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Autism and gambling: A systematic review, focusing on neurocognition

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ABSTRACT

Autism spectrum disorders (hereafter autism) are prevalent and often associated with elevated rates of substance use disorders. A subset of people who gamble develop gambling disorder, which is functionally impairing. Characterization of relationships between autism and gambling, particularly as relates to cognition, may have important implications. We conducted a systematic review of the literature. Nine out of 343 publications were found eligible for inclusion. Most studies examined decision-making using cognitive tasks, showing mixed results (less, equivalent or superior performance in autistic people compared to non-autistic people). The most consistent cognitive finding was relatively slower responses in autistic people on gambling tasks, compared to non-autistic people. One study reported a link between problem gambling and autism scores, in people who gamble at least occasionally. This systematic review highlights a profound lack of research on the potential neurocognitive overlap between autism and gambling. Future work should address the link between autism and behavioral addictions in adequately powered samples, using validated tools.

1. Introduction

Autism is a neurodevelopmental disorder defined by deficits in social reciprocity and by restricted and repetitive behaviors (American Psychiatric Association, 2000; Lord, Cook, et al., 2000). The Diagnostic and Statistical Manual Version 5 (DSM-5) uses the term 'Autism Spectrum Disorder' and includes symptoms such as deficits in social emotional reciprocity, nonverbal communicative behaviors used for social interaction, and the development and maintenance of relationships (American Psychiatric Association, 2013). We recognize there is no universally accepted agreement on phraseology; however, for the purposes of this paper, we use the term 'autistic people' to refer to individuals with Autism Spectrum Disorder (ASD), because identity first language has advantages and is preferred by a variety of stakeholders including autistic adults, family members and their friends (Kenny et al., 2016). When referring to autism-related symptoms we use the diagnostic term 'ASD' in accordance with the current psychiatric classification system (DSM-5).

Symptoms of ASD usually begin early in life but diagnosis of ASD may come much later during adolescence or adulthood (Baxter et al., 2015; Lauritsen, 2013). Depending on definition and age range considered, it has been estimated that ASD affects around 0.8 % of people (Baxter et al., 2015).

One approach towards understanding putative overlap between autism and gambling may be to consider findings from studies using validated neurocognitive tasks. For example, autistic people often report difficulties making the best decision when faced with uncertainty (Luke et al., 2012; Fujino et al., 2017). Compared to non-autistic people, some autistic people find aspects of decision-making challenging: stress, overthinking, information overload or concern that they will be

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perceived as "autistic" may contribute, making it harder to make optimal decisions (Luke et al., 2012). Links between ASD and candidate behavioral addictions have proved to be inconclusive (Kervin et al., 2021) however it has been hypothesized that gambling related behaviors might be an area in which autistic people display different tendencies to non-autistic people (Wu et al., 2018). The need for perfection (Bolton, 2004); but see also Greenaway and Howlin (2010) could also lead to problems on objective neurocognitive tasks examining decision-making but also other executive functioning domains (e.g. planning). Within this review, we therefore assess relationships between ASD and gambling alongside any resultant etiological, biological and clinical implications, with a particular focus on validated neurocognitive tasks.

Gambling refers to situations whereby something of value (such as money, items, or points on a neurocognitive task) is put forward at risk, with the prospect of then obtaining some reward (e.g. see Bloch, 1951; Clark, 2010; Potenza et al., 2002). Gambling disorder is the only recognized behavioral addiction in the DSM-5 (see American Psychiatric Association, 2013 and it is generally more extensively researched than other candidate conditions that may be considered behavioral addictions. In the UK, current policy facilitates a particularly permissive gambling landscape (Sharman et al., 2021) and harms associated with gambling in England are estimated to cost society at least £1.27 billion [US$1.66 billion] per year (Public Health England, 2021). It is estimated that 0.5 % of the population have gambling disorder and 3.8 % gamble at at-risk levels (i.e. have some degree of subsyndromal gambling disorder) (Public Health England, 2021) yet there is a scarcity of research into gambling-related harms (Bowden-Jones et al., 2022).

There has been much research on contributing factors to compulsive and addictive behaviors such as gambling disorder (see Chamberlain et al., 2016), however little is known about how they might coincide with behavioral characteristics of autistic people (for example autistic traits and other co-occurring disorders [such as attention-deficit hyperactivity disorder, ADHD]; Grant and Chamberlain, 2021). A history of ADHD is associated with more severe gambling symptomatology (Brandt and Fischer, 2019; Silbernagl et al., 2019) and an increased probability of developing gambling disorder (Botterill et al., 2016; Jacob et al., 2018). This has resulted in recommendations for the treatment of gambling disorders alongside psychiatric comorbidities (Petry et al., 2005; Silbernagl et al., 2019) and the need for increased clinical recognition of autistic tendencies, which can co-occur with ADHD (Grant and Chamberlain, 2021). Examination of neurocognition could provide new insights into mechanisms that may help to account for any comorbid overlap. For example, cognitive deficits have previously been identified in people with ADHD and in people with gambling disorder, including on decision-making tasks (e.g. see Mowinckel et al., 2015; Ioannidis et al., 2019). Closer scrutiny of evidence pertaining to ASD, compulsive and addictive behaviors is additionally required given that phenomenologically they can share similarities in terms of impaired self-control, preoccupation with repetitive activities and habits, often at the expense of personal relationships and other aspects of life (Chamberlain et al., 2017; Ioannidis et al., 2016; Fineberg et al., 2018). In a prior meta-analysis, interestingly, autism was not associated with impairment on the Iowa Gambling Task (Zeif and Yechiam, 2020). However, the prior paper – while valuable – had a very specific focus on just one neurocognitive task.

Therefore, the aim of this paper was to conduct a systematic review of studies that have explored links between ASD and gambling, with a primary focus on objective neurocognitive tasks.

2. Methods

A literature search was conducted using PubMed in June 2021 using the search string: ((Autis*) OR (Asperger*) OR (child development* disorder*) OR (pervasive development*) OR (infantile-autis*) OR (Kanner-syndrom*) OR (neurodevelopment*) OR (Child Development Disorders, Pervasive[MeSH Major Topic])) AND ((Gambl*) OR (Bet*) OR (casino*) OR (slot machine*) OR (lotter*) OR (bingo) OR (poker) OR (scratch ticket*) OR (scratch card*) OR (electronic gaming machine*) OR (craps) OR (roulette) OR (blackjack) OR (Gambling[MeSH Major Topic])). The search string was developed based on adaption from prior work (Matheson et al., 2019; Moon et al., 2020), and through modifications and consensus of the current paper authors. The search was re-conducted in June 2022 to identify any further papers manually, in view of a gap between the first search and the publication date.

Screening for literature exploring ASD and gambling was conducted in two stages. In the first stage, an initial title and abstract screen was conducted. In the second stage, copies of the papers were obtained and read. The inclusion criteria were that papers tangibly examined the overlap between ASD (or autistic traits) and gambling, in the opinion of the study team, with a primary focus on validated neurocognitive tasks or related metrics (e.g. trait impulsivity or compulsivity). Key findings were extracted and presented in summary form. In the case of any disagreements regarding whether papers were in scope, these were resolved via discussion and consensus amongst the study team as a group.

3. Results

Findings from the initial literature search are presented in Fig. 1. In total 343 initial articles were identified in PubMed, with nine being retained for final inclusion. An overview of the nine studies is provided in Table 1. These studies were conducted in the United Kingdom or the United States of America, except for one, which was conducted in China. The majority of studies examined aspects of decision-making, typically comparing autistic people to non-autistic people, on tasks such as the Iowa Gambling Task or Cambridge Gamble Task. Decision-making findings were inconsistent, with some reporting group differences, some impairment in autistic people, and some better performance in autistic people, compared to non-autistic people. Only four studies (44.4 %) had samples of at least 26 people per group of interest, this being the minimum sample size required to detect an effect of large magnitude (Cohen's D 0.8 or higher) with at least 80 % power and alpha = 0.05, using a conventional t-test. Smaller samples have elevated risk of false positives and false negatives (type 1 and type 2 errors) (Ioannidis, 2005; Button et al., 2013).

Wu et al. (2018) recruited 33 autistic people with 47 non-autistic people from a recruitment database (Institute of Cognitive Neuroscience). All were adults aged 18–70 years, and had no history of visual, motor, or hearing impairments. ASD diagnoses were made by clinicians against standard diagnostic criteria and involved the use of structured instruments such as the Autism Diagnostic Observation Schedule (Lord, Risi, et al., 2000; Lord et al., 2012). The groups were well matched in terms of age, gender, and IQ; and all had an IQ > 80. Participants undertook a gambling task involving decisions about choosing between a risky option and a sure option of winning different imaginary monetary amounts. There was no indication that the task had been validated, and the study did not psychometrically validate the task in this population. There was some evidence that autistic people had higher repetitive tendencies on some trial types, as indicated by a complex three-way interaction term being significant, and follow-up post-hoc tests. There was a significant main effect of group on task reaction times, due to autistic people responding significantly slower than non-autistic people. Effect sizes were not reported.

Hosozawa et al. (2021) examined decision-making in adolescents using data from the millennium Cohort Study – this is a population-representative UK cohort study of around 20,000 children (original sample size) being followed up over time. Children completed the previously extensively validated computerized Cambridge Gambling Task (CGT) when they were aged 11 and/or 14 years. The authors defined two groups: those whose parents reported their child had been diagnosed with ASD by a health professional, and those whose parents

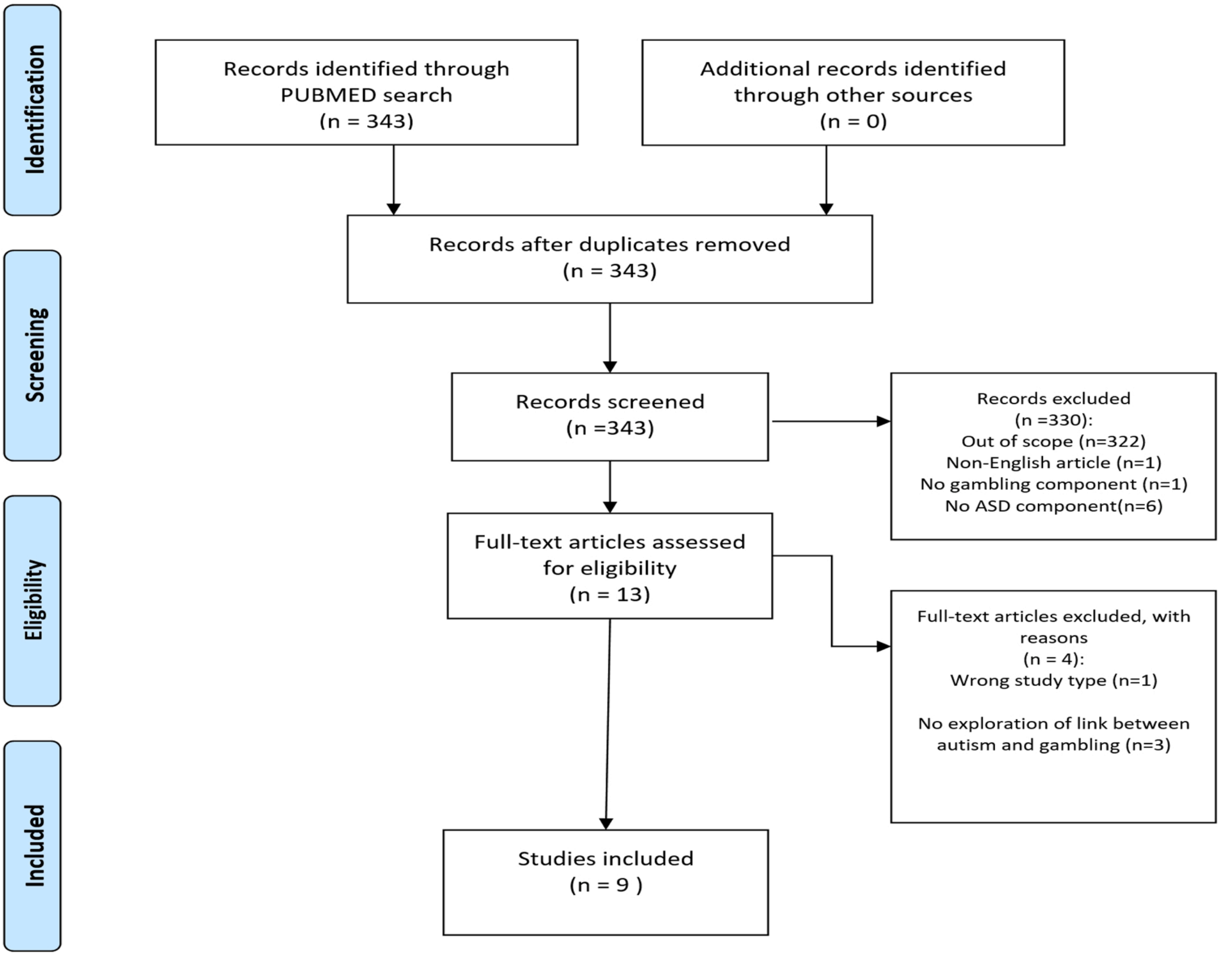

Fig. 1. PRISMA diagram showing results of the systematic literature search.

reported this had not been the case. As such the groups were not defined based on diagnostic criteria or rigorous instruments but rather retrospective recall. The sample size in the analysis was 270 autistic children and 9713 non-autistic children. The non-autistic group was defined based on a negative response to the autism question but also not having a history of accessing special educational needs education, nor having learning disabilities, social or behavioral difficulties, or neurological impairments. Also, any child for whom a parent reported an ADHD diagnosis was excluded from both groups. Potential confounding variables, such as age, sex, parental education level, socioeconomic disadvantage, and general cognitive ability were covaried in their analyzes. In regression modeling, the autistic people had significantly worse performance on the task as indexed by decision-making as well as deliberation times, compared to non-autistic people. However, only the link with slower deliberation times remained significant when controlling for the potential confounders. Effect sizes were not reported although beta weights could be interpreted roughly as being of generally small effect size.

Vella et al. (2018) recruited 38 autistic people and 40 non-autistic people with no family history of ASD, aged 16–65 years. Autistic people were recruited through volunteer databases and autism support organizations; and non-autistic people via local advertisements and word of mouth. Diagnoses were made using rigorous procedures including clinical interviews combined with validated structured tools such as the Autism Diagnostic Interview-Revised (Le Couteur et al., 2003). Decision-making was assessed using the previously extensively validated Iowa Gambling Task (IGT) and Cambridge Gambling Task (CGT). The autistic people had significantly higher levels of anxiety and depression than non-autistic people, and levels were statistically controlled for when there was a significant relationship with the outcome measure of interest. On the IGT, autistic people performed better than non-autistic people in terms of the selections from advantageous decks; this was especially apparent on the final block of trials. On the CGT, autistic people performed worse than non-autistic people: they selected the most logical choice less often (worse quality of decision-making) and had slower response times. Effect sizes were not reported. No group differences were found on an Information Sampling task, which measures the tendency to collect information before making a decision. Because both Iowa and Cambridge Gamble are underpinned by similar cognitive circuitry, performance in opposite directions cannot be easily reconciled in terms of an interpretable profile.

Grant and Chamberlain (2021) examined a sample of 102 young adults aged 18–29 years who gambled at least occasionally in the past year. The data were collected as part of a wider body of work examining gambling over time in young people. The authors examined correlations between autism scores (AQ-10, Allison et al., 2012) and several gambling-relevant metrics: first, the number of diagnostic criteria met for gambling disorder (based on the Structured Clinical Interview for Gambling Disorder, SCI-GD); and second, performance on the computerized CGT. Higher autism scores were significantly associated with higher levels of gambling disorder symptoms (correlation $r = 0.24$) but not with performance on the CGT. The significant link between autism scores and gambling disorder symptoms was thus of small-to-moderate effect size. Higher autistic traits were also significantly associated with higher impulsivity (including ADHD tendencies and Barratt Impulsivity Scale scores; small-medium effect size), higher rates of

Table 1
Summary of relevant studies identified in the literature search.

Authors	Country	Participants and measure(s)	Key findings
(Johnson et al., 2006)	USA	15 autistic people vs 14 non-autistic people, adolescents/young adults: Iowa Gambling Task. Recruitment strategy not stated	No group differences on selection of advantageous decks; more frequent behavioral shifts in autistic people.
(Lin et al., 2012)	USA	10 autistic people and 10 non-autistic people: instrumental learning task with monetary and social rewards. Recruitment strategy not stated	Similar performance between groups
(Faja et al., 2013)	USA	21 autistic people vs 21 non-autistic people, young children: gambling task. Recruited as part of a larger study through registries, flyers, mailing etc.	No group differences on selection of advantageous decks. ASD associated with increased EDR during feedback about winnings.
(Mussey et al., 2015)	USA	15 autistic people (high functioning), 18 non-autistic people: Iowa Gambling task. Recruited from University of Alabama ASD clinic	Autistic people made fewer choices of advantageous card decks as task progressed; more likely to switch decks; vs non-autistic people.
(Chen et al., 2021)	China	22 autistic people vs 22 non-autistic people (from pool of 824), young adults: modified Iowa gambling task with EEG. Recruited from Anhui Medical University undergraduates	Autistic people more likely to select high-risk options, interpreted as less likely to realize importance of social reward feedback and/or slower learning rates, vs non-autistic people
(Wu et al., 2018)	UK	33 autistic people vs 47 non-autistic people, adults: Gambling test. "TD participants were volunteers recruited from the Institute of Cognitive Neuroscience subject database. ASD participants were invited and screened by licensed clinicians"	No group differences in risk-taking; autistic people had slower decision-making vs non-autistic people.
(Hosozawa et al., 2021)	UK	270 autistic people vs 9713 non-autistic people, adolescents: Cambridge Gambling Task. "Participants were drawn from the Millennium Cohort Study, a population-representative cohort study of 19,517 children born between September 2000 and January 2002 in the UK"	Some evidence autistic people had longer deliberation time at aged 14 (but linked to higher well-being), compared to non-autistic people
(Vella et al., 2018)	UK	38 autistic people vs 40 non-autistic people: Iowa Gambling Task, Cambridge Gambling Task, and Information Sampling Task. Recruited from volunteer databases and word of mouth (2009)	Autistic people had better Iowa Gambling Task performance, but slower performance on the Cambridge Gambling Task, compared to non-autistic people. Autistic people sampled more information than non-autistic people.
(Grant and Chamberlain, 2021)	UK	102 people who gamble, young adults: AQ-10 correlations with cognitive tests and other measures. 'Recruited from the surrounding communities near two large Midwestern universities'	ASD traits correlated with disordered gambling, ADHD, trait impulsivity, some OCD symptoms.

obsessive-compulsive tendencies (small-medium effect size), and with lower quality of life (medium effect size). The relationship between AQ10 and gambling disorder symptoms remained significant in regression modeling, when ADHD symptoms were controlled for.

Only one further relevant paper was identified when the literature search was re-conducted in June 2022 (of 131 articles identified in the relevant period). Goris et al. (2020) recruited 161 participants aged from 18 to 50 for their study. AQ10 was used to assess the autistic traits and a gambling paradigm was developed by the researchers to examine decision-making. The authors did not find a correlation with gambling behavior and autistic traits but analyzes showed participants with elevated autistic traits appeared to be faster to choose the predictable deck.

4. Discussion

This is the first systematic review to examine the overlap between ASD/autistic traits and gambling, focusing primarily on neurocognition. We found a remarkable poverty of literature in this area, which is surprising given that ASD affects 0.8 % of people (Baxter et al., 2015); that approximately 50 % of the general adult population gamble; 3.8 % gamble at at-risk levels (Public Health England, 2021) and that gambling disorder affects 0.4–2 % of the general population (Hodgins et al., 2011). Importantly, problem gambling is considerably higher in young adults, with data indicating prevalence of around 10 % (Nowak and Aloe, 2014; Chamberlain et al., 2017). Also, it is worth noting that even higher percentages of people experience subthreshold problem gambling (i.e. meeting some but not all diagnostic criteria for gambling disorder) but still experience impaired quality of life and high rates of mental health comorbidities [e.g. approximately 30 % of people who gambled in one sample, when defined using latent class analysis (Chamberlain et al., 2017)].

Only four studies met the threshold of having at least 26 participants per study group of interest, which is the typical sample size minimally needed to even detect a large effect size group difference by a conventional statistical test. Smaller samples have elevated risk of false positives and false negatives (Ioannidis, 2005; Button et al., 2013). This may partly account for why the findings on decision-making tests were inconsistent (Table 1) although, findings were also inconsistent for studies with larger sample sizes than this threshold.

On validated decision-making cognitive tasks, notably the Iowa Gambling Task and Cambridge Gambling Tasks, there were conflicting results. One study reported superior performance in autistic people on one task, but worse performance on the other, compared to non-autistic people: findings that cannot be easily reconciled (Vella et al., 2018) given what is known about the neural underpinnings of these tasks. Another found impaired CGT in autistic people vs non-autistic people, but only the link with slower deliberation times remained significant after controlling for confounders (Hosozawa et al., 2021). This link was not explained by variance in spatial working memory, suggesting it may have been task-specific. Another study found no significant correlation between autism scores and performance on the CGT; however, the same study (Grant and Chamberlain, 2021) found that autism scores were correlated with the extent of problem gambling symptoms (i.e. gambling disorder symptoms), with small-medium effect size (see Table 2). The

Table 2
Correlations between autism scores (AQ10) and other variables, including problem gambling. Reprinted with permission from (Grant and Chamberlain, 2021). The study comprised people who gambled at least occasionally, and showed that AQ10 was significantly correlated with higher levels of problem gambling, ADHD symptoms, obsessive-compulsive symptoms, trait impulsivity, and with lower quality of life.

Against AQ total score	Pearson's correlations	
	Correlation	p value
Age, years	-0.133	0.181
Education level	-0.063	0.531
Dollars lost to gambling, past year	0.119	0.232
Nicotine Quantity (packs per day equivalent)	-0.102	0.329
SCI-GD Criteria, number endorsed	0.239	0.016*
PG-YBOCS	0.239	0.016*
ASRS	0.198	0.048*
BIS Attentional Impulsivity	0.231	0.019*
BIS Motor Impulsivity	0.109	0.275
BIS Non-Planning Impulsivity	0.110	0.27
Quality of Life score	-0.293	0.003*
PADUA contamination obsessions, washing compulsions	0.114	0.256
PADUA dressing/grooming compulsions	0.034	0.737
PADUA checking compulsions	0.199	0.045*
PADUA thoughts of harm to self/others	0.239	0.016*
PADUA impulses to harm self/others	0.147	0.142
PADUA Total scores	0.217	0.029*

AQ: Autism-Spectrum Quotient-10; SCI-GD: Structured Clinical Interview for Gambling Disorder; PG-YBOCS: Pathological Gambling Yale-Brown Obsessive-Compulsive Scale; ASRS: Adult ADHD Rating Scale; BIS: Barratt Impulsivity Scale; PADUA: Padua obsessive-compulsive symptom scale. * indicates significant at $p<0.05$.

study was conducted in a non-treatment seeking sample of young adults who gamble, recruited using community advertisements.

Overall, this systematic review found a lack of studies exploring links between autistic traits/ASD and gambling, in relation to neurocognitive processes. In a previous review focusing on behavioral addictions, only one publication (a conference abstract) relating to gambling disorder was identified (Kervin et al., 2021), again highlighting a poverty of research in this area.

We also found that there was some evidence linking autistic traits to higher levels of problem gambling, but only one study examined this using a validated problem gambling instrument. From a cognitive perspective, the studies reported inconsistent findings on primary task metrics for gambling (decision-making) paradigms: some studies indicating normal performance in autistic people, some impaired, and some superior to non-autistic people. The most consistent cognitive finding was of slower decision-making (i.e., longer time taken to make decisions, or increased latency to respond) in autistic people compared to non-autistic people – but again, this was not a consistent finding.

There are several limitations that should be considered. For necessary pragmatic reasons, this systematic review focused on the PubMed database and on English language papers; this may mean some literature has been overlooked. We did not include grey literature, because this often does not undergo appropriate peer-review. The study was not pre-registered. There are also limitations common to the data studies that were identified in this review. Small sample sizes and a lack of comprehensive cognitive assessment domains contribute to difficulty in interpretation of these results. The substantial variability in study design also meant that the use of Quality Assessment Scores (e.g. The Joanna Briggs Institute checklists), which assist in comparing studies of similar design, but do not provide an overall risk of bias score, were not used. In research areas where there is not yet a coherent body of evidence, such tools do not significantly enhance the assessment of studies (O'Neill et al., 2022). Future research should be adequately powered to reduce the risk of statistical errors, and report not only statistical p values but also effect sizes. Another limitation is that autism spectrum conditions are often under-identified in women and thus the findings may have included samples where women were under-represented. The available studies did not permit examination of effects of the nature of an activity on behavior; for example, cognitive task performance could be affected by whether someone is sitting at home on a telephone or computer as compared to situations such as laboratory-controlled conditions involving social interactions. Some clinical instruments (such as AQ10) are convenient but of course have their limitations as compared to using detailed structured in-person interviews. Lastly, the scope of the review was gambling and autism, with a particular focus on cognition, and as such this review does not comprehensively cover findings in other domains (e.g. rates of comorbidity).

In conclusion, the implication of this review is that further research is needed to better understand the potentially very important neurocognitive links between autistic traits/autism spectrum disorders and gambling, including as a function of gender. This needs to include cognition and compulsive and impulsive habit mechanisms (see Fineberg et al., 2018) as well as gambling behavior in the real world – both recreational gambling and problem gambling. Another implication of the review is that it would also be important to consider the influence of co-occurring conditions such as alcohol or substance use disorders on any reported findings.

Declaration of interest

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Data Availability

Not applicable.

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