability (ω_t ranging from .84–.91), while McDonald’s ω_t for pragmatic language ranged from .73 to .78. Cronbach’s α showed similar coefficients.

Bivariate correlation analyses were conducted to test convergent validity of each of the measures (Table 5 and Table 6). Each of the instruments used to assess the BAP (i.e., BAPQ, AQ-10, AQ-50, and SRS-A) correlated moderately to strongly with the other three. The BAPQ-G correlated negatively with all personality facets of the BFI except neuroticism (Table 7). The three BAPQ-G subscales correlated with each other at a statistically significant level ($p < .01$) between $r = .35$ and $.59$. Overall, these results are in line with previous research (e.g., Ingersoll et al., 2011) and suggest convergent validity, although an acceptable model fit was not obtained in either data set.

Discussion

The aim of this study was to validate the BAPQ-G regarding its factorial structure and association with other measures of the BAP. The present data demonstrate that the BAPQ-G does not fit its proposed theoretical model. These findings are in line with previous studies examining the BAPQ regarding its factorial validity (e.g., Broderick et al., 2015; Godoy-Giménez et al., 2018). Closer examination on item level suggested the pragmatic language subscale to be the main cause of misfit in all three samples. One reason might be content-overlapping (i.e., items on the pragmatic language scale being more related to the

Table 3. Factor loadings and standard errors BAPQ-G in all three data sets

Item (abbreviation)	Factor loading	Standardized factor loading	SE
Factor aloof personality			
I like being around other people. (a1r)	1.00/1.00/1.00	.77/.77/.75	–
I would rather talk to people to get information than to socialize. (a2)	.90/.98/.53	.69/.75/.64	0.05/0.05/0.05
I enjoy being in social situations. (a3r)	1.04/1.02/1.02	.80/.78/.76	0.04/0.04/0.05
People find it easy to approach me. (a4r)	.82/.65/.87	.63/.50/.65	0.06/0.06/0.06
I look forward to situations where I can meet new people. (a5r)	1.06/1.06/1.07	.82/.82/.80	0.04/0.04/0.05
When I make conversation, it is just to be polite. (a6)	.76/.89/.93	.58/.68/.70	0.07/0.05/0.06
I am good at making small talk. (a7r)	.97/.90/.95	.75/.68/.71	0.05/0.05/0.05
I feel like I am really connecting with other people. (a8r)	.73/.98/.83	.56/.75/.62	0.06/0.04/0.06
Conversation bores me. (a9)	.71/.81/.92	.55/.62/.69	0.07/0.05/0.05
I am warm and friendly in my interactions with others. (a10r)	.73/.77/.76	.56/.59/.57	0.06/0.06/0.06
I prefer to be alone rather than with others. (a11)	.91/1.03/.93	.70/.79/.70	0.04/0.04/0.06
I enjoy chatting with people. (a12r)	1.03/1.05/1.07	.79/.81/.80	0.04/0.04/0.05
Factor pragmatic language			
I find it hard to get my words out smoothly. (pl1)	1.00/1.00/1.00	.57/.55/.28	–
It's hard for me to avoid getting sidetracked in conversation. (pl2)	.63/.72/1.46	.36/.40/.40	0.11/0.12/0.41
I am "in-tune" with the other person during conversation. (pl3r)	.80/1.05/2.34	.46/.58/.65	0.14/0.14/0.57
My voice has a flat or monotone sound to it. (pl4)	1.07/1.16/1.93	.61/.64/.54	0.12/0.13/0.50
I feel disconnected or "out of sync" in conversations with others. (pl5)	1.33/1.55/2.90	.76/.86/.80	0.15/0.16/0.71
People ask me to repeat things I've said because they don't understand. (pl6)	.91/.96/1.67	.52/.53/.46	0.13/0.12/0.42
I have been told that I talk too much about certain topics. (pl7)	.59/.37/.78	.34/.21/.22	0.13/0.12/0.30
I speak too loudly or softly. (pl8)	.70/.52/1.50	.40/.29/.41	0.12/0.11/0.41
I can tell when someone is not interested in what I am saying. (pl9r)	.54/.31/1.18	.31/.17/.33	0.13/0.11/0.41
I leave long pauses in conversation. (pl10)	.89/1.12/2.20	.51/.66/.61	0.14/0.12/0.53
I lose track of my original point when talking to people. (pl11)	1.03/1.27/1.65	.59/.71/.46	0.13/0.14/0.38
I can tell when it is time to change topics in conversation. (pl12r)	.71/.69/1.79	.40/.38/.50	0.13/0.11/0.45
Factor rigid personality			
I am comfortable with unexpected changes in plans. (r1r)	1.00/1.00/1.00	.37/.52/.53	–
People have to talk me into trying something new. (r2)	2.06/1.47/1.51	.77/.77/.80	0.32/0.13/0.15
I have to warm myself up to the idea of visiting an unfamiliar place. (r3)	1.92/1.34/1.33	.71/.70/.70	0.29/0.12/0.13
I feel a strong need for sameness from day to day. (r4)	1.81/1.30/1.19	.67/.68/.63	0.28/0.12/0.14
I am flexible about how things should be done. (r5r)	1.87/1.19/1.22	.69/.63/.65	0.26/0.11/0.14
I look forward to trying new things. (r6r)	2.16/1.49/1.46	.80/.78/.77	0.31/0.12/0.14
I have a hard time dealing with changes in my routine. (r7)	2.01/1.37/1.38	.75/.72/.73	0.28/0.12/0.13
I act very set in my ways. (r8)	1.79/1.38/1.09	.67/.72/.58	0.26/0.13/0.11
People get frustrated by my unwillingness to bend. (r9)	1.09/.83/.51	.41/.44/.27	0.22/0.12/0.13
I alter my daily routine by trying something different. (r10r)	1.46/1.16/1.03	.54/.61/.55	0.21/0.12/0.13
I like to closely follow a routine while working. (r11)	1.21/.69/.56	.45/.36/.30	0.20/0.11/0.11
I keep doing things the way I know, even if another way might be better. (r12)	1.40/.89/.96	.52/.46/.51	0.22/0.11/0.12

Note. BAPQ = Broader Autism Phenotype Questionnaire, BAPQ-G = German version of the BAPQ. Item abbreviations in brackets. Suffix *r* refers to reverse-scored items.

aloof personality factor). For example, item 5 of the pragmatic language factor ("I feel disconnected or 'out of sync' in conversations with others") might be too similar in

meaning to items of the aloof personality subscale (e.g., "I feel like I am really connecting with other people"; item 8 [reverse scored]). Furthermore, the error covariance

Table 4. Descriptive statistics and reliability coefficients

	α (ω)	<i>M</i> (<i>SD</i>)	Skew	Kurtosis
AQ 50	.82 (.84)	2.15 (0.34)	0.49	0.87
AQ-10	.62 (.69)	2.10 (0.34)	0.54	0.52
IIP-D	.83 (.83)	2.50 (0.28)	0.43	−0.71
OCI-R	.90 (.91)	1.90 (0.31)	0.94	0.61
SRS-A	.96 (.96)	1.59 (0.37)	1.58	2.73
SPIN	.93 (.93)	2.32 (0.36)	0.68	−0.12
Openness	.71 (.74)	5.03 (1.20)	−0.54	−0.01
Conscientiousness	.64 (.68)	5.35 (0.90)	−0.43	0.15
Extraversion	.84 (.85)	4.72 (1.30)	−0.21	−0.72
Agreeableness	.56 (.58)	5.16 (0.95)	−0.41	−0.19
Neuroticism	.73 (.75)	4.37 (1.26)	−0.04	−0.77
BAPQ-G				
Data set 1	.91 (.93)	2.69 (0.55)	0.58	0.68
Data set 2	.92 (.93)	2.80 (0.62)	0.40	−0.29
Data set 3	.91 (.92)	2.69 (0.55)	0.47	0.64
Aloof personality				
Data set 1	.89 (.90)	2.85 (0.80)	0.49	0.11
Data set 2	.91 (.91)	3.00 (0.90)	0.26	−0.47
Data set 3	.90 (.90)	2.83 (0.81)	0.24	−0.21
Pragmatic language				
Data set 1	.76 (.77)	2.42 (0.55)	0.79	0.86
Data set 2	.78 (.78)	2.52 (0.62)	0.67	0.32
Data set 3	.74 (.73)	2.46 (0.54)	0.44	0.52
Rigid personality				
Data set 1	.86 (.86)	2.81 (0.68)	0.39	0.46
Data set 2	.86 (.87)	2.89 (0.75)	0.48	0.23
Data set 3	.83 (.84)	2.79 (0.66)	0.43	0.30

Note. AQ = autism quotient, BAPQ-G = Broader Autism Phenotype Questionnaire German Version, IIP-D = Inventory of Interpersonal Problems, OCI-R = Obsessive Compulsive Inventory, SPIN = Social Phobia Inventory, SRS-A = Social Responsiveness Scale – Adult.

between items of the pragmatic subscale suggests the potential existence of another factor.

Hurley et al. (2007) suggest that the items of the BAPQ have face validity and report that the data show internal

consistency of the BAPQ subscales. Apparently, the original BAPQ was never tested with confirmatory factor analyses. The assumed factorial structure of the model was only tested with an exploratory factor analysis (Ingersoll et al., 2011) and a principal component analysis (Sasson et al., 2013). CFA structures are more restrictive than EFA structures due to the fact that cross-loadings in CFA are traditionally constrained to zero while they are freely estimated in EFA. This leads to exactly the problem encountered in the analyses in the current study: instruments that have been well established by means of EFA research are not supported by CFAs (Marsh et al., 2014).

The results of the correlational analyses correspond with previous studies (Hollander et al., 2003; Jacob et al., 2009; Wainer et al., 2011). The results in the current study suggest a high association between the SPIN and the BAPQ-G total and moderate positive correlations between the SPIN and all the BAPQ-G subscales. Similar to previous studies (Murphy et al., 2000; Wakabayashi et al., 2006), we found higher levels of BAP came with lower scores in extraversion, conscientiousness, and agreeableness. All assumptions regarding correlations between all BAPQ-G subscales with the BFI personality inventory subscales were met. It is noteworthy that the correlation of the aloof personality subscale with extraversion was higher than the correlation between aloof personality and the BAPQ-G subscales. This might indicate that the aloof personality items assess extraversion to some degree (e.g., item 3, “I like being in social situations”). Furthermore, the three subscales of the BAPQ-G exhibited relatively low correlations with each other ($r = .35-.59$), suggesting that focusing on an overall score, as was intended by Hurley et al. (2007), is at least questionable. It seems more plausible that the BAPQ-G assesses three domains, rather than a higher order construct. With the SRS-A, the AQ-50, and the AQ-10, we included instruments originally developed to assess ASC, which were previously used in studies to assess the BAP. The correlation coefficients of the three instruments with the BAPQ-G were very different, especially that the BAPQ-G and the AQ-10 showed only a moderate correlation. Furthermore, the SRS-A correlated higher with the total BAPQ-G scale than with

Table 5. Intercorrelations in data set 1

	BAPQ-G	Aloof	Rigidity	Pragmatic language	AQ-10	SRS-A
BAPQ-G	1					
Aloof	.84***	1				
Rigidity	.84***	.54***	1			
Pragmatic language	.75***	.43***	.52***	1		
AQ-10	.58***	.42***	.52***	.48***	1	
SRS-A	.75***	.58***	.56***	.72***	.64***	1

Note. AQ-10 = Autism Spectrum Quotient (short form), BAPQ = Broader Autism Phenotype Questionnaire, BAPQ-G = BAPQ-G = BAPQ German Version, SRS-A = Social Responsiveness Scale for Adults. *** $p < .001$; $N = 248$.

Table 6. Intercorrelations data set 2

	BAPQ	Aloof	Rigidity	Pragmatic language	AQ	SPIN	OCI	IIP
BAPQ	1							
Aloof	.89***	1						
Rigidity	.81***	.59***	1					
Pragmatic language	.72***	.50***	.35***	1				
AQ	.80***	.75***	.61***	.56***	1			
SPIN	.67***	.57***	.57***	.48***	.59***	1		
OCI	.40***	.23***	.41***	.35***	.44***	.51***	1	
IIP	.70***	.66***	.55***	.46***	.62***	.73***	.39***	1

Note. AQ = Autism Spectrum Quotient, BAPQ = Broader Autism Phenotype Questionnaire, BFI = Big Five Inventory, IIP = Inventory of Interpersonal Problems, OCI = Obsessive-Compulsive Inventory-Revised, SPIN = Social Phobia Inventory. ** $p < .01$, *** $p < .001$; $N = 289$.

its subscales with the exception of the pragmatic language subscale. This is not surprising since the SRS-A assesses reciprocal social behavior as well as communication. However, these results suggest that the instruments used in the past to assess the BAP cannot be used interchangeably.

Similar Findings and Future Directions

Recent studies involving the BAPQ have found similar results regarding the instrument's model fit across cultures. For instance, a study by Godoy-Giménez et al. (2018) suggests that pragmatic language as a subscale was a problematic point in their CFA of a Spanish version of the BAPQ. Losh and Piven (2007) report aloofness and rigidity to have been the most valid and reliable scales to distinguish relatives of individuals on the autism spectrum from controls in past studies, which puts a spotlight on the more recent findings regarding the pragmatic language subscale.

Broderick et al. (2015) found limited goodness-of-fit for the original three-factor structure of the BAPQ as well as their adapted four-factor version that included an anxiety factor. Finally, Sharma and Bhushan (2018) performed EFAs to validate the Hindi version of the BAPQ. They

reported a different factor structure and suggested a brief, adapted version of the questionnaire.

These findings suggest problems with the operationalization of the BAP, especially the pragmatic language factor. It is possible that this factor is more heterogeneous than previous ideas would suggest and in fact needs a representation with more than just one factor. Future research should focus on the conceptualization of the construct. Another possible approach would be to revise the pragmatic language factor with new items. Additionally, in the original paper on the BAPQ, Hurley et al. (2007) reported that the subscales form an overall score. It thus would be possible to include a theoretical general factor into the estimation of the CFA model. It is important to keep in mind that this addition would be theoretically plausible when calculating an overall score, but would not change the model fit unless additional constraints are added as the three correlations would be replaced by three factor loadings. However, with regard to the relatively low intercorrelations of the three BAPQ-G subfacets in the current samples, we did not include a general factor. Future instruments to assess the BAP should aim for a stricter approach to develop a valid instrument. Loevinger (1957) proposed a theory-driven approach to scale

Table 7. Intercorrelations for BAPQ and BFI subscales in data set 2

	BAPQ	Aloof	Rigidity	Pragmatic language	O	C	E	A	N
BAPQ	1								
Aloof	.89***	1							
Rigidity	.81***	.59***	1						
Pragmatic language	.72***	.50***	.35***	1					
O	-.28***	-.25***	-.28***	-.13*	1				
C	-.28***	-.18**	-.21***	-.32***	.13*	1			
E	-.69***	-.76***	-.45***	-.42***	.23***	.10	1		
A	-.30***	-.23***	-.26***	-.24***	.09	.12*	.00	1	
N	.39***	.24***	.46***	.26***	-.06	-.10	-.20***	-.08	1

Note. BAPQ = Broader Autism Phenotype Questionnaire, BFI = Big Five Inventory, O = Openness, C = Conscientiousness, E = Extraversion, A = Agreeableness, N = Neuroticism. * $p < .05$, ** $p < .01$, *** $p < .001$; $N = 255$.

construction involving three aspects of construct validity: substantive validity, structural validity, and external validity. Unfortunately, the majority of research conducted in the behavioral and psychological sciences is focused on external validity without providing evidence for substantive and structural validity, respectively (Flake et al., 2017). This leads not only to the problems encountered in the present study but also poses questions regarding the validity of the results found in the external phase. Applied to the BAPQ, it seems necessary to begin with a sound conceptualization and generation of new items to better reflect the concept and consequently use CFAs to validate its factor structure. Furthermore, we suggest that scholars emphasize the replication of possible factor structures with a CFA approach during the validation process using a split data set or even more than one data set.

Additionally, more research is needed to investigate the assumption that the BAPQ is more suitable to assess the BAP than standard autism assessment. Empirical evidence for this claim is inconsistent, and we encourage scholars to further explore the relation between BAP and ASC, especially regarding the sensitivity and validity of existing and future assessment tools.

Limitations

Some limitations concerning the generalizability of the results should be considered. First, due to using a non-probability sample, generalizability is questionable. When interpreting the results, it should be kept in mind that the samples predominantly self-identified as female with a higher educational background.

Second, since the BAPQ-G is a self-report questionnaire and there is no comparison of the results of the BAPQ-G to direct clinical assessment such as a combination of data on a person's developmental history, family history of ASC, medical/genetic data, and standardized assessments of cognitive, behavioral, and language skills (Richdale & Schreck, 2008), it is not possible to establish with certainty its ability to identify the BAP.

Conclusion

The BAPQ-G met the assumptions regarding the subscales' association with other constructs. The BAPQ-G subscales correlate positively with scales assessing related constructs, indicating convergent validity. Yet, the confirmatory factor analyses of the model did not provide acceptable model fit, suggesting that the assumed three-

factor structure of the BAPQ-G appears inappropriate. Taking into account the aforementioned similar findings from different translations, the BAPQ may have to be re-evaluated regarding the items of the pragmatic language factor or even the factor itself.

Electronic Supplementary Material

The electronic supplementary material is available with the online version of the article at doi: 10.1027/2698-1866/a000016.

ESM 1. The BAPQ-G.

ESM 2. Model for BAPQ-G

ESM 3. Item statistics for BAPQ-G

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Open Data

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