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Enhanced Creativity in Autism Is Due to Co-Occurring Attention-Deficit/Hyperactivity Disorder

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There has been longstanding speculation that enhanced creativity is associated with autism. Evidence for this association, however, is limited and derived from small-scale studies in nonclinical samples. Furthermore, nothing is known about autism-related creativity after accounting for general cognitive ability and attention-deficit/hyperactivity disorder (ADHD), that is, other factors known to predict creativity. Addressing these issues, we conducted preregistered comparisons of the creativity of autistic and nonautistic adults ($N = 352$), matched on age, sex, and general cognitive ability. We found clear evidence that there were no group differences on a divergent thinking creativity task. Autistic adults did self-report more real-world creative accomplishments and behaviors, but these differences did not hold after accounting for ADHD. We conclude that enhanced creativity, where observed in autistic people, is likely to be driven by co-occurring ADHD. The clinical and practical implications of these findings for strength-based approaches to psychopathology are discussed.

General Scientific Summary
We found that autistic adults perform comparably to nonautistic people in a divergent thinking creativity task. Autistic adults report more creative accomplishments and behaviors than nonautistic adults, but these differences could be explained by attention-deficit/hyperactivity disorder. We conclude that enhanced creativity in autism may largely be driven by co-occurring attention-deficit/hyperactivity disorder.

Keywords: autism, attention-deficit/hyperactivity disorder, creativity, divergent thinking

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Associations between psychopathology and creativity have long been discussed, with many conditions, including schizophrenia, bipolar disorder, and attention-deficit/hyperactivity disorder (ADHD), having been linked to enhanced creativity (Hoogman et al., 2020; Knudsen et al., 2019; Simonton, 2019). More recently, enhanced creativity has been suggested as a key strength associated with autism spectrum disorder (henceforth autism), whereby autism-related perceptual and attentional differences are thought to contribute to a unique perception of the world and an original thinking style (Lyons & Fitzgerald, 2013; Pennisi et al., 2021). This accords with extensive qualitative research highlighting creativity as an autistic strength (e.g., Cope & Remington, 2022; Russell et al., 2019; Warren et al., 2021) and the

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prominence of several autistic[1] savants with extraordinary creative skills (e.g., Stephen Wiltshire; Pennisi et al., 2021). Consequently, there are growing calls for autistic strengths in creativity to be incorporated into clinical and educational practice (Huntley et al., 2019). It is also argued that employers should recognize autism-related creativity skills as a way in which autistic people can contribute to organizational settings and wider society (e.g., Austin & Pisano, 2017; Cosslett, 2016). However, despite the widespread advocacy and media coverage of creativity as an autistic strength (Fenn, 2018; Jones, 2016; McVeigh, 2015), very few empirical studies have investigated creativity in relation to autism (see Pennisi et al., 2021 for review).

Empirical evidence for enhanced creativity in autism has largely stemmed from a very small range of studies investigating the relationship between autistic traits and creativity in nonclinical samples. These studies used divergent thinking (DT) tasks, which are the most widely used performance-based measures of creativity, assessing an individual's capacity for generating novel ideas. For example, the alternative uses task (Guilford et al., 1978) requires participants to generate alternative uses for an everyday object (e.g., a brick). On these tasks, those with higher autistic traits tend to provide fewer ideas (i.e., reduced ideational fluency; Best et al., 2015), but their ideas are generally more original (Best et al., 2015; Jankowska et al., 2019). This contrasted with the earlier studies that found no relationship between autistic traits and DT (Claridge & McDonald, 2009; Zabelina et al., 2014). The more recent studies are thought to provide a more valid assessment of creativity in autism as they had better statistical power (Pennisi et al., 2021); however, there is clearly a small and highly equivocal body of empirical evidence. We argue there are several limitations in previous research that warrant exposition.

First, while measuring clinical traits in nonclinical samples is increasingly common, there remains debate regarding the appropriateness of using dimensional approaches to study discrete conditions (e.g., Chown & Leatherland, 2021; Coghill & Sonuga-Barke, 2012). To date, gold-standard DT measures, as used in trait-based autism creativity research (Best et al., 2015; Jankowska et al., 2019), have never been used to compare the creativity of autistic and nonautistic adults. Thus, the generalizability of previous trait-based findings to clinically diagnosed individuals remains unclear. Two studies appear to have compared autistic and nonautistic adults (Pennisi et al., 2021), but only using measures that loosely tap into creativity. Kasirer and Mashal (2014) assessed originality using a domain-specific linguistic task (generation of novel metaphors), whereas Constable et al. (2018) assessed the number of ideas produced during a categorization task with a finite number of solutions and thus more consistent with measures of fluency. There were further discrepancies here, with Kasirer and Mashal (2014) reporting enhanced "creativity" and Constable et al. (2018) reporting diminished "creativity" in relation to autism. The discrepancy between these studies likely reflects the tasks used and, despite their inclusion of clinically diagnosed autistic people, the generally low statistical power in these small-scale studies does not inspire confidence in their overall conclusions. Overall, further work in clinically diagnosed samples is critical to clarify these potential inconsistencies and the generalizability of trait-based work to clinically diagnosed autistic adults. Indeed, research using DT tasks, as in trait-based research (i.e., Best et al., 2015; Jankowska et al., 2019), is now required. Such tasks allow the measurement of both the number and originality of ideas on a more domain-general creativity task, and thus assess idea generation with broader applicability. The present study is, therefore, the first to administer classical DT tasks in a large sample of clinically diagnosed autistic people and a matched control group of nonautistic people.

Second, while DT tasks are optimal and the most widely used performance-based creativity measures, they still assess a limited component of creativity, that is, idea generation. In the field of creativity research, idea-generation tasks are considered a measure of creative potential, rather than a direct measure of real-world creative achievements (see Runco & Acar, 2012). Consequently, their use is best supplemented with well-validated self-report questionnaire measures that offer a more comprehensive assessment of creativity, including an individual's real-world engagement in creative abilities, behaviors, achievements, and personality (Silvia et al., 2012). Two studies to date have utilized such self-report measures to explore associations between autistic traits and creativity. Zabelina et al. (2014) found no association between autistic traits and real-world creative accomplishments (e.g., presenting artwork in a gallery), as assessed with the Creative Achievement Questionnaire (CAQ; Carson et al., 2005). In contrast, Jankowska et al. (2019), found an association between autistic traits and lower self-reported creative personality and abilities. Although these studies have their own limitations (e.g., limited statistical power, use of composite scores limiting differentiation between creativity constructs, no clinically diagnosed participants), they suggest that previously identified associations between autistic traits and DT may not translate into real-world creativity. Further research, using DT measures and self-report measures assessing different dimensions of creativity, is critical to determine whether associations between autism and DT confer real-world differences in creative behavior and achievements. Importantly, it is again essential to move beyond research using nonclinical samples. The current study will be the first to use self-report measures of creativity in a clinically diagnosed sample of the autistic population.

A final, critical issue is that numerous factors known to be associated with creativity have not been well accounted for in previous autism research. Associations between general cognitive ability and creativity are well established. Both fluid and crystallized intelligence have been implicated in creativity. For example, abstract thinking and reasoning, the effective retrieval of relevant domain-general and domain-specific knowledge, and more general cognitive capacities (e.g., processing speed), are all thought to contribute to DT and real-world creative achievements (e.g., Gerwig et al., 2021; Karwowski et al., 2021). However, general cognitive ability was neither measured nor accounted for in any of the previous work exploring associations between autistic traits and creativity. This alone could be driving previously identified associations and/or contributing to the equivocal results across different studies. Similarly, ADHD, a neurodevelopmental condition that frequently co-occurs with autism (e.g., Rong et al., 2021), has been independently linked with enhanced creativity (Hoogman et al., 2020; Sedgwick et al., 2019). Several core features of ADHD, including heightened distractibility and impulsivity (American Psychiatric Association [APA], 2013), are thought to boost creativity through an enhanced ability to think flexibly and switch between different perspectives and approaches to generate novel ideas (Boot et al., 2020; Hoogman et al., 2020). Furthermore,

[1] We use identity first language throughout the current article, following Kenny et al. (2016). However, language preferences are evolving, and the interested reader may wish to see Buijsman et al. (2023) and Keating et al. (2023) for alternative suggestions.

reflecting atypical reward processing and impulsivity (Barkley, 1997; Volkow et al., 2011), people with ADHD also show heightened extrinsic, goal-directed motivation to attain more real-world creative achievements (Boot et al., 2020). Yet, despite the clear interrelationships between autism, ADHD, and creativity, ADHD has never been explored in any autism-related creativity research to date, in either clinical or nonclinical samples.

To address these limitations of previous research, we conducted a preregistered study on creativity in a large sample of autistic and nonautistic adults, very closely matched on age, sex (at birth), and general cognitive ability. We assessed creativity across multiple dimensions, using both a DT performance-based task, as well as well-validated self-report measures of creativity. Finally, we explored the specificity of the findings to autism by measuring and accounting for general cognitive ability and co-occurring ADHD.

Method

Participants

A sample of 352 adults (176 autistic, 176 nonautistic) were recruited via Prolific.co. All participants were U.K. residents and had undergone participant verification processes (Prolific, 2019). Autistic participants (87 female, 89 male, sex at birth), aged 18–63, had a clinical diagnosis of an autism spectrum disorder from an independent U.K. or U.S.-based health care professional according to *Diagnostic and Statistical Manual of Mental Disorders* or *International Statistical Classification of Diseases and Related Health Problems* criteria (APA, 2013; World Health Organization, 2019). Participants provided detailed information about their diagnosis, diagnosing clinician(s), and diagnosis location, consistent with previous research recruiting large autistic samples online (e.g., Clutterbuck et al., 2021; Taylor et al., 2022). Diagnoses were confirmed multiple times during the screening process and within the study. Seven additional autistic participants were recruited but excluded as they either did not provide sufficient diagnostic information or failed at least one of two attention checks (e.g., "Please select 'slightly agree' to indicate that you are reading these questions"). Nonautistic participants (87 female, 89 male), aged 18–65, did not have autism nor suspected they were autistic. The final sample size gave us 80% and 90% power to detect at least "small-to-medium" sized group differences ($d = 0.30$ and 0.35, respectively, $\alpha = .05$, two-tailed).

The autistic and nonautistic groups did not differ in age, sex (at birth), and general cognitive ability, and there was a large group difference in autistic traits, measured using the Autism-Spectrum Quotient (AQ; Baron-Cohen et al., 2001; Table 1). The autistic group reported significantly more autistic traits ($M = 35.52$) than the nonautistic ($M = 19.35$) group, with group means within the range of AQ scores reported in a large meta-analysis of clinically diagnosed autistic ($M = 35.19$, range = 27.6–41.1) and nonautistic samples ($M = 16.94$, range = 11.6–20.0; Ruzich et al., 2015). Most of the autistic group scored ≥32 (73%) on the AQ, that is, meeting the "clinical" threshold, and 88% scored ≥26, that is, the "screening" threshold for clinically significant levels of autistic traits (Baron-Cohen et al., 2001). In contrast, almost all nonautistic participants scored <26 and <32 on the AQ (84% and 94%, respectively). These percentages align with the sensitivity and specificity of the AQ to clinically diagnosed autism (Ashwood et al., 2016; Woodbury-Smith et al., 2005) and composition of other autistic and nonautistic groups recruited via Prolific (Taylor et al., 2022). Accordingly, we did not exclude any participants based on AQ thresholds.

Highly consistent with recent meta-analytic estimates of the co-occurrence of ADHD with autism (22%–38%; Mutluer et al., 2022; Rong et al., 2021), there was a higher rate of ADHD in the autistic group, with 41 participants (23%) reporting a clinical diagnosis and an additional 56 (32%) suspecting they have ADHD, compared with one (1%) and 23 (13%), respectively, in nonautistic participants. Reflecting this difference, ADHD traits were significantly higher in the autistic than in the nonautistic group (Table 1).

Measures

DT

DT was assessed with the most widely used variant of the alternative use task, the brick task (Guilford et al., 1978). This has also previously been used in autism-trait-based creativity research (Best et al., 2015). Participants listed as many uses for a brick as possible in 2 min. Responses were scored across three indices of creativity: fluency, flexibility, and originality. Fluency ($M = 6.77$, $SD = 2.80$) was the number of ideas provided by the participant after duplicate or incomplete responses were removed. Flexibility ($M = 5.17$, $SD = 1.97$) was the number of semantic categories used by the participant, that is, different types of ideas given. A preexisting coding scheme was used to categorize each idea (Steffens et al., 2016; as in Gocłowska et al., 2019). For example, ideas such as "table" and "art" were respectively coded into categories of "furniture" and "decoration." Finally, originality ($M = 1.09$, $SD = 1.33$) was computed as the number of original ideas

Table 1
Matching Autistic and Nonautistic Groups

Measure	Autistic	Nonautistic	Group differences: *t*	*p*	*d* [95% CI]	BF_{10}
Sex at birth (*n* female, male)	87, 89	87, 89				
Age	31.81 (9.84)	32.18 (10.21)	−0.35	.73	−0.04 [−0.24, 0.17]	0.13
General cognitive ability	8.23 (3.73)	8.07 (3.34)	0.41	.68	0.04 [−0.16, 0.26]	0.13
Autistic traits	35.52 (8.28)	19.35 (7.06)	19.71	<.001	2.10 [1.82, 2.44]	1.04×10^{55}
ADHD traits	40.69 (12.10)	28.68 (10.71)	9.87	<.001	1.05 [0.82, 1.31]	1.90×10^{17}

Note. Values represent means and standard deviations are in parentheses. Independent samples *t* tests are reported, with effect sizes reported as Cohen's *d*. General cognitive ability, autistic traits, and ADHD traits were measured using the International Cognitive Ability Resources (Condon & Revelle, 2014), AQ (Baron-Cohen et al., 2001), and ASRS (Kessler et al., 2005), respectively. 95% CI = percentile bootstrapped confidence intervals for Cohen's *d* computed using the rstatix package in R (5,000 resamples; Kassambara, 2023, V. 0.7.2); BF = Bayes factor; ADHD = attention-deficit/hyperactivity disorder; AQ = Autism-Spectrum Quotient; ASRS = ADHD Self-Report Scale.

provided by the participant, where an original idea was defined as any idea given by less than 1% of the sample (i.e., by three or fewer participants). All data were coded by a trained coder. Consistent with previous research (Best et al., 2015; Gocłowska et al., 2019), a second trained coder double-coded 10% of ideas to ensure accurate and reliable coding of the data. There was excellent interrater reliability (Cohen's κs of .99, .96, and .88 when coding for fluency, flexibility, and originality, respectively).

Creative Achievements

The CAQ (Carson et al., 2005) measured creative accomplishments across 10 domains (visual arts, music, dance, architectural design, creative writing, humor, inventions, scientific discovery, theatre and film, culinary arts). Participants indicated their accomplishments across eight ranked items for each domain representing increasing levels of creative achievement (e.g., in the visual arts domain, "I have no training or recognized talent in this area" to "My work has been critiqued in national publications"). Some items required an indication of frequency of achievements (e.g., number of times work has been critiqued in publications), which is used as a score multiplier. This resulted in an unrestricted upper range of scores, with higher scores indicating greater creative achievements. The CAQ is particularly robust as individuals do not evaluate their own creativity abilities, but rather indicate whether they have completed specific, publicly recognizable creative accomplishments. As such, it has been extensively used and validated in creativity research. It demonstrates high construct and predictive validity, correlates well with the ability to produce creative products, and produces a distribution of scores that reflects the true population distribution of creative achievements (Carson et al., 2005; Silvia et al., 2012).

Creative Behaviors

The 34-item Biographical Inventory of Creative Behaviors (BICB; Batey, 2007; see Silvia et al., 2021) was used to measure self-reported engagement in everyday creative behaviors. Participants indicated (yes/no) whether they had completed a creative behavior (e.g., "Written a short story") at least once in the last 12 months. Scores range from 0 to 34, with one point scored for each activity. Due to its brevity and binary response format, the BICB is the most accessible self-report measure of creative behaviors (Silvia et al., 2012, 2021).

Creative Personality

Gough's Creative Personality Scale (CPS; Gough, 1979) was used to measure creative personality. Participants were asked to indicate which adjectives best describe them, from a list of 30 personality adjectives highly predictive of creativity. Adjectives indicative of creative (e.g., resourceful, reflective) and noncreative (e.g., cautious, conventional) personalities were scored 1 and −1, respectively. Thus, scores range from −12 to 18, with higher scores indicating more creative personality. As the most widely used measure of creative personality, the reliability and validity of CPS has been extensively examined (e.g., Gough, 1979; Kaduson & Schaefer, 1991; McCrae, 1987; Zampetakis, 2010), with expected associations between CPS scores and other self-report and performance-based creativity measures.

Creative Self-Efficacy

The widely used three-item Creative Self-Efficacy Scale, validated by Tierney and Farmer (2002), measured participants' creative self-efficacy; belief in their ability to produce creative outcomes. Participants responded to items (e.g., "I feel that I am good at generating novel ideas") on a 7-point scale (*strongly disagree* to *strongly agree*). Scores range from 3 to 21, with higher scores indicating greater self-efficacy.

Autistic Traits

The 50-item AQ (Baron-Cohen et al., 2001) measured self-reported autistic traits. Participants responded to items (e.g., "I find social situations easy"), on a 4-point scale (*definitely agree* to *definitely disagree*). Scores range from 0 to 50, with higher scores indicating more autistic traits. This well-validated measure has been extensively used in clinical and nonclinical samples (Ruzich et al., 2015), including previous autism-trait-based creativity research (Jankowska et al., 2019; Zabelina et al., 2014).

ADHD Diagnoses and Traits

Though not an inclusion/exclusion criterion, all participants were asked if they had a clinical diagnosis of ADHD or whether they suspected they had ADHD. As with autism diagnoses, participants provided additional information regarding diagnoses (i.e., diagnosis type, location, age, and clinician) where applicable. The 18-item Adult ADHD Self-Report Scale (ASRS-V1.1; Kessler et al., 2005) also measured self-reported ADHD traits, that is, symptoms of inattention and hyperactivity. Participants responded to items (e.g., "How often do you feel restless or fidgety?") on a 5-point scale (*never* to *very often*). Scores range from 0 to 72, with higher scores indicating more ADHD traits.

General Cognitive Ability

The 16-item version of the International Cognitive Ability Resource (Condon & Revelle, 2014) assessed general cognitive ability. This well-validated measure was purposefully designed for online use, strongly correlates with in-person intelligence tests (Condon & Revelle, 2014; Dworak et al., 2021), and has been used previously in autism (e.g., Clutterbuck et al., 2021; Taylor et al., 2022) and creativity (Karwowski et al., 2020; Zabelina et al., 2019) research. It contains four 4-item subtests of matrix reasoning, three-dimensional rotation, verbal reasoning, and letter and number series. Each item is presented with four response options, with one being correct. Each correct response scores one point. Therefore, International Cognitive Ability Resource scores range from 0 to 16, with higher scores indicating higher cognitive ability.

Procedure

This study was codeveloped with autistic adults of different ages, genders, and cultural backgrounds in accordance with participatory research guidelines (Fletcher-Watson et al., 2019). Though the initial idea for the study was grounded in previous research, autistic adults were consulted to ensure our research aims were relevant to the autism community. Furthermore, autistic adults drove several additional study aims; for instance, our aim is to measure both self-reported creative behavior and achievements to adequately capture autistic creativity, which may potentially manifest more as hobbies or specialized interests rather than professional achievements. Autistic adults also assisted with developing the procedure, particularly informing measurement selection to ensure the measures were easy to complete and used suitable language. For instance, we opted for the BICB over the revised Creative Behavior Inventory (Dollinger, 2003) as the measure of self-reported creative behavior due to expressed preferences for binary over frequency-based response options. Finally, group-based discussions were held to receive input on our interpretation of the results and to discuss the implications of the findings. Research was conducted according to APA ethical standards, and ethical clearance was granted by the University of Bath Psychology Ethics Committee (PREC 19-025). Participants completed all measures which were presented in a randomized order, followed by key demographic questions relating to their age, sex assigned at birth, and autism diagnosis (as described in the Participants section). Data relating to race and ethnicity were not collected.

Transparency and Openness

The study design and statistical analysis plan were preregistered (https://aspredicted.org/MGQ_MQJ), and the data are available in the online supplemental materials. Data analysis was conducted in R (Version 4.2.0; R Core Team, 2022). In addition to frequentist analyses, we also sought to conduct Bayesian equivalent statistical tests to quantify the relative strengths of evidence for the null and the alternative hypothesis, that is, testing for the existence or absence of autism-related differences in creativity (see the online supplemental materials for details). All Bayesian analyses were conducted in JASP (Version 0.17.2; JASP Team, 2023). Analysis code is also available in the online supplemental materials.

Results

In line with previous research (e.g., Best et al., 2015; Zabelina et al., 2014), scores on the creativity measures were skewed (see Table 1 in the online supplemental materials). This reflects the expected population distribution of creativity, whereby a small proportion of the general population is most creative. In accordance with recommendations (e.g., Silvia et al., 2012), previous research (e.g., Gocłowska et al., 2019; Zabelina et al., 2014), and our preregistered plan, skewed data (skewness statistic greater than ± 1) were transformed. CAQ scores were log-transformed, that is, $\log_{10}$(CAQ scores + 1), and DT originality scores were square root transformed, to reduce skew and achieve approximate normality of model residuals. All analyses were conducted with the transformed data.

The primary focus of the study was to compare autistic and nonautistic people, thus we specifically recruited participants for a case–control study design. Frequentist and Bayesian *t* tests compared the group means on each of the creativity measures (Table 2). The autistic and nonautistic groups did not significantly differ in performance on the DT task, with comparable levels of fluency, flexibility, and originality. Bayesian *t* tests further indicated more evidence in support of the null, than alternative, hypothesis ($BF_{10} < 1$; see the online supplemental materials for details on interpreting Bayes factors [BFs]). The autistic group reported significantly more creative achievements and creative behaviors than the nonautistic group, with BFs indicating "strong" and "extreme" evidence of these group differences respectively. The two groups, however, did not differ in self-reported creative personality or creative self-efficacy, with Bayesian analysis suggesting "substantial" evidence in support of the null hypothesis.

As we had no prior knowledge about the diagnostic status or extent of ADHD traits in the participants, the measurement of ADHD diagnoses and traits was preregistered as an "exploratory" analysis. Because there were numerous participants with ADHD in the autistic group, and autistic and nonautistic groups significantly differed on ADHD traits (see Table 1), we conducted additional analyses to test the specificity of the foregoing findings to autism. Specifically, we used two analytical approaches. First, we conducted regression analyses with autism (1 = *diagnosis*, 0 = *no diagnosis*) and ADHD (1 = *diagnosis*, 0 = *no diagnosis*) as predictors of each of the creativity measures (Analysis 1). Those who suspected they had ADHD, but had not received a formal diagnosis, were excluded from these analyses, resulting in a sample of 273 (120 autistic, 153 nonautistic). As the groups were no longer matched on age, sex, and general cognitive ability, these variables were included in the models. In a second analysis, to ensure that any changes in the pattern of results were not due to the exclusion of those who suspected they had ADHD, we repeated the analyses with the full sample ($N = 352$), instead including autism and ADHD continuous trait measures as predictors rather than measures of clinical diagnoses (Analysis 2). This analysis also accounted for the possibility that participants may have ADHD but had not

Table 2
Group Mean and Mean Differences in Creativity

Measure	Autistic	Nonautistic	Group comparisons				
			t	*p*	*d* [95% CI]	BF_{10}	$M_{\text{difference}}$ [95% CI]
DT fluency	6.90 (2.91)	6.65 (2.70)	0.84	.40	0.09 [−0.12, 0.30]	0.17	[−0.34, 0.84]
DT flexibility	5.38 (2.00)	4.97 (1.91)	1.96	.051	0.21 [0.00, 0.42]	0.74	[0.01, 0.81]
DT originality	0.76 (0.71)	0.74 (0.74)	0.19	.85	0.02 [−0.18, 0.23]	0.12	[−0.13, 0.16]
Creative achievements	0.82 (0.47)	0.66 (0.41)	3.30	.001	0.35 [0.14, 0.57]	20.96	[0.06, 0.25]
Creative behaviors	8.94 (6.22)	6.35 (4.64)	4.44	<.001	0.47 [0.26, 0.69]	1,246.69	[1.42, 3.75]
Creative personality	2.28 (4.03)	2.53 (3.56)	−0.62	.54	−0.07 [−0.28, 0.15]	0.14	[−1.04, 0.57]
Creative self-efficacy	14.26 (3.84)	14.37 (3.29)	−0.28	.78	−0.03 [−0.24, 0.19]	0.12	[−0.87, 0.66]

Note. Values represent means and standard deviations are in parentheses. Results from independent samples and Bayesian *t* tests are reported, with effect sizes as Cohen's *d*. DT originality and creative achievement scores were square root and log transformed, respectively. 95% CI = percentile bootstrapped 95% confidence intervals for Cohen's *d* and the mean difference computed using the rstatix (Kassambara, 2023, V. 0.7.2) and sjPlot (Lüdecke, 2023, V. 2.8.14) packages in R, respectively (5,000 resamples); BF = Bayes factor; DT = divergent thinking.

previously been able to receive a simultaneous clinical diagnosis of autism and ADHD prior to the *Diagnostic and Statistical Manual of Mental Disorders*, fifth edition (APA, 2013).

Across these analyses, once ADHD was accounted for, autism was either a null or negative predictor of creativity across the measures (Table 3). Consistent with the group comparisons, autism was a nonsignificant predictor of DT. The exception was that autism, when conceptualized as autistic traits, predicted lower levels of originality, whereas ADHD traits had an equal, but opposite effect, predicting higher levels of originality. ADHD, not autism, was a significant predictor of greater creative achievement and behaviors, suggesting that our previously identified group differences were likely due to co-occurring ADHD, rather than autism. Results pertaining to creative personality and self-efficacy were not consistent. Autism, when measured as autistic traits, was significantly associated with lower levels of creative personality and self-efficacy. However, there were no significant associations between clinically diagnosed autism and these creativity measures.

Table 3
Multiple Regression Analyses Exploring Autism and ADHD as Predictors of Creativity

	Analysis 1: clinical diagnoses				Analysis 2: traits			
Criterion predictor	*B* [95% CI]	SE_B	B	BF_{incl}	*B* [95% CI]	SE_B	β	BF_{incl}
DT fluency								
Autism	−0.04 [−0.68, 0.59]	0.35	−0.01	0.17	−0.01 [−0.04, 0.02]	0.02	−.05	0.23
ADHD	0.94 [0.00, 1.97]	0.49	0.13	0.96	0.02 [−0.00, 0.05]	0.01	.10	0.56
General cognitive ability	0.13 [0.05, 0.20]	0.04	0.17**	4.31	0.11 [0.03, 0.18]	0.04	.13*	2.42
Sex	−0.24 [−0.84, 0.37]	0.31	−0.05	0.16	−0.23 [−0.80, 0.37]	0.30	−.04	0.18
Age (years)	0.04 [0.01, 0.07]	0.02	0.17**	5.75	0.05 [0.02, 0.07]	0.01	.16**	6.37
DT flexibility								
Autism	0.25 [−0.22, 0.70]	0.25	0.07	0.46	0.00 [−0.02, 0.02]	0.01	.02	0.26
ADHD	0.60 [−0.04, 1.25]	0.34	0.12	1.87	0.01 [−0.01, 0.03]	0.01	.07	0.54
General cognitive ability	0.11 [0.05, 0.17]	0.03	0.21**	40.32	0.10 [0.06, 0.16]	0.03	.19***	82.98
Sex	0.00 [−0.41, 0.42]	0.22	0.00	0.13	−0.14 [−0.54, 0.25]	0.20	−.03	0.16
Age (years)	0.04 [0.02, 0.07]	0.01	0.23***	144.59	0.04 [0.02, 0.06]	0.01	.20***	186.18
DT originality								
Autism	−0.00 [−0.19, 0.18]	0.10	−0.00	0.14	−0.01 [−0.02, −0.00]	0.00	−.13*	0.35
ADHD	0.09 [−0.17, 0.35]	0.14	0.05	0.21	0.01 [0.00, 0.01]	0.00	.13*	0.38
General cognitive ability	0.01 [−0.01, 0.04]	0.01	0.07	0.22	0.02 [−0.00, 0.04]	0.01	.09	0.40
Sex	−0.01 [−0.18, 0.15]	0.09	−0.01	0.13	0.00 [−0.15, 0.16]	0.08	.00	0.12
Age (years)	0.01 [−0.00, 0.01]	0.00	0.08	0.31	0.01 [−0.00, 0.01]	0.00	.10	0.44
Creative achievements								
Autism	0.09 [−0.03, 0.22]	0.06	0.10	0.95	−0.00 [−0.01, 0.00]	0.00	−.02	0.23
ADHD	0.19 [0.00, 0.37]	0.08	0.15*	3.69	0.01 [0.00, 0.01]	0.00	.18**	22.43
General cognitive ability	0.02 [0.00, 0.03]	0.01	0.15*	2.64	0.02 [0.00, 0.03]	0.01	.12*	2.50
Sex	−0.02 [−0.13, 0.08]	0.05	−0.03	0.14	−0.02 [−0.11, 0.07]	0.05	−.02	0.14
Age (years)	−0.00 [−0.01, 0.00]	0.00	−0.07	0.38	−0.00 [−0.01, 0.00]	0.00	−.08	0.71
Creative behaviors								
Autism	1.25 [−0.28, 2.79]	0.73	0.11	0.94	−0.02 [−0.07, 0.04]	0.03	−.03	0.20
ADHD	3.42 [1.07, 5.88]	1.02	0.23**	55.63	0.12 [0.07, 0.17]	0.03	.27***	15,237.72
General cognitive ability	0.07 [−0.10, 0.24]	0.09	0.05	0.20	0.02 [−0.13, 0.17]	0.08	.01	0.17
Sex	−0.66 [−1.99, 0.64]	0.64	−0.06	0.22	−0.42 [−1.59, 0.71]	0.59	−.04	0.16
Age (years)	−0.03 [−0.09, 0.04]	0.03	−0.05	0.21	−0.03 [−0.09, 0.03]	0.03	−.05	0.28
Creative personality								
Autism	−0.31 [−1.27, 0.68]	0.51	−0.04	0.15	−0.06 [−0.10, −0.01]	0.02	−.16**	4.40
ADHD	0.46 [−1.15, 2.13]	0.71	0.05	0.21	0.01 [−0.03, 0.05]	0.02	.04	0.21
General cognitive ability	0.02 [−0.11, 0.15]	0.06	0.02	0.15	0.01 [−0.10, 0.12]	0.06	.01	0.18
Sex	0.61 [−0.29, 1.51]	0.45	0.08	0.35	0.46 [−0.32, 1.24]	0.41	.06	0.20
Age (years)	−0.01 [−0.05, 0.04]	0.02	−0.02	0.15	−0.00 [−0.04, 0.04]	0.02	−.01	0.18
Creative self-efficacy								
Autism	−0.24 [−1.24, 0.74]	0.50	−0.03	0.14	−0.04 [−0.09, −0.00]	0.02	−.14[a],*	1.22
ADHD	0.62 [−0.90, 2.14]	0.70	0.06	0.24	0.01 [−0.03, 0.04]	0.02	.03	0.20
General cognitive ability	0.00 [−0.11, 0.12]	0.06	0.00	0.15	0.03 [−0.08, 0.12]	0.05	.03	0.17
Sex	1.18 [0.30, 2.08]	0.44	0.16**	4.84	0.84 [0.11, 1.60]	0.38	.12*	1.14
Age (years)	0.03 [−0.01, 0.07]	0.02	0.09	0.41	0.03 [−0.01, 0.06]	0.02	.07	0.31

Note. In Analysis 1, autism and ADHD were measured as clinical diagnoses (1 = *diagnosis*, 0 = *no diagnosis*). In Analysis 2, autism and ADHD were measured as autistic and ADHD traits, using the AQ (Baron-Cohen et al., 2001) and Adult ADHD Self-Report Scale (Kessler et al., 2005), respectively. Sex was measured as sex at birth with *male* = 1, *female* = 0. ADHD = attention-deficit/hyperactivity disorder; 95% CI = percentile bootstrapped confidence intervals 5,000 resamples; BF_{incl} = Bayes factor of inclusion; DT = divergent thinking.
[a] Robust regression analyses produced the same pattern of results, with one exception, where the result was no longer statistically significant (see the online supplemental materials).
* $p < .05$. ** $p < .01$. *** $p < .001$.

Robustness Checks

Robust Regressions

To ensure the robustness of our reported results, bootstrapped analyses and robust regression analyses (see the online supplemental materials) were conducted. These analyses showed a similar pattern of results.

Replication of Analyses Using More Stringent Inclusion Criteria

Consistent with other large-scale autism research studies, it was not possible to conduct independent clinical assessments to confirm autism diagnoses (e.g., Autism Diagnostic Observation Schedule; Lord et al., 2000). Without such assessments, it could be argued that our results were due to poorly defined groups. To determine the sensitivity of our results to different inclusion criteria, we reanalyzed our data using well-established AQ score thresholds (Baron-Cohen et al., 2001) as additional inclusion criteria to define the autistic and nonautistic groups. Specifically, the autistic group comprised only individuals who scored ≥32 (i.e., the "clinical" threshold), and the nonautistic group comprised individuals scoring <26 (i.e., the "screening" threshold). These thresholds were chosen as they are considered the most stringent and therefore inspire the most confidence in our definition of our autistic and nonautistic groups.

After applying the inclusion criteria, the autistic ($n = 128$) and nonautistic ($n = 147$) groups still did not differ in age, sex (at birth), and general cognitive ability (Table 2 in the online supplemental materials). As expected, the autistic group reported significantly more autistic and ADHD traits. Replicating the *t* tests and regressions, we found the same pattern of results as the analyses conducted with the full sample. That is, where the autistic and nonautistic groups showed differences on the creativity measures, these differences were accounted for by ADHD (see Tables 3 and 4 in the online supplemental materials).

Discussion

This study compared autistic and nonautistic adults on a range of widely used and well-validated creativity measures, to gain a comprehensive understanding of autism-related creativity. Overcoming various limitations in previous research, this study was the first to compare creativity in diagnosed autistic with nonautistic adults, while also accounting for general cognitive ability and ADHD. We found that autistic and nonautistic people performed comparably in terms of DT; however, autistic people reported greater engagement in real-world creative behaviors and more creative accomplishments. Critically, however, after accounting for ADHD, autism was no longer predictive of creativity on these measures. Rather, the results revealed a pattern whereby ADHD was more predictive of creativity than autism. Overall, our results suggest that enhanced creativity may only be apparent in a subgroup of the autistic population with co-occurring ADHD.

Our findings in relation to DT are in contrast with previous research exploring associations between autistic traits and performance on DT tasks (Best et al., 2015; Jankowska et al., 2019). We did not find evidence that autism was associated with a diminished ability to produce ideas (fluency) or enhanced originality. In fact, Bayesian analyses indicated the data provided much more evidence in support of the null, than alternative, hypothesis. One explanation for the inconsistency with previous research could be that our groups were well matched on general cognitive ability, which was not measured or accounted for in the previous studies. Indeed, consistent with previous research (Gerwig et al., 2021), general cognitive ability was highly predictive of fluency across our sample. While no differences in the DT performance of autistic and nonautistic people were observed, it remains possible that autistic people may have achieved similar performance through alternative neurocognitive compensatory mechanisms (Livingston & Happé, 2017). For example, when generating ideas, autistic individuals may draw more on domain-specific knowledge relating to special interests, to make novel associations with incoming information. In the future, exploring potential group differences in underlying neurocognitive mechanisms may be valuable to ascertain if there are certain contexts where autistic people do demonstrate greater creativity than nonautistic people (e.g., exploring if autistic people are more creative when generating ideas pertaining to their areas of special interests).

Until now, self-report questionnaire measures have not been used to explore creativity in clinically diagnosed autistic populations. Our novel findings of enhanced creative accomplishments and behaviors in autism offer the first quantitative insights into the real-world creativity of autistic people. Our findings suggest autistic people may have strengths in aspects associated with creativity, aside from idea generation (e.g., refining and producing creative products). This finding supports and provides more robust quantitative evidence for previous qualitative literature where autistic people have cited creativity as an autistic strength (e.g., Russell et al., 2019). Critically, however, exploratory analyses revealed enhanced creativity was fully accounted for by ADHD, suggesting strengths in creativity may only be characteristic of subgroups in the autistic population with co-occurring ADHD or elevated ADHD traits. Arguably, previous inconsistencies in autism-related creativity research in both adulthood (e.g., Constable et al., 2018; Kasirer & Mashal, 2014) and childhood (e.g., Kasirer et al., 2020; Liu et al., 2011), may be entirely explained by the unmeasured ADHD in these studies. More generally, our findings add a clear example to a growing body of work (e.g., Hargitai et al., 2023), evidencing the critical need for cross-condition research, which better accounts for the overlap between autism and ADHD. Such research is necessary to understand condition-specific and cross-condition effects, which are overlooked when autism and ADHD are studied in isolation.

Our findings of associations between ADHD and enhanced creative achievements and behaviors are consistent with research in ADHD populations (e.g., Boot et al., 2020; Hoogman et al., 2020). Understanding the clinical features of ADHD that contribute to these associations will be an important next step. Given that autism without ADHD was not associated with enhanced creativity, clinical features common to both ADHD and autism (e.g., some social and executive function differences; Antshel & Russo, 2019; Farhat et al., 2022; Kushki et al., 2019) are likely to make limited contributions to enhanced creativity. Rather, clinical features unique to ADHD, such as impulsivity, are likely to be more relevant. Boot et al. (2020), for example, suggested that heightened extrinsic motivation for real-world creative achievements may be associated with atypical reward processing and impulsivity uniquely characteristic of ADHD. Many other unexplored features of ADHD may also be implicated. For instance, ADHD is linked to mind wandering (Bozhilova et al., 2018; Mowlem et al., 2019) which, in non-ADHD populations, is thought to be conducive for creative thought (e.g., Preiss et al., 2016). Thus, it may be interesting to conduct further research, facilitated by novel measures of mind wandering (Mowlem et al., 2019), to explore whether such processes contribute to enhanced creative achievement and behaviors in ADHD. More generally, it would be fruitful to explore the full creative lifecycle used by individuals with neurodevelopmental conditions. The process of generating an idea and engaging behaviors to produce a creative outcome or accomplishment requires engagement of multiple processes that may generalize outside of the creative domains. For instance, sustained effort, deliberate practice to develop expertise, and organization capabilities are all likely involved in the generation of more sophisticated creative products over time (e.g., Ericsson et al., 1993). Understanding any differences in these capabilities or compensatory mechanisms engaged will ultimately further elucidate mechanisms that contribute to creativity more generally, and thus shed light on how creativity may also be enhanced or impaired in both clinical and nonclinical populations.

Both the measures of creative achievements and behaviors in this research required participants to indicate their completion of specific, observable creative accomplishments and behaviors. This was particularly advantageous as it did not require individuals to make subjective assessments of their own creative abilities. Autistic individuals may otherwise find such subjective assessments particularly challenging due to difficulties with metacognition (e.g., Brosnan et al., 2016). Similarly, some individuals with ADHD have also been shown to demonstrate a positive illusory bias (e.g., Crisci et al., 2022, Volz-Sidiropoulou et al., 2016) which is a tendency to overestimate one's abilities. Therefore, our choice of creativity measures is also likely to have guarded against the potential effect of this bias influencing the current pattern of results.

Despite higher creative achievement and behaviors in the autism group, albeit due to co-occurring ADHD, there were no observed differences between autistic and nonautistic adults in creative self-efficacy, that is, subjective assessments of their own creative abilities. This suggests autistic individuals may underestimate their creative abilities, not appreciating their heightened creative accomplishments relative to others. Indeed, this was despite a potential positive bias expected due to the higher rates of ADHD in the autism group. This might be driven by the possibility that autistic adults show lower levels of self-efficacy and self-esteem more generally (e.g., Lorenz & Heinitz, 2014; Newark et al., 2016), and difficulties in accurately predicting their performance on tasks in other domains (e.g., decision making; Sahuquillo-Leal et al., 2020; Taylor et al., 2022). Given our findings, we speculate that neurodivergent people may need additional support to help identify their strengths and abilities which will in turn promote self-efficacy. Such support, in line with recent advancements away from deficit-orientated approaches to autism (Pellicano & den Houting, 2022), may have considerable potential to improve individuals' quality of life. Indeed, recent research in autistic adults has shown that identifying one's strengths and increasing their use is highly related to positive outcomes, including quality of life, subjective well-being, and fewer anxiety and depressive symptoms (Taylor et al., 2023). In light of our findings on ADHD, it would also be valuable to explore how estimation of one's own abilities varies across different and co-occurring neurodevelopment conditions, to determine if more populations may also benefit from such support.

This study has wider implications, speaking to the importance of robust empirical testing of autistic and neurodivergent strengths. This includes the use of clinical samples and measurement of co-occurring conditions, for a better understanding of the strengths of clinical populations and within-population variability. It is likely that other putative autistic strengths, identified in qualitative literature and not yet rigorously explored with quantitative research (e.g., hyperfocus; Russell et al., 2019), may well be due to co-occurring conditions. Widespread integration of poorly evidenced strengths into clinical practice and promotion of such strengths in the media may cause more harm than benefit to those who may not possess enhanced abilities in that domain. Instead, better characterizing the strengths of subgroups of the autistic population may offer a more precise and targeted approach to strengths-based interventions. Indeed, our findings suggest that clinical and educational interventions, as well as employment strategies, grounded on autistic strengths in creativity may perhaps benefit a sizable subgroup of the autistic population (e.g., around 20%–30% with co-occurring ADHD) but not others. Consequently, we suggest that until such research is conducted, a more nuanced approach is taken to understanding autism-related strengths pertaining to creativity, whereby strengths are identified at an individual level to avoid making inaccurate generalizations regarding the autistic population (see also, Taylor et al., 2023).

While our research has many strengths, including the use of multiple measures of creativity, large samples, and well-powered preregistered analyses, there are limitations to be addressed. First, we could not conduct independent diagnostic assessments to confirm autism or ADHD diagnoses. Instead, we were reliant on self-reported diagnoses and traits. Mitigating this concern, it is important to emphasize that we consistently found the same pattern of results across dimensional and diagnostic classifications of autism and ADHD, and replicated our analyses with more stringently defined autistic and nonautistic groups (based on AQ thresholds—see the Robustness Checks section). Nonetheless, a replication of our results in a study with a more in-depth protocol for confirming both autism and ADHD diagnoses (e.g., via the Autism Diagnostic Observation Schedule; Lord et al., 2000) would be valuable in future research. Second, we used a verbal DT task. This is the best validated and most widely used cognitive measure of creativity and it has previously been used in neurodiversity-related creativity research (e.g., Best et al., 2015). However, verbal and nonverbal (i.e., figural) DT tasks potentially engage different neurocognitive processes (e.g., Chen et al., 2019). Therefore, it is possible that autistic people, especially those with limited verbal skills, may perform differently on nonverbal tasks. Further research is required to determine if our pattern of results holds when nonverbal creativity tasks are administered. It would be of interest to systematically investigate creativity in autistic people with different levels of verbal and nonverbal skills. Due to the nature of the study design and recruitment, it is likely we did not recruit autistic participants with co-occurring intellectual disability. This is further suggested by the similarity in the intellectual ability of the autistic and nonautistic groups, despite far higher rates of intellectual disability in autistic populations (Loomes et al., 2017). As such, our research findings cannot be generalized to this subgroup of the autistic population. Finally, we did not collect data on race, ethnicity, and gender identity, Measuring and accounting for these variables may therefore be valuable in future research on creativity in autism and ADHD.

Conclusion

In summary, following methodological advancements in previous research, we present evidence that enhanced creativity, where observed in autism, is fully explained by co-occurring ADHD. This challenges previous speculation that creativity is a fundamental strength linked to autism that should be incorporated into strengths-based clinical, educational, and occupational interventions to support autistic adults. Rather, it perhaps presents a strength that can be targeted for a specific subgroup of the autistic population—those with co-occurring ADHD and/or heightened ADHD traits. As a result, this work demonstrates the importance of further cross-condition research to understand the specificity of potential strengths associated with neurodevelopmental conditions. This is critical to ensure strength-based approaches in clinical science are grounded in empirical evidence.

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