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Autistic-like and Schizotypal Traits in a Life History Perspective: Diametrical Associations with Impulsivity, Sensation Seeking, and Sociosexual Behavior

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Abstract

According to recent theoretical models, autistic-like and schizotypal traits can be regarded as opposite sides of a single continuum of variation in personality and cognition, and may be diametrically associated with individual differences in life history strategies. Schizotypy is hypothesized to constitute a psychological phenotype oriented toward high mating effort and reduced parenting, consistent with a fast life history strategy; autistic-like traits are hypothesized to contribute to a slow strategy characterized by reduced mating effort and high parental investment. In this study, we tested the hypothesis that autistic-like and schizotypal traits would be diametrically associated with unrestricted sociosexuality, impulsivity, and sensation seeking (three key behavioral correlates of fast life history strategies in humans) in a sample of 152 young adults (18-38 years). The results were consistent with a diametrical autism-schizotypy axis of individual variation. In line with with our hypotheses, autism-schizotypy scores were uniquely associated with individual differences in impulsivity, sensation seeking, and sociosexual behavior, even after controlling for variation in Big Five personality traits. However, we found no significant associations with sociosexual attitude in the present sample. Our findings provide additional support for a life history model of autistic-like and schizotypal traits and demonstrate the heuristic value of this approach in the study of personality and psychopathology.

Keywords: Autistic-like traits; diametrical model; impulsivity; life history strategy; schizotypal traits; sexual selection; sociosexuality.

1. Introduction

Initially described as milder manifestations of psychopathology (Meehl, 1962; Wing, 1988), autistic-like and schizotypal traits stand at the boundary between normal and disordered variation. Autistic-like traits—also known as the "broader autistic phenotype"—comprise reduced social/communicative skills, narrow interests and repetitive behaviors, and heightened attention to patterns and details; they are elevated in patients with autism spectrum disorders (ASDs) as well as in their relatives (Baron-Cohen et al., 2001). Mirroring the distinction between positive and negative symptoms in schizophrenia, schizotypal traits include both *positive schizotypy*—a tendency to experience unusual cognitive and perceptual phenomena, magical ideation, and reference/paranoid thoughts—and *negative schizotypy*—traits of social anxiety, social withdrawal, and constricted affect. Measures of schizotypy usually include a third dimension labeled *disorganization* that reflects odd or eccentric patterns of speech and behavior. Schizotypal traits are elevated in relatives of psychotic patients and constitute a risk factor for schizophrenia spectrum disorders (SSDs; Claridge, 1997; van Os et al., 2009). Both autistic-like and schizotypal features show moderate to substantial heritability, with estimates in the .50 to .70 range (Ericson et al., 2011; Hoekstra et al., 2007; Ronald et al., 2011).

While autistic-like and schizotypal traits can be associated with pathological outcomes, they exist outside the diagnostic spectra of ASDs and SSDs, and are increasingly recognized as important dimensions of normal personality variation. Indeed, accumulating empirical findings show that moderate amounts of autistic and schizotypal features may confer desirable and potentially adaptive traits such as creativity, enhanced perceptual and spatial skills, and even artistic and scientific talent (e.g., Baron-Cohen et al., 2009; Fletcher-Watson et al., 2012; Happé & Vital, 2009; Kyaga et al., 2011; Nettle & Clegg, 2006; Stevenson & Gernsbacher, 2013).

Intriguingly, there is evidence that autistic-like and schizotypal traits may be understood as functionally opposite sides of a single overarching continuum, as postulated in the *diametrical model* developed by Crespi and Badcock (2008).

1.1. The Diametrical Model of Autism and Psychosis

The relation between autism spectrum disorders (ASDs) and schizophrenia spectrum disorders (SSDs) has been debated for the better part of a century (see Crespi, 2011; Crespi & Badcock, 2008). At the descriptive level, the two clusters of disorders show a number of overlapping features, including social discomfort, reduced social skills, and impaired or dysfunctional mindreading. In addition, several genes and chromosome regions have been implicated in the etiology of both ASDs and SSDs (e.g., Carroll & Owen, 2009; see Crespi et al., 2010). The phenotypic overlap with autism is stronger for negative symptoms of schizophrenia such as blunted affect, poverty of speech, and anhedonia than for positive symptoms such as delusions, hallucinations, and thought disorganization.

According to the diametrical model of autism and psychosis (Crespi & Badcock, 2008; see Crespi et al., 2010; Dinsdale et al., 2013), the commonalities between ASDs and SSDs are mostly superficial; the apparent phenotypic similarities between autistic features and negative psychotic symptoms actually reflect the action of largely *opposite* causal factors. On this view, ASDs and SSDs represent opposite pathological extremes in the development of the human social brain. The autistic extreme of the autism-psychosis continuum is characterized by high levels of *mechanistic cognition* (visuospatial abilities, cause-effect inference) and low levels of *mentalistic cognition* (communication deficits, reduced empathy and social understanding). In contrast, psychosis is characterized by high mentalistic and low mechanistic abilities; in SSDs, hyper-mentalizing—expressed in traits such as paranoid ideation, exaggerated sensitivity to nonverbal cues, and over-responsiveness to gaze—is characteristically associated with poor visuospatial abilities and failures in logical reasoning (Crespi & Badcock, 2008; Zhai et al., 2011). For different reasons, both profiles may result in a pattern of reduced social skills, dysfunctional mindreading, and high levels of social anxiety. In addition, the negative features of premorbid schizophrenia are liable to be misdiagnosed as autistic disorders in younger patients who later go on to develop SSDs, thus contributing to inflate the apparent diagnostic overlap between the two spectra (Crespi, 2011).

Further support for a diametrical relation between ASDs and SSDs comes from the divergent patterns of brain and body development associated with the two spectra. While the autism spectrum is marked by early overgrowth (e.g., high birth weight and length, large brain volume, fast childhood growth), psychosis correlates with reduced growth, especially during prenatal and early postnatal development (Crespi & Badcock, 2008). Finally, when the same genes are implicated in both ASDs and SSDs, the relevant genetic and/or epigenetic effects often show opposite functional profiles in the two spectra. For example, different mutations of the same gene may determine up-regulation of a molecular pathway in ASDs and down-regulation in SSDs; in other cases, ASDs and SSDs are associated with opposite patterns of copy number variation (more versus fewer copies of a genetic region), opposite methylation patterns (hyper- versus hypo-methylation), and so forth (see Crespi & Badcock, 2008; Crespi et al., 2010; Gilman et al., 2012; see also Kalkman, 2012). In particular, Crespi and Badcock (2008) reviewed evidence that ASDs are associated with over-expression of paternally expressed imprinted genes (i.e., genes that are differentially expressed depending on a chromosome's parent of origin) and/or under-expression of maternally expressed genes, while SSDs tend to show the opposite expression pattern.

It is important to stress that, in this model, not *all* etiological factors are assumed to operate in a diametrical fashion. For example, deleterious mutations that affect neural integrity and developmental insults such as infections and nutritional deficits are likely to act as non-specific risk factors for both kinds of disorders (Crespi, 2011; Crespi et al., 2010; see also Keller & Miller, 2006).

1.2. The Diametrical Model and the Structure of Trait Variation

The logic of the diametrical model is not restricted to diagnosable disorders, but extends to normative individual variation in autistic-like and schizotypal traits. According to the model, autistic-like traits and schizotypy represent opposite sides of a mechanistic-mentalistic continuum, with ASDs and SSDs as pathological extremes (Crespi & Badcock, 2008; Dinsdale et al., 2013). For example, Brosnan and colleagues (2010) found that a profile of high empathizing and low systemizing specifically predicted the occurrence of positive symptoms in a female sample. Russell-Smith and colleagues (2010) showed that autistic-like and positive schizotypal traits had diametrical associations with performance on a perceptual task involving local visual processing. In another study, Russell-Smith and colleagues (2013) tested the association between autistic-like and schizotypal traits and various measures of mechanistic and mentalistic cognition, with mostly null results. However, the analytic strategy employed by these authors (comparing matched groups of $N = 20$ extracted from a larger sample) suffers from low statistical power and a high likelihood of Type II errors.

In non-clinical samples, questionnaire measures of autistic-like and schizotypal traits show moderate positive correlations with one another. This pattern is explained by the large statistical overlap that exists between negative schizotypy and the interpersonal facet of autistic-like traits (Del Giudice et al., 2010; Dinsdale et al., 2013; see also Russell-Smith et al., 2011). However, such overlap is likely to be at least in part spurious, reflecting vague formulation of questionnaire items rather than true phenotypic similarity (discussed in Del Giudice et al., 2010).

When the overlap with negative schizotypy is statistically controlled for, measures of positive schizotypy and autistic-like traits become approximately orthogonal (reviewed in Del Giudice et al., 2010; Dinsdale et al., 2013), suggesting a two-dimensional structure rather than a single bipolar continuum.[1] This, however, is only one possible interpretation of the data. In a recent study, Dinsdale and colleagues (2013) applied principal component analysis (PCA) to a mixture of scales assessing autistic-like and schizotypal traits. The first unrotated component captured the common variance attributable to general manifestations of social isolation, impairment, and/or anxiety (as well as shared method variance due to item similarity). After the first component was extracted, the second component showed a clear-cut diametrical structure, with opposite loadings from scales measuring positive schizotypy and autistic-like traits (Fig. 1c). As can be seen in Fig. 1c, negative schizotypy and disorganization have smaller loadings on the bipolar factor, thus falling in the middle of the autistic-schizotypal continuum. This finding was replicated in a previously published dataset by Wakabayashi and colleagues (2012; see Dinsdale et al., 2013 and Fig. 1d).

[1] In this context, the term “bipolar” is used to describe a factor or component characterized by sets of opposite-sign loadings, as is customary in the psychometric literature; it does not imply any connection with symptoms or disorders in the bipolar spectrum.

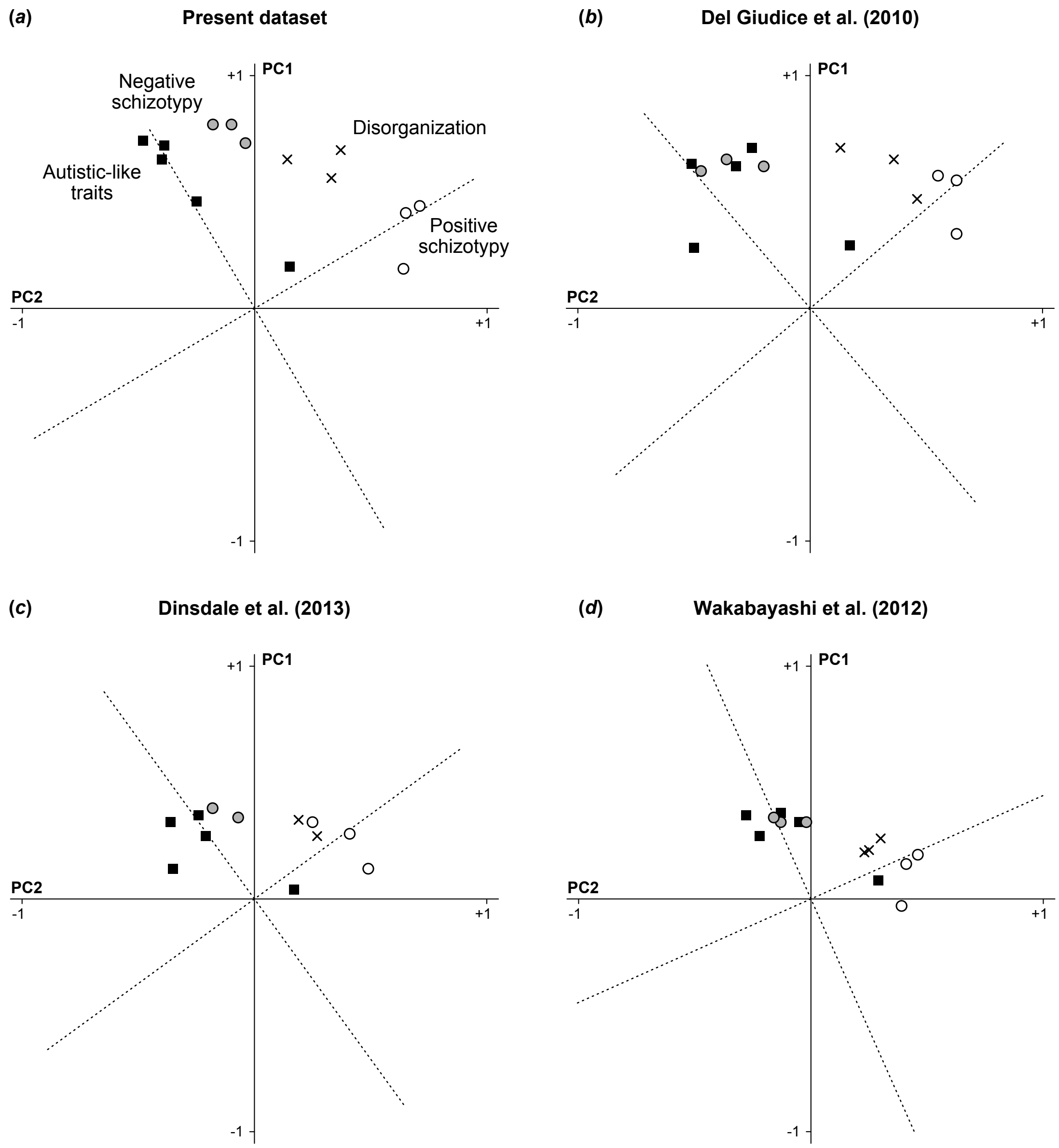

Figure 1. Psychometric structure of autistic-like and schizotypal traits in four empirical studies. The first two unrotated principal components (PC1 and PC2) are shown as solid axes. Varimax-rotated components are shown as dotted lines. Each dot displays the component loadings of a single subscale. See Methods and Results for more information on dataset (a).

In fact, questionnaire data are equally consistent with two mathematically equivalent psychometric structures: (a) a bipolar autism-schizotypy factor coupled with an orthogonal unipolar factor of social difficulty; and (b) two orthogonal unipolar factors of autistic-like traits (plus negative schizotypy) and positive schizotypy (plus disorganization). As shown in Fig. 1, the latter is readily obtained as an orthogonal rotation of the former. Whereas unrotated solutions tend to recover a general factor followed by a number of smaller bipolar factors, standard rotation algorithms (e.g., Varimax) are designed to break down general and bipolar factors to approximate a "simple structure", whereby each of the variables tends to load highly on some of the factors and have small loadings on the other factors (see Darton, 1980; Russell, 2002). Although the simple structure criterion can be a useful exploratory heuristic, it becomes highly misleading when the variables *do* reflect a bipolar construct, such as the mentalistic-mechanistic continuum hypothesized in the diametrical model. When this is the case, the unrotated solution offers a more meaningful description of the data. The diametrical model offers *a priori* reasons to expect a bipolar continuum rather than two independent constructs, and is corroborated by genetic and developmental evidence of diametrical effects in the etiology of autism and psychosis (see above). For these reasons, it may be theoretically preferable to interpret the data as consistent with a bipolar dimension of autism versus positive schizotypy.

1.3. A Life History Perspective on Autistic-like and Schizotypal Traits

While Crespi and Badcock's model offers an elegant unified description of autistic and schizotypal traits, it does not provide a compelling evolutionary explanation for the maintenance of individual differences across generations, except as a result of intragenomic conflict between maternally and paternally derived genes (see Crespi & Badcock, 2008). Del Giudice and colleagues (2010) argued that, regardless of the initial reasons for the evolution of autistic and schizotypal features (including their potential survival benefits), sexual selection may contribute to maintain them in human populations because of their diametrical effects on mating- and parenting-related behaviors. In a nutshell, schizotypy is regarded as a psychological phenotype oriented toward high mating effort and reduced parenting, consistent with a *fast* life history strategy (see Kaplan & Gangestad, 2005; Stearns, 1992). On the contrary, autistic-like traits are hypothesized to contribute to *slow* life history strategy characterized by reduced mating effort coupled with high parental investment.

If the autism-schizotypy continuum is functionally linked to individual differences in life history strategy, various selective processes may be invoked to explain the maintenance of genetic variation in autistic-like and schizotypal traits. To begin, alternative strategies may be subject to negative frequency-dependent selection; for example, fast strategists that invest heavily in mating effort and early reproduction may be especially successful when most other individuals are engaging in slower, parenting-oriented strategies. Also, temporal and spatial variability in life history-relevant parameters such as mortality risk and resource availability (see Ellis et al., 2009) can maintain genetic polymorphism in life history-related traits, especially in species with overlapping generations such as humans (Ellner & Hairston, 1994; see also Réale et al., 2010). In particular, temporal fluctuations in sex ratios have been proposed as a source of genetic variation in mating- and parenting-related traits in human populations (Del Giudice, 2012). While spatial and temporal variability may also favor the evolution of plastic organisms that respond facultatively to environmental cues, evolutionary models show that developmental plasticity can coexist with various amounts of genetic variation in the same traits (e.g., Draghi & Whitlock, 2012; Svanbäck et al., 2009).

1.3.1. Schizotypal traits in a life history perspective

The association between schizotypy and elevated mating effort has been theorized by various authors (Nettle, 2001, 2006a; Shaner et al., 2004). According to the sexual selection model of schizotypy, schizotypy-increasing alleles affect brain processes so as to increase traits such as verbal and artistic creativity, thus conferring mating advantages on those individuals who do not develop a psychiatric condition. However, the outcomes of schizotypy may be either beneficial (greater mating success) or harmful (schizophrenia), depending in part on the individual's genetic quality (including lack of deleterious mutations) and developmental condition. Verbal/artistic creativity would then function as a sexually selected indicator of individual fitness (see Shaner et al., 2004), with schizotypy acting as an "amplifier" of individual differences in genetic quality and condition. The sexual selection model is thus consistent with a central role of mutation load in the etiology of SSDs, and is compatible with reduced fertility in schizophrenic patients and their close relatives (Del Giudice, 2010). Consistent with the sexual selection model, positive schizotypal traits are associated with verbal and artistic creativity, larger numbers of sexual partners, and unrestricted sociosexuality (Haselton & Miller, 2006; Kinney et al., 2001; Kyaga et al., 2011; Nettle, 2006b; Nettle & Clegg, 2006; Miller & Tal, 2007; Rawlings & Locarnini, 2008).

1.3.2. Autistic-like traits in a life history perspective

Del Giudice and colleagues (2010) extended the logic of the sexual selection model to the evolution of autistic-like traits. Specifically, they argued that autistic-like traits in their non-pathological form contribute to a slow life history phenotype geared toward high parental investment, low mating effort, and long-term allocation of resources. Mild autistic features can be expected to promote relational stability through a preference for routines and a predictable lifestyle, reduced novelty seeking and risk taking, and low interest in potential alternative partners. Moreover, the mechanistic abilities associated with autistic-like traits may significantly contribute to increased resource acquisition, perhaps especially so in agricultural and post-agricultural societies (discussed in Del Giudice et al., 2010). These features can be attractive in prospective long-term partners, especially from the standpoint of female choice—leading to stronger sexual selection for autistic-like traits in men. Clinically significant ASDs are seen as maladaptive syndromes resulting from excessive levels of trait expression, possibly combined with high mutation load and/or early developmental insults (Del Giudice, in press a). The idea that ASDs are functionally associated with slow life history strategies is also highly consistent with the recent proposal that the main cognitive and behavioral correlates of the autistic spectrum—both adaptive and maladaptive—can be framed in a heterochronic perspective as delays or non-completions of typical developmental trajectories (Crespi, 2013).

This hypothesis provides a novel explanation of the male-biased distribution of autistic-like traits and ASDs (Baron-Cohen et al., 2001), and is consistent with the (limited) evidence on the relational style associated with autistic features. People high in autistic-like traits report shorter duration of friendships but longer duration of romantic relationships (Jobe & White, 2007); moreover, their partners are on average just as satisfied as those of people low in autistic-like traits (Pollmann et al., 2009). Intriguingly, interest in sexual and romantic relationships is usually conserved even in high-functioning ASDs, although the development of courtship and sexual abilities in these individuals follows a delayed trajectory (see Hellemans et al., 2007; Stokes et al., 2007). In a recent study, Bejerot and Eriksson (2014) found that high-functioning ASD patients of both sexes report lower sex drive, reduced orgasm frequency, and lower levels of stereotypically masculine traits such as assertiveness and competitiveness compared with same-sex controls.

The predictions of the diametrical sexual selection hypothesis were first tested in a sample of 199 Italian young adults (Del Giudice et al., 2010). Structural equation modeling (SEM) was employed to model the shared variance between autistic-like and negative schizotypal traits. In line with predictions, autistic-like traits predicted restricted sociosexuality, fewer sexual partners, stronger commitment to long-term relationships, and increased investment of time and resources in one's romantic partner. Positive schizotypy showed the opposite pattern of effects, while negative schizotypy displayed no significant association with mating-related measures once the overlap with autistic features was controlled for.

More recently, Del Giudice (in press a) integrated the sexual selection hypothesis into a broader life history framework for psychopathology. In this framework, ASDs are categorized as *slow spectrum disorders* because of their functional associations with indicators of slow life history strategies such as low mating effort, delayed sexuality, relationship stability, and low levels of impulsivity and sensation seeking (note that the model recognize the possibility of heterogeneity within ASDs, especially in the most severe forms). Other disorders in the slow spectrum include obsessive-compulsive personality disorder (OCPD), the reactive subtype of obsessive-compulsive disorder (OCD; see Lee & Kwon, 2003), and the perfectionistic and overcontrolled subtypes of eating disorders (see Westen & Harnden-Fischer, 2001). In contrast, SSDs are regarded as *fast spectrum* conditions (again with the possibility of some heterogeneity), together with disorders in the bipolar spectrum, externalizing disorders, borderline personality disorder (BPD), the autogenous subtype of OCD (Lee & Kwon, 2003), and the dysregulated subtype of eating disorders (Westen & Harnden-Fischer, 2001). All these conditions share a pattern of associations with fast life history indicators such as precocious sexuality, unrestricted sociosexuality, relationship instability, and high levels of impulsivity and sensation seeking.

1.3.3. The role of impulsivity and sensation seeking

Impulsivity and sensation seeking play a central role in the life history framework for psychopathology advanced by Del Giudice (in press a). Impulsivity is arguably the most important dimension of individual variation in self-regulation, and can be described as the tendency to act without deliberation and without consideration of future consequences—a combination of behavioral disinhibition and present orientation (DeYoung, 2011). In both humans and nonhuman animals, impulsivity is systematically associated with other behavioral indicators of fast life history strategy (reviewed in Del Giudice, in press a, in press b). Indeed, virtually every behavioral trait associated with slow life histories—forming stable long-term relationships, refraining from short-term sexual opportunities, avoiding immediate risks, and so forth—is predicated on the ability to effectively inhibit present tendencies and prioritize long-term goals over short-term rewards.

Sensation seeking can be described as the tendency to seek out novel, stimulating, and emotionally intense experiences. Sensation seeking involves a tendency to take risks in the pursuit of thrills and excitement, is strongly correlated with impulsivity (DeYoung, 2011), and is an especially powerful predictor of investment in short-term mating (e.g., Lalasz & Weigel, 2011). Whereas men and women show similar average levels of impulsivity, sensation seeking is characteristically higher in men (Cross et al., 2011). Impulsivity and sensation seeking can be employed as behavioral "markers" of fast life history strategies, together with correlated traits such as attachment instability, sexual promiscuity, and social antagonism (see Del Giudice, in press a).

1.4. Aim and Hypotheses of the Study

In the present study, we set out to replicate and extend some of the findings by Del Giudice and colleagues (2010) in a new sample from the United States. Specifically, we tested the hypothesis that autistic-like and schizotypal traits would show diametrical associations with measures of sociosexuality. In addition, we made the novel prediction that autistic-like and schizotypal traits would show diametrical associations with impulsivity and sensation seeking. Finally, we assessed the specificity of the predicted effects by controlling for correlations between autistic-like and schizotypal traits and "Big Five" personality factors (Costa & McCrae, 1995). We hypothesized that variation in autistic-like and schizotypal traits would predict individual differences in sociosexuality, impulsivity, and sensation seeking over and above the contribution of broad personality dimensions such as neuroticism, conscientiousness, and extraversion.

2. Methods

2.1. Participants and Procedure

One hundred fifty-two men ($N = 77$) and women ($N = 75$) aged between 18 and 38 years ($M = 22.7$, $SD = 3.8$) took part in the study. Participants were 54.6% White, 17.8% Asian, 13.2% Black, and 14% of other/mixed ancestry; overall, 13.8% identified as Hispanic. Approximately 80% were undergraduate or graduate students at a private Midwestern university; most of the others were employed by the same university under various capacities (e.g., research or administrative staff). They were recruited through fliers posted on campus, mailing lists, and a human subject recruitment website. All study participants completed a written informed consent form before participating in the study and were paid $20 after completion of the testing procedure. The study was approved by the IRB. Participants were asked to complete a battery of anonymous questionnaires, both online and in paper-and-pencil format. An initial demographic survey included questions about participants' age and race/ethnicity. The survey was followed by measures of personality and sociosexuality.

2.2. Measures

2.2.1. Autistic-like and schizotypal traits

Autism-spectrum Quotient (AQ; Baron-Cohen et al., 2001). The AQ is a 50-item self-report measure of autistic-like traits in adults with normal IQ. In the original AQ, four-point Likert-type responses are dichotomized to yield a binary score for each item. We followed current practice (e.g., Hoekstra et al., 2008) and employed four-point scores to maximize scale reliability. The AQ comprises five subscales: *communication* ($\alpha = .57$), *social skills* ($\alpha = .77$), *attention switching* ($\alpha = .61$), *imagination* ($\alpha = .60$), and *attention to detail* ($\alpha = .70$). These values of α are typical for AQ subscales, owing mainly to the small number of items in each subscale (Baron-Cohen et al., 2001; Hoekstra et al., 2008; Hurst et al., 2007).

Schizotypal Personality Questionnaire (SPQ; Raine, 1991). The SPQ is a 74-item self-report measure of schizotypal traits in the general population. Items have a yes/no response format. The AQ comprises three positive schizotypy subscales: *magical thinking* ($\alpha = .72$), *unusual perceptual experiences* ($\alpha = .69$), and *ideas of reference* ($\alpha = .74$); three negative schizotypy subscales: *social anxiety* (α = .80), *constricted affect* (α = .71), and *no close friends* (α = .77); and three disorganization subscales: *odd/eccentric behavior* (α = .79), *odd speech* (α = .72), and *suspiciousness* (α = .81).

2.2.2. Sociosexuality

Multidimensional Sociosexual Orientation Inventory (MSOI; Jackson & Kirkpatrick, 2007). The MSOI is a 23-item measure of sociosexual orientation and behavior. Two attitude scales assess short-term mating orientation (STMO; α = .94) and long-term mating orientation (LTMO; α = .90) with 7-point Likert-type items. STMO reflects the desire for and pursuit of casual, uncommitted sexual relations, whereas LTMO reflects the desire for long-term commitment to one romantic partner. In addition, the MSOI includes three behavioral questions about the lifetime number of sexual partners, the lifetime number of casual sexual partners, and the number of sexual partners in the previous year.

2.2.3. Impulsivity and sensation seeking

Eysenck Impulsivity Questionnaire (EIQ; Eysenck & Eysenck, 1978). The EIQ is a multidimensional questionnaire consisting of three subscales: *impulsivity* (lack of planning and behavioral inhibition), *venturesomeness* (excitement-seeking and risk-taking), and *empathy*. Items have a yes/no response format. In the present study we only employed the impulsivity subscale (26 items, α = .79) and the venturesomeness subscale (17 items, α = .77). The wording of some items was slightly altered to reflect current US usage (e.g., "having a couple of drinks" instead of "taking a couple of drinks"; "risk their lives" instead of "risk their necks"). Venturesomeness correlates strongly with other measures of sensation seeking (e.g., Lejuez et al., 2002; Whiteside & Lynam, 2001).

Zimbardo Time Perspective Inventory (ZTPI; Zimbardo & Boyd, 1999). The ZTPI is a multidimensional measure of time orientation with five subscales: *future* (long-term planning and discounting of short-term rewards), *present-hedonistic* (orientation toward present rewards and risk-taking), *present-fatalistic* (perceived lack of control over future events), *past-positive* (warm, nostalgic attitudes toward one's past), and *past-negative* (negative, aversive attitudes toward one's past). Responses are on a 5-point Likert-type scale. In the present study we employed the following three scales as additional measures of impulsivity and sensation seeking: future (14 items, α = .81), present-hedonistic (16 items, α = .81), and present-fatalistic (8 items, α = .81).

2.2.4. Big Five personality factors

Big Five Inventory (BFI; John et al., 1991). The BFI is a 44-item measure of the five personality domains of the Five Factor Model (Costa & McCrae, 1995): *extraversion* (α = .87), *agreeableness* (α = .78), *conscientiousness* (α = .83), *neuroticism* (α = .83), and *openness to experience* (α = .74). Responses are on a 5-point Likert-type scale.

3. Results

3.1. Preliminary Analyses

3.1.1. Data reduction

In preparation for the main analysis, we sought to reduce the data to a smaller number of summary variables so as to improve the robustness of the results. Means and standard deviations of the original variables are reported in Table 1. All analyses were performed in SPSS™

Statistics 20 (IBM Corporation, New York) and R™ 2.15 (R Core Team, 2012; packages *psych* 1.3.2 and *reldist* 1.6.2). To begin, we followed Dinsdale and colleagues (2013) and performed a principal component analysis (PCA) on the correlation matrix of the AQ and SPQ subscales. The first two components accounted for 51.8% of the variance and were retained on a theoretical basis without further rotations (see above). Component loadings are shown in Table 2 and graphically displayed in Figure 1a. As expected, the first component represents a general dimension of social difficulty, while the second component shows a clear bipolar structure with autistic-like traits at one end, positive schizotypy at the other, and negative schizotypy and disorganization falling in between. Individual scores on the two components were employed as summary variables in subsequent analyses and labeled *social difficulty* (higher scores = higher difficulty) and *autism-schizotypy* (higher scores = higher schizotypy). One of the male participants had missing answers on the entire SPQ and was dropped from subsequent analyses.

Table 1. Descriptive statistics and standardized sex differences (Cohen's *d*) for all the study variables.

	Total		Males		Females		M-F	
	M	*SD*	*M*	*SD*	*M*	*SD*	*d*	*p*
Age (years)	22.7	3.8	23.2	4.3	22.2	3.2	.27	.130
AQ – communication	1.96	.41	2.01	.40	1.90	.42	.27	.096
AQ – social skills	2.00	.53	2.03	.52	1.97	.53	.12	.518
AQ – attention switching	2.37	.42	2.39	.41	2.34	.43	.12	.466
AQ – imagination	1.92	.40	2.00	.41	1.83	.37	.44	.009
AQ – attention to detail	2.60	.50	2.60	.48	2.60	.51	.00	.973
SPQ – magical thinking	.15	.22	.16	.23	.14	.20	.12	.488
SPQ – unusual experiences	.22	.21	.26	.22	.19	.21	.30	.069
SPQ – ideas of reference	.32	.26	.33	.28	.31	.24	.08	.602
SPQ – social anxiety	.42	.31	.43	.32	.42	.29	.05	.780
SPQ – constricted affect	.24	.22	.29	.24	.19	.19	.45	.007
SPQ – no close friends	.26	.25	.30	.27	.23	.22	.26	.116
SPQ – odd/eccentric behavior	.41	.30	.47	.29	.35	.30	.43	.010
SPQ – odd speech	.40	.26	.46	.26	.34	.24	.49	.004
SPQ – suspiciousness	.29	.29	.33	.30	.25	.27	.30	.073
MSOI – STMO	4.03	1.79	4.30	1.72	3.75	1.83	.31	.060
MSOI – LTMO	5.89	1.01	5.92	.97	5.86	1.06	.06	.720
MSOI – sexual partners (life)	5.45	7.05	6.55	8.37	4.33	5.21	.32	.053
MSOI – one-time partners (life)	1.95	3.70	2.40	4.56	1.49	2.47	.25	.130
MSOI – sexual partners (last year)	1.66	2.38	2.00	2.95	1.32	1.56	.29	.079
EIQ – impulsivity	.39	.18	.40	.19	.37	.17	.17	.290
EIQ – venturesomeness	.58	.21	.61	.20	.55	.23	.28	.070
ZTPI – future	3.62	.63	3.58	.66	3.67	.59	−.14	.360
ZTPI – present-hedonistic	3.30	.62	3.31	.65	3.29	.59	.03	.820
ZTPI – present-fatalistic	2.41	.68	2.48	.66	2.34	.69	.21	.190
BFI – extraversion	3.16	.82	3.13	.86	3.19	.78	−.07	.688

BFI – agreeableness	3.63	.61	3.61	.64	3.66	.59	−.08	.615
BFI – conscientiousness	3.57	.68	3.50	.73	3.63	.62	−.19	.217
BFI – neuroticism	2.95	.78	2.87	.85	3.03	.71	−.21	.201
BFI – openness to experience	3.89	.54	3.86	.54	3.92	.55	−.11	.543
Social difficulty	.00	1.00	.21	1.02	−.21	.94	.42	.011
Autism-schizotypy	.00	1.00	.04	1.06	−.04	.95	.09	.589
Impulsivity	.00	1.00	.08	1.04	−.08	.95	.17	.313
Sensation seeking	.00	1.00	.09	1.00	−.10	1.00	.19	.243
Unrestricted behavior	.00	1.00	.17	1.19	−.17	.72	.35	.034
Unrestricted attitude	.00	1.00	.07	1.00	−.07	1.00	.13	.408

Table 2. Unrotated component loadings of AQ and SPQ subscales. Note that PC1 and PC2 are orthogonal (uncorrelated).

Measure	Subscale	PC1 Social difficulty	PC2 Autism-schizotypy
AQ	Communication	.70	−.39
	Social skills	.72	−.48
	Attention switching	.64	−.40
	Imagination	.46	−.25
	Attention to detail	.18	.15
SPQ	Social Anxiety (N)	.71	−.04
	Constricted affect (N)	.79	−.18
	No close friends (N)	.79	−.10
	Odd behavior (D)	.56	.33
	Odd speech (D)	.64	.14
	Suspiciousness (D)	.68	.37
	Magical thinking (P)	.17	.64
	Unusual experiences (P)	.41	.65
	Ideas of reference (P)	.44	.71

Note. P = positive schizotypy; N = negative schizotypy; D = disorganization.

We then performed PCA on the EIQ and ZTPI subscales. Parallel analysis suggested extracting two components, which together accounted for 73.3% of the variance. Oblimin rotation returned two clearly interpretable, positively correlated components (r = .32) that were labeled *impulsivity* and *sensation seeking*. Component loadings are shown in Table 3.

Table 3. Oblimin-rotated component loadings of EIQ and ZTPI subscales (pattern matrix). The correlation between PC1 and PC2 is $r = .32$.

Measure	Subscale	PC1 Impulsivity	PC2 Sensation seeking
EIQ	Impulsivity	.56	.45
	Venturesomeness	−.14	.93
ZTPI	Future	−.69	−.26
	Present-hedonistic	.41	.67
	Present-fatalistic	.90	−.22

Finally, we performed PCA on the two attitude subscales and three behavioral questions of the MSOI. Parallel analysis suggested extracting two components, which together accounted for 74.6% of the variance. Oblimin rotation returned two negatively correlated components. The first component showed high loadings from the behavioral questions and was labeled *unrestricted behavior* (higher scores = more sexual partners). The second component had a high positive loading from LTMO and negative loading from STMO, plus a smaller negative loading from the number of sexual partners during the last year. We reversed the score on this component and labeled it *unrestricted attitude* (higher scores = more interest in casual sex and less interest in committed long-term relations). After reversal, the between-component correlation was $r = .41$. Component loadings are shown in Table 4. The distinction between sociosexual attitude and behavior has been discussed by Penke and Asendorpf (2008). Sociosexual attitude determines behavior in interaction with personal (e.g., age, attractiveness) and social factors (e.g., cultural norms, social control) that may constrain, enable, or amplify the expression of an individual's dispositions. Consistent with the present findings, sociosexual attitude and behavior show only moderate correlations with one another (about $r = .50$ in Penke & Asendorpf, 2008).

Table 4. Oblimin-rotated component loadings of MSOI subscales and behavioral items (pattern matrix). Loadings on PC2 have been reversed for ease of interpretation. The correlation between PC1 and PC2 is $r = .41$.

Measure	Subscale/item	PC1 Unrestricted behavior	PC2 Unrestricted attitude
MSOI	STMO	.25	.61
	LTMO	.16	−.95
	Sexual partners (life)	.94	.07
	One-time partners (life)	.96	−.09
	Sexual partners (last year)	.45	.46

3.1.2. Correlations

Zero-order correlations between the main study variables in the whole sample are shown in Table 5. Predictably, social difficulty was negatively related to extraversion, agreeableness, and sensation seeking, and positively related to neuroticism. Autism-schizotypy scores showed positive correlations with extraversion, openness, impulsivity, and sensation seeking. This is consistent with our hypothesis that autistic and schizotypal traits would show diametrical associations with impulsivity and sensation seeking. In turn, both impulsivity and sensation seeking were positively related to unrestricted attitude; sensation seeking also exhibited a significant positive correlation with unrestricted behavior. Separate correlation matrices for males and females are shown in Table 6. Given the small size of the male and female subgroups, all subsequent analyses were carried out on the whole sample.

Table 5. Zero-order correlations between the main study variables. Italicized correlations are significant at $p < .05$.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Age	1.00											
2. Sex: Male	.12	1.00										
3. Social difficulty	.12	*.21*	1.00									
4. Autism-schizotypy	−.10	.04	.00	1.00								
5. Impulsivity	−.12	.08	.02	*.23*	1.00							
6. Sensation seeking	−.10	.10	*−.18*	*.39*	*.32*	1.00						
7. Unrestricted behavior	*.34*	*.17*	.07	.15	.13	*.21*	1.00					
8. Unrestricted attitude	−.01	.07	.06	−.01	*.17*	*.25*	*.41*	1.00				
9. Extraversion	−.10	−.03	*−.59*	*.39*	.09	*.31*	.07	.13	1.00			
10. Agreeableness	.04	−.04	*−.35*	.01	−.14	−.09	−.10	*−.28*	.12	1.00		
11. Conscientiousness	.04	−.10	−.14	.05	*−.58*	*−.22*	−.14	*−.24*	.06	*.29*	1.00	
12. Neuroticism	−.12	−.10	*.50*	−.08	.16	−.11	−.02	.03	*−.29*	*−.34*	*−.24*	1.00
13. Openness	.14	−.05	−.07	*.29*	.02	*.33*	.14	−.12	.13	−.02	−.03	−.06

Table 6. Zero-order correlations between the main study variables computed separately for males (below the diagonal) and females (above the diagonal). Italicized correlations are significant at $p < .05$.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Age		.15	−.11	−.09	−.19	*.32*	−.08	−.14	.11	.01	−.02	−.02
2. Social difficulty	.07		−.09	−.03	−.13	.06	.17	*−.46*	*−.28*	−.02	*.53*	−.03
3. Autism-schizotypy	−.10	.05		*.26*	*.42*	.07	.05	*.57*	.11	−.07	−.13	*.23*
4. Impulsivity	−.16	.03	.20		*.29*	*.29*	*.26*	.04	−.17	*−.58*	.12	−.08
5. Sensation seeking	−.05	*−.28*	*.35*	*.35*		*.26*	*.25*	*.33*	−.05	−.21	−.06	*.30*
6. Unrestricted behavior	*.34*	.03	.20	.02	.17		*.33*	.00	−.07	−.23	.07	−.12
7. Unrestricted attitude	.01	−.07	−.07	.09	*.25*	*.46*		.05	*−.44*	*−.30*	.10	−.12
8. Extraversion	−.08	*−.71*	*.25*	.14	*.30*	.11	.20		.08	−.01	−.17	.17
9. Agreeableness	.01	*−.40*	−.06	−.12	−.12	−.12	−.14	.16		*.27*	*−.32*	−.03
10. Conscientiousness	.09	−.20	.14	*−.57*	−.21	−.07	−.18	.11	*.31*		−.13	−.05
11. Neuroticism	−.17	*.54*	−.04	.20	−.14	−.04	−.01	*−.40*	*−.37*	*−.34*		.00
12. Openness	*.27*	−.08	*.36*	.12	*.37*	*.31*	−.12	.11	−.01	−.02	−.12	

3.1.3. Sex differences

As can be seen in Table 1, males had significantly higher scores of social difficulty (*d* = .42) and unrestricted behavior (*d* = .35). In addition, males scored significantly higher in the imagination subscale of the AQ (*d* = .44) and in the odd behavior/odd speech subscales of the SPQ (*d* = .43 and .49, respectively). There were only small and non-significant differences in sensation seeking (*d* = .19) and unrestricted attitude (*d* = .13), two dimensions that tend to show consistent sex differences across studies.

In line with previous findings by Dinsdale and colleagues (2013), sex differences were moderately large on the social difficulty dimension but small and non-significant on the autism-schizotypy dimension (*d* = .09). A likely explanation is that males tend to be over-represented at both ends of the autism-schizotypy dimension, in line with previous findings that males outnumber females at the high end of autistic-like traits *and* at the high end of positive schizotypy (Del Giudice et al., 2010). Relative density plots (see Handcock & Morris, 1998) showed this to be the case (Fig. 2). While the male:female ratio increases gradually as one moves toward higher levels of social difficulty (Fig. 2a), males are clearly over-represented at both ends of the autism-schizotypy continuum, as well as in the middle of the distribution (Fig. 2b).

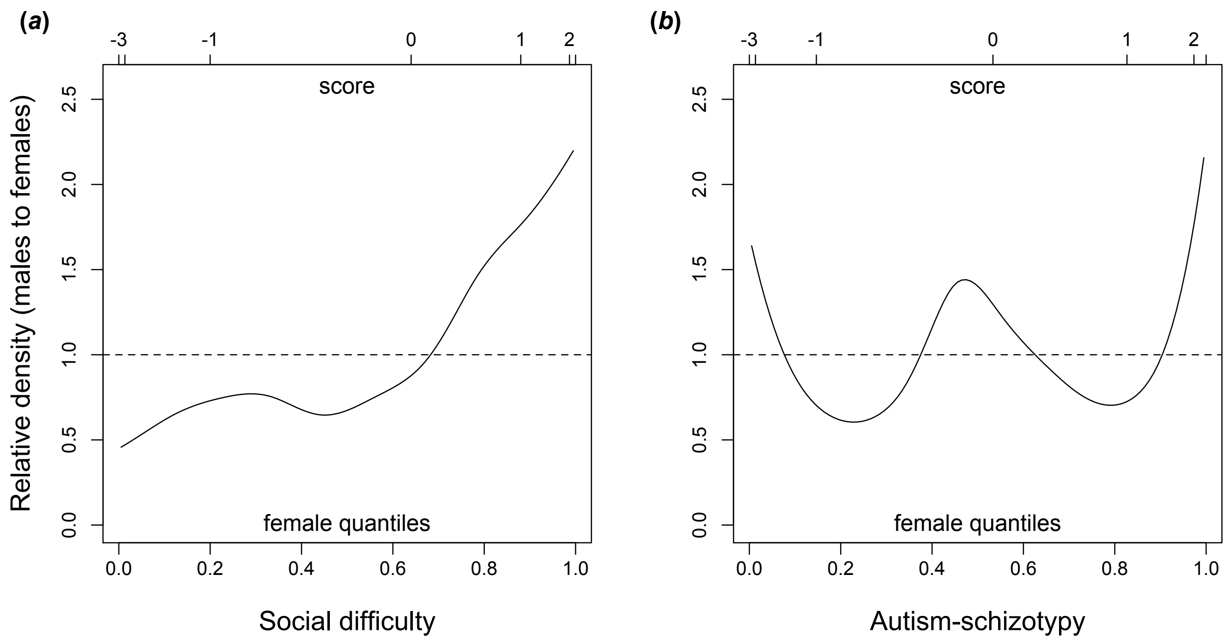

Figure 2. Relative density plots of social difficulty and autism-schizotypy scores. Solid lines show the male:female ratio at different levels of the investigated variable, with females serving as the reference group. In the lower axis, the variable has been rescaled to fit the cumulative distribution in females; for example, quantile 0.8 is the 80th percentile of the female distribution. The corresponding raw scores of the variable are shown in the upper axis. Dashed lines indicate equal proportions of males and females. Males are over-represented at high levels of social difficulty (a) and at both ends of the autism-schizotypy continuum (b).

3.2. Associations with Sociosexuality, Impulsivity, and Sensation Seeking

The main hypotheses of the study were tested by fitting a series of ordinary least squares multiple regression models. Each dependent variable was regressed on two hierarchically organized sets of predictors. In step 1, the predictor set comprised social difficulty, autism-schizotypy, and demographics (age, sex, and race). In step 2, Big Five personality scores were added to the initial set to assess the unique contribution of the autism-schizotypy dimension.

3.2.1. Sociosexuality

Multiple regression results for sociosexuality are shown in Table 7. Consistent with our hypothesis, the autism-schizotypy score was a significant positive predictor of unrestricted behavior. Because of the bipolar nature of the autism-schizotypy score, a positive association means that unrestricted behavior increases toward the schizotypal end of the continuum and decreases toward the autistic end. The effect remained significant after controlling for Big Five personality factors. In contrast with our hypothesis, unrestricted attitude showed virtually no association with the autism-schizotypy dimension. When controlling for Big Five factors, social difficulty emerged as a significant positive predictor of unrestricted attitude. In addition, unrestricted attitude was predicted by high levels of extraversion and low levels of agreeableness and conscientiousness.

Table 7. Multiple regression results for unrestricted behavior and attitude.

Unrestricted behavior		β	p	R^2	Unrestricted attitude		β	p	R^2
Step 1				.20	Step 1				.04
	Age	.35	<.001			Age	−.03	.695	
	Sex: Male	.07	.393			Sex: Male	.04	.636	
	Race: Black	−.19	.023			Race: Black	−.12	.204	
	Race: Asian	−.08	.368			Race: Asian	−.17	.058	
	Race: Other	.00	.974			Race: Other	−.01	.874	
	Social difficulty	.04	.610			Social difficulty	.11	.231	
	Autism-schizotypy	.24	.003			Autism-schizotypy	.01	.909	
Step 2				.23	Step 2				.21
	Age	.36	<.001			Age	.02	.847	
	Sex: Male	.05	.571			Sex: Male	−.03	.703	
	Race: Black	−.18	.036			Race: Black	−.12	.157	
	Race: Asian	−.08	.350			Race: Asian	−.21	.015	
	Race: Other	.00	.997			Race: Other	−.04	.616	
	Social difficulty	.07	.563			Social difficulty	.26	.046	
	Autism-schizotypy	.20	.030			Autism-schizotypy	−.05	.605	
	Extraversion	.10	.369			Extraversion	.32	.005	
	Agreeableneess	−.07	.440			Agreeableneess	−.23	.008	
	Conscientiousness	−.13	.104			Conscientiousness	−.18	.029	
	Neuroticism	−.02	.811			Neuroticism	−.13	.197	
	Openness	.01	.894			Openness	−.16	.060	

3.2.1. Impulsivity and sensation seeking

Multiple regression results for impulsivity and sensation seeking are shown in Table 8. Consistent with our hypothesis, the autism-schizotypy score was a significant positive predictor of both impulsivity and sensation seeking. Because of the bipolar nature of the autism-schizotypy score, such positive associations mean that impulsivity and sensation seeking increase toward the schizotypal end of the continuum and decrease toward the autistic end. Both effects remained significant after controlling for Big Five personality factors. While social difficulty predicted lower levels of sensation seeking in step 1, the effect was no longer significant when Big Five factors were included in the model. Finally, conscientiousness emerged as a negative predictor of both impulsivity and sensation seeking, while openness to experience was associated with higher levels of sensation seeking.

Table 8. Multiple regression results for impulsivity and sensation seeking.

Impulsivity		β	p	R^2	Sensation seeking		β	p	R^2
Step 1				.10	Step 1				.23
	Age	−.11	.179			Age	−.05	.494	
	Sex: Male	.11	.184			Sex: Male	.10	.196	
	Race: Black	.05	.588			Race: Black	−.10	.216	
	Race: Asian	.00	.971			Race: Asian	−.08	.318	
	Race: Other	−.16	.056			Race: Other	−.13	.104	
	Social difficulty	.00	.975			Social difficulty	−.18	.023	
	Autism-schizotypy	.22	.010			Autism-schizotypy	.43	<.001	
Step 2				.45	Step 2				.36
	Age	−.05	.485			Age	−.07	.347	
	Sex: Male	.07	.319			Sex: Male	.08	.281	
	Race: Black	.11	.138			Race: Black	−.07	.399	
	Race: Asian	.01	.905			Race: Asian	−.07	.375	
	Race: Other	−.07	.289			Race: Other	−.13	.095	
	Social difficulty	−.14	.181			Social difficulty	−.13	.257	
	Autism-schizotypy	.27	.001			Autism-schizotypy	.32	<.001	
	Extraversion	−.02	.876			Extraversion	.11	.264	
	Agreeableneess	−.01	.881			Agreeableneess	−.13	.105	
	Conscientiousness	−.59	<.001			Conscientiousness	−.22	.004	
	Neuroticism	−.09	.275			Neuroticism	−.09	.301	
	Openness	−.07	.322			Openness	.21	.004	

4. Discussion

According to the diametrical model of autism and psychosis (Crespi & Badcock, 2008), autistic-like and schizotypal traits represent opposite sides of a mentalistic-mechanistic continuum of individual differences. A life history perspective puts the diametrical model in a broader context, suggesting that variation on the autistic-schizotypal axis may be maintained—at least in part—by the diametrical effects of autistic-like and schizotypal features on mating- and parenting-related behaviors (Del Giudice et al., 2010; Del Giudice, in press a). In this study we tested a number of hypotheses derived from this approach; specifically, we predicted a pattern of diametrical associations between autistic-like and schizotypal traits and key behavioral correlates of life history strategy—sociosexuality, impulsivity, and sensation seeking.

Our results were consistent with the existence of a bipolar autistic-schizotypal axis of individual variation (Dinsdale et al., 2013; see Fig. 1). In support of our hypotheses, we found clear diametrical associations between autistic-like and schizotypal traits and impulsivity, sensation seeking, and sociosexual behavior. These effects were not explained by correlations between the autistic-schizotypal axis and broad personality traits such as extraversion and openness to experience, corroborating the idea that autistic-like and schizotypal traits are functionally distinct from other dimensions of personality. The data-analytic strategy of computing a single autism-schizotypy score with PCA has a number of advantages over the alternative of computing separate variables for autistic, negative schizotypal, and positive schizotypal traits (e.g., Del Giudice et al., 2010). First, the resulting statistical analyses correspond more closely to the underlying theoretical model. Second, it becomes possible to isolate the construct of interest (the autistic-schizotypal axis) from the potentially confounding dimension of social difficulty. Finally, each hypothesis can be addressed with a single statistical test, considerably lowering the risk of both type I and II errors.

In contrast with our hypotheses and previous findings (Del Giudice et al., 2010), we found no significant association between the autistic-schizotypal axis and sociosexual attitude. This is especially puzzling in view of (a) the robust association between the autistic-schizotypal axis and impulsivity/sensation seeking, and (b) the association between impulsivity/sensation seeking and unrestricted attitude. More research will be needed to resolve this contradiction and clarify the implications of autistic and schizotypal traits for different aspects of sociosexuality. It would be especially useful to replicate the present study in a more demographically representative sample. Of course, if future studies consistently fail to support the connection between the autistic-schizotypal axis and sociosexual attitude the model will have to be revised or partially rejected.

In addition to the main results we just discussed, our study yielded some interesting collateral findings that may stimulate future research. First of all, the lack of average sex differences on the autistic-schizotypal axis masks the fact that males tend to be over-represented at both ends of the continuum (Fig. 2). This finding is broadly consistent with the sexual selection model, given that sexually selected traits tend to be hyper-variable in men (Archer & Mehdikhani, 2003). It is also consistent with the idea that mating strategies in men comprise a multiplicity of specialized phenotypes; on this view, there is not a single "extreme male brain" (Baron-Cohen, 2002) but many—including a highly schizotypal brain associated with increased mating effort and higher risk of SSDs. A related finding is that, when isolated from variation on the autistic-schizotypal axis, social difficulty showed a clear association with sex, replicating the pattern observed by Dinsdale and colleagues (2013). Higher levels of social difficulty may contribute to the disproportionate prevalence of both ASD and SSD diagnoses in males (Aleman et al., 2003, Baron-Cohen at al., 2001), above and beyond the over-representation of males at the extremes of the autistic-schizotypal continuum. Finally, it is noteworthy that social difficulty scores showed a relative lack of association with outcome variables. In particular, higher levels of social difficulty did not predict fewer sexual partners—and, if anything, tended to be associated with *unrestricted* sociosexual attitude. These findings run counter to a possible common-sense explanation of associations between autistic-like traits and restricted sociosexuality, i.e., that individuals high in autistic-like traits have fewer sexual partners because they are socially anxious and/or inept. On the contrary, autism-schizotypy scores predicted sociosexual behavior independently of social difficulty, and the latter was not significantly associated with either restricted attitude or restricted behavior.

In conclusion, our results provide additional support for the life history approach to autistic-like and schizotypal traits, and demonstrate the heuristic value of this framework in the evolutionary study of personality and psychopathology. Future research should aim to replicate these findings in larger, demographically representative samples, and further extend the scope of our investigation to a broader spectrum of life history correlates—including maturation patterns, motivation, and self-regulation styles (see Del Giudice, in press a, in press b). Given the limitations of current self-report instruments, it will be especially valuable to supplement questionnaires with observational measures and performance-based tasks such as handedness tests, mental rotation, eye tracking, and motor coordination. In a few years, it may also become feasible to map genetic and epigenetic data on known variants associated with ASDs and SSDs. So far, the diametrical model of autism and psychosis and its extension in a life history perspective have proved both theoretically fertile and empirically fruitful. If future research will confirm the validity of this approach, we may finally come close to solving some of the most enduring puzzles in psychology and psychiatry.

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