Published in final edited form as:

Autism. 2018 October ; 22(7): 814–824. doi:10.1177/1362361317709603.

Hooked on a Feeling: Repetitive Cognition and Internalizing Symptomatology in Relation to Autism Spectrum Symptomatology

Elliot Gavin Keenan¹, Katherine Gotham², and Matthew D. Lerner¹

¹Stony Brook University

²Vanderbilt University

Abstract

Repetitive cognition, including rumination such as that seen in depression, has been shown to correlate with depression symptoms in both typically-developing individuals and individuals with autism spectrum disorder. Repetitive cognition is more common in autism spectrum disorder than in typically-developing peers, as is depression; thus, this study evaluated the role of repetitive cognition in the relation between autism spectrum symptomatology and depressive symptomatology. Two hundred typically-developing adults completed self-report questionnaires measuring autism spectrum symptomatology, different forms of repetitive cognition (general perseveration and depressive rumination), depression, and rejection sensitivity. Perseveration was found to mediate the relation between autism spectrum symptoms and depression, and to partially mediate the relation between autism spectrum symptoms and rejection sensitivity. We conclude that it is of vital importance to consider cognition when considering depression in autism spectrum disorder.

Keywords

Autism spectrum disorders; depression; repetitive cognition; rumination; perseveration; rejection sensitivity; broader autism phenotype

One of the two key symptom domains of autism spectrum disorder (ASD) is restricted and repetitive behaviors and interests (American Psychiatric Association, 2013). Typically, this category includes repetitive sensorimotor behaviors (performing the same action over and over) and language (saying the same words over and over), restricted interests (engaging with the same activities over and over), rigidity (inflexibility to change in routines and/or insisting things are done the same way each time), and ritualistic behavior (requiring actions to be done in a specific way; Carcani-Rathwell et al., 2006). Repetition of thoughts, in particular, extends beyond ASD symptomatology. Repetitive cognition is a tendency to perseverate on particular thoughts, often accompanied by difficulty disengaging with these

Address correspondence to: Matthew D. Lerner, Department of Psychology, Stony Brook University, Stony Brook, NY 11794-2500, 631-632-7660, matthew.lerner@stonybrook.edu.

Declaration of Conflict of Interests

EGK, KG, and MDL declare no conflicts of interest.

thoughts; repetitive cognition ranges from fixation on favorite topics or activities (whether actually doing these activities or merely thinking about them) to rumination, which is a perseveration on negative thoughts noted in typically-developing individuals with depression; Nolen-Hoeksema, 2000). Rumination, in particular, has been found to be correlated with some types of repetitive behavior seen in ASD, specifically those related to rigidity/IS behaviors (Carcani-Rathwell et al., 2006; Gotham et al., 2014); the nosological implications of this relationship in terms of classifying rumination in ASD are not yet well understood, though individuals with ASD do have a higher prevalence of rumination than typically-developing (TD) peers (Crane et al., 2013). This study endeavors to examine the relationship between repetitive cognition, depression, and ASD symptoms in a sample of college students.

In TD populations, repetitive cognition has shown correlations with depression (Nolen-Hoeksema, 2000). One might expect to see the same thing in ASD, and indeed, “insistence on sameness” (IS) behaviors and repetitive cognition in ASD both appear to be correlated with depressive symptoms in this special population as well (Gadow et al., 2012; Gotham et al., 2014; Crane et al., 2013). Depression, in turn, has been similarly found to be more prevalent in individuals with ASD than in TD peers (Buck et al., 2014). While the repetitive cognitions seen in ASD (rigidity, fixation on interests) may be developmentally distinct from those seen in TD peers (depressive rumination), it may function similarly to predispose an individual to depression. Therefore, repetitive cognition itself, even when an expression of ASD symptoms, may place an individual at risk for depression, just as rumination is a risk factor for depression in TD populations (Nolen-Hoeksema, 2000); if so, this might be one reason for the increased prevalence in this population.

Individuals with more ASD symptoms measured dimensionally may also demonstrate more repetitive behavior (Piven et al., 1997; Uljarevic et al., 2016) as well as more depression (Ingersoll et al., 2011), but this has rarely been studied. The present study aims to investigate whether differences in repetitive cognition may explain differences in depression seen in individuals with greater ASD symptoms.

Repetitive Behavior: Insistence on Sameness and Repetitive Sensorimotor Behavior

Restricted and repetitive behaviors and interests can be divided into two factors: the “repetitive sensorimotor” factor (RSM) and the “insistence on sameness” factor (IS; Bishop et al., 2013). RSM behaviors have shown inverse correlations with nonverbal IQ, whereas minimal relation has been observed between IQ and IS behaviors (Bishop et al., 2013; Troyb et al., 2016). Although repetitive behaviors are said to decrease with age overall, RSM behaviors seem to decrease with age at a greater overall magnitude and at a faster rate than IS behaviors (Chowdhury et al., 2010). For these reasons, IS behaviors have been suggested to be “higher-order” RRBs thought to be more specific to autism compared to developmentally-mediated RSM (Carcani-Rathwell et al., 2006). These findings suggest that IS behaviors transcend the spectrum of ASD (at least in terms of age and cognitive ability) in a way that RSM does not, thus supporting the idea that while these two types of repetitive

behavior share an element of repetition, they may be functionally and mechanistically distinct.

Again, rumination has shown correlations with IS behaviors in both children (Carcanti-Rathwell et al., 2006) and adults (Gotham et al., 2014) with ASD. Rumination and IS share a perseverative element; cognitive rigidity and perseverative thinking are generally considered to fall under the IS category of behaviors (Bishop et al., 2013). Though the distinct developmental trajectory associated with repetitive behaviors (Chowdhury et al., 2010) may differentiate perseverative thinking as defined in ASD (rigidity, restricted interests) from rumination as it develops in TD depression, it is not clear if or how these two forms of repetitive cognition are different on a functional level.

Increased Prevalence of Depression in ASD

As noted above, depression appears to be more prevalent in ASD than in TD populations (Buck et al., 2014). Depression has been found to correlate with IQ (Sterling et al., 2008) and age (Mayes et al., 2011) as well as IS behaviors (Gotham et al., 2014) in the ASD population. It is unclear if both IS and depression are independently correlated with higher IQ and greater chronological age (and thus correlated with each other), or if the two are more causally related.

The precise reasons accounting for the increased prevalence of depression seen in ASD are unclear. It has been historically posited that this increased prevalence of depression can be attributed to executive functioning deficits, a common history of social rejection, and growing awareness of differences from peers as cognitively-able individuals with ASD age into adulthood (Sterling et al., 2008). However, these factors are shared with individuals who have other neurodevelopmental disorders – individuals with ADHD, for example, may also widely experience impaired executive functioning skills (Boonstra et al., 2015), social deficits (Nijmeijer et al., 2008), and peer rejection (Hoza, 2007). Yet, there is some evidence to suggest that depression is more prevalent in ASD than it is in ADHD (Gadow et al., 2012). The challenges faced by cognitively-able adults with ASD and individuals with ADHD may be etiologically distinct and differentially severe, but their functional implications may be broadly similar (Nijmeijer et al., 2008).

Thus, it seems unlikely that the increased risk of depression seen in individuals with ASD is due to these shared factors (such as peer rejection and executive functioning deficits). Additional consideration of the specific cognitive factors that may place individuals with ASD at increased risk for depression is therefore warranted. There may be specific risk factors linked to ASD symptomatology, but through what mechanism might this occur?

Rejection Sensitivity

Another construct that may be associated with rumination is rejection sensitivity, which is an anxious preoccupation with perceived or expected interpersonal rejection (Pearson et al., 2010; Downey & Feldman, 1996). Interestingly, one longitudinal study of TD adults found that rejection sensitivity predicted later rumination, but that rumination did not predict later rejection sensitivity (Pearson et al., 2011). As rejection sensitivity is defined by this anxious

preoccupation, it may be considered another form of repetitive cognition centered on thoughts of rejection.

One study found that in TD women rejection sensitivity predicts depression related to interpersonal relationship difficulties, but not depression related to other (non-social) stressors (Ayduk et al., 2001). No known research has examined rejection sensitivity relative to ASD symptomatology. If depression in ASD is attributable to interpersonal difficulties, increased rejection sensitivity might be one factor that leads to increased depression risk in ASD.

Repetitive Cognition: Perseveration and Rumination

Repetitive cognition, regardless of content/focus, which is associated with the ASD phenotype, could produce affective states such as depression. Rumination and ASD-related perseverative cognition are not necessarily identical. While rumination is definitionally negative, repetitive cognition in ASD may be content-neutral; in this case, repetitive cognition in ASD may itself be a risk factor which predisposes people with ASD to developing depression, and thus these perseverations may also be correlated with depression regardless of content. Further, the individuals who are the most perseverative in general may perseverate most frequently on negative cognitions. Indeed, clinical characterizations do depict a parallel increase in general perseverative behavior alongside an increase in specifically depressive rumination in depressed individuals with ASD (Ghaziuddin et al., 2002), suggesting that in individuals with ASD generalized perseveration and negative perseveration are linked. Therefore, those individuals who have the most perseveration in a generalized sense may also be those who are the most vulnerable to developing depression (Gotham et al., 2014).

Hence, taken as a whole, the evidence suggests that it is necessary to investigate the relationships of perseveration and rumination as a potential mechanism that would explain the link between IS behaviors and depression.

Broader Autism Phenotype

The large sample sizes made possible by recruitment of nonclinical individuals (individuals spanning across the distribution of ASD traits) may enable the degree of power required to detect more subtle relations among variables, particular cognitive factors like repetitive cognition and depression. ASD symptoms seem to have a normal distribution in the population (Ruzich et al., 2015). The Broader Autism Phenotype (BAP), which refers to individuals who fit into the upper extreme of nonclinical ASD traits measured on a normal curve, is reported to be associated with increased repetitive behavior (Piven et al., 1997); however, this has largely been overlooked in research, which to date has focused almost exclusively on the social-communication aspects of the BAP (Uljarevic et al., 2016). In particular, there is some evidence for increased IS behaviors in BAP individuals, especially “intense preoccupations” (Uljarevic et al., 2016). There is also some evidence which suggests an increased prevalence of depression in the BAP (Ingersoll et al., 2011).

If it is true that the ASD phenotype implicates risk factors for depression (as opposed to depression being augmented solely by, for example, a history of peer rejection stemming from clinical social impairments; Sterling et al., 2008), the effect may also be visible in individuals with ASD traits measured dimensionally. Thus, an examination of the role of repetitive cognition in the relation between ASD symptomatology and depression is needed.

Present Study

This study aimed to clarify the nature of repetitive cognition in relation to ASD symptoms and depression symptoms. The following hypotheses were evaluated: 1) that a measure developed to quantify repetitive cognition trans-diagnostically would exhibit convergent validity in a large sample of TD adults regardless of ASD symptoms; 2) that in individuals with greater ASD symptoms, there would be greater convergence between trans-diagnostic repetitive cognition and an established measure of depressive rumination, thus illustrating an underlying proclivity to both forms of repetitive cognition in ASD; 3) that repetitive cognition would predict depression regardless of ASD symptoms, thus demonstrating that repetitive cognition is similarly associated with depression across the distribution of ASD symptoms, even if it otherwise functions differently across the TD-ASD distribution, per Hypothesis 2; 4a) that repetitive cognition would explain the relationship between ASD symptoms and depressive symptoms, and 4b) that repetitive cognition would also explain the relationship between ASD symptoms and rejection sensitivity, which is another internalizing construct, thus providing some evidence that this effect may not be limited to depression but may be applicable to multiple internalizing psychopathologies. Thus, we expect that individuals with greater ASD symptoms will show greater convergence between perseveration and rumination measures, that both forms of repetitive cognition will be associated with depression, and that perseveration will explain the relationship between ASD symptoms and depression or ASD symptoms and rejection sensitivity.

Method

Participants

Two-hundred typically-developing adults (see Table 1 for demographic information) were recruited through an online subject pool of university undergraduates at a large public university in the Northeastern United States. The mean age of participants in the subject pool was 20.43. All participants received class credit for participation and were given the option to enter into a raffle for a \$10 gift certificate. Participants had to be at least 18 years old, speak English fluently, and be currently enrolled undergraduates. Participants were asked several demographic questions, including estimated yearly household income.

Measures

ASD symptomatology.—The Autism Quotient (AQ; Baron-Cohen et al., 2001) was designed to measure ASD symptoms in adults with “high-functioning” ASD as well as typically developing adults; it takes a dimensional approach to measurement of ASD symptomatology. It is a 50-item self-report with each response rated on a 4-point Likert scale and incorporates several reverse-scored items. The maximum score is 50, with a

typical ASD cutoff of 32 (Baron-Cohen et al., 2001). Previous studies have reported moderate to high internal reliability, as well as good test-retest reliability (Baron-Cohen et al., 2001; Austin, 2005). Due to its relatively high sensitivity, it is an ideal instrument for capturing variation in ASD traits in the typically-developing population, and it has frequently been used in this capacity (Austin, 2005; White et al., 2011). In the present sample the AQ demonstrated fair Cronbach's alpha consistency ($\alpha = .78$), and it was used to measure ASD symptoms in typically-developing adults. By recruiting a large sample, study participants represented a broadly distributed range of ASD symptoms (at least in those without intellectual disability, as suggested by college matriculation).

Repetitive cognition.—The Perseverative Thinking Questionnaire (PTQ; Ehring et al., 2011) and Rumination Response Scale (RRS; Treynor et al., 2003) were used as measures of maladaptive repetitive cognition.

The PTQ was developed as a content-neutral measure of repetitive cognition (Ehring et al., 2011), therefore differentiating it from existing measures of depressive rumination such as the RRS. It is a 15-item self-report questionnaire with responses ranging on a five-point scale from “Never” to “Almost always”. The maximum score is 60. The PTQ has been reported to have excellent internal consistency as well as good convergent and predictive validity (Ehring et al., 2011). It has been used in patients with depression and anxiety.

The RRS is a standard measure of depressive rumination and has been reported to have high reliability and validity (Treynor et al., 2003). It is similar in structure to the PTQ, with 22 items and a four-point response scale ranging from “Almost never” to “Almost always”. The maximum score is 88. In the present sample, the RRS and the PTQ both demonstrated excellent internal consistency ($\alpha = .96$ and $\alpha = .96$, respectively). It was used to assess the convergent validity of the PTQ as a function of varying AQ scores.

Depression.—The Patient Health Questionnaire – 9 item version (PHQ-9; Kroenke et al., 2001) was developed as a brief inventory of depression symptoms. The PHQ-9 is used clinically to measure depression severity. It consists of 9 self-report items rated on a 4-point scale from “Not at all” to “Nearly every day”. The maximum score is 27. It has been reported to have good internal consistency, excellent test-retest reliability, and good construct and criterion validity (as measured by a structured interview by a mental health professional; Kroenke et al., 2001).

It demonstrated excellent internal consistency in the present sample ($\alpha = .90$). In the present study, the PHQ-9 was used as a measure of depressive symptomatology.

Rejection sensitivity.—In addition to depression, the present study examined rejection sensitivity as an outcome variable, measured by the Rejection Sensitivity Questionnaire (RSQ; Downey & Feldman, 1996). This questionnaire consists of 13 interpersonal scenarios for which the participant rates how likely the desired outcome is to occur (reverse-scored into rejection expectancy) and how anxious they are about the outcome (rejection concern), both on a six-point Likert scale. A score is then calculated for each situation by multiplying the rejection concern by the rejection expectancy, and these scores are averaged for the total

score. The RSQ has been reported to have good internal consistency, good test-retest reliability, and good validity (Downey & Feldman, 1996). For the 13 situation scores, internal consistency in the present sample was excellent ($\alpha = .92$).

Procedures

This study was approved by the University's institutional review board for human subjects research. Data collection was completed through administration of an online battery of questionnaires (including the AQ, PTQ, RRS, PHQ-9, RSQ, and TIPI). The study was described to participants as evaluating the usefulness of a questionnaire to measure repetitive cognition for the purpose of using it in future studies. Answers were collected electronically and linked only to a deidentified code, unless the participants opted to provide their email address for entry into the raffle.

Data Analytic Plan

In order to assess hypothesis 1, that the PTQ would exhibit convergent validity in the present sample, a multitrait-multimethod correlation matrix (Campbell and Fiske, 1959) was used to assess correlations between each of the measures. It was expected that high scores on the PTQ would be correlated most strongly with high scores on the RRS, the RSQ, and the PHQ-9, as well as high scores on the AQ. Fischer's r-to-z transformations was used to test these comparative effects.

In our evaluation of hypothesis 2, that the PTQ and the RRS would converge more strongly in high AQ individuals, moderated regression was used to assess whether the AQ would function as a moderator of the relation between the Rumination Response Scale and the PTQ, such that when the AQ score is high the correlation between the Rumination Response Scale and the PTQ becomes stronger. If so, this would provide support that in high-AQ individuals the PTQ and the RRS are interrelated.

Further, to assess hypothesis 3, that the PTQ would predict the PHQ-9 regardless of AQ score, multiple regression was used to assess the relationship between the PTQ and the PHQ-9 while controlling for AQ scores – thus potentially illustrating that the PTQ functions similarly across AQ scores. Effect sizes were calculated using kappa-squared (Preacher and Kelly, 2011).

Finally, to investigate hypothesis 4a, that differences in PTQ score would explain the relationship between higher AQ score and higher PHQ-9 score, a mediation model was employed examining the role of repetitive cognition as a mediator in the relationship between AQ score and depression symptoms on the PHQ-9. This would provide support that increased perseverative cognition explains the relationship between high AQ and increased prevalence of depression. Similarly, in our exploration of hypothesis 4b, that differences in PTQ score would explain the relationship between higher AQ score and higher RSQ score, the same mediation model was used with rejection sensitivity as measured by the RSQ in place of depressive symptomatology.

Results

Sixty-nine point five percent of study participants identified themselves as female (see Table 1). Household income was distributed almost uniformly across estimate ranges of \$30,000 increments. The most common range was \$30,000 a year and below; in contrast, relatively fewer participants fell into the \$30,000 to \$60,000 a year range. The average GPA was 3.1. The mean AQ (autism quotient) score was 18.68, higher than the reported average typically-developing population score of 16.4 ($t = 4.99, p < .001$; Baron-Cohen et al., 2001; see Table 1); AQ scores ranged from 4 (very few ASD symptoms) to 43 (with 4.5% of the sample at or above clinical cutoff). No difference in AQ score was observed by gender, $t(196) = .90, p = .37$. AQ correlated positively with RSQ (rejection sensitivity), PTQ (perseveration), PHQ-9 (depression), and RRS (rumination); all were medium effects, except for PHQ-9, which was a small effect (see Table 2).

In support of hypothesis 1, PTQ (perseverative thinking) exhibited large correlations with the RRS (rumination) and PHQ-9 (depression) and a medium correlation with RSQ (rejection sensitivity; see Table 2). Its correlation with AQ (autism quotient), while exhibiting a medium effect size, was weaker than its correlation with RRS, PHQ-9, and RSQ (all $z > 1.96, p < .02$).

Hypothesis 2 was not supported, as AQ (autism quotient) was not a significant moderator of the relation between PTQ (perseverative thinking) and RRS (rumination; $p = .13$).

Hypothesis 3 was supported, as PTQ (perseverative thinking) remained a significant predictor of PHQ-9 (depression) score after controlling for AQ (autism quotient; see Table 3). In this model, AQ was not a significant predictor of PHQ-9 ($p = .20$).

We also found support for hypothesis 4a. The model assessing PTQ (perseverative thinking) as a mediator between AQ (autism quotient) and PHQ-9 (depression) had a significant total effect ($b = .25, p < .001$). Using a bootstrap estimation approach with 5000 samples, a significant indirect effect was found ($b = .18, 95\% \text{ CI } [.09, .28]$; see Figure 1a). Normal theory tests for indirect effect also indicated a significant indirect effect ($b = .18, p < .001$). The direct effect of AQ (autism quotient) on PHQ-9 (depression) after taking the mediator into account was nonsignificant ($b = .07, p = .18$), consistent with full mediation. Effect size was medium ($\kappa^2 = .13, 95\% \text{ CI } [.03, .23]$).

Hypothesis 4b, assessing PTQ as a mediator between AQ and RSQ, was similarly supported with a significant total effect ($b = .40, p < .0001$) and a significant indirect effect using bootstrap estimation with 5000 samples ($b = .14, 95\% \text{ CI } [.07, .24]$; see Figure 1b). Normal theory tests for indirect effect also indicated a significant indirect effect ($b = .14, p = .001$). There was also a significant direct effect ($b = .26, p < .0001$), consistent with partial mediation. Effect size was medium ($\kappa^2 = .14, 95\% \text{ CI } [.02, .12]$). In sum, it was found that perseverative thinking explained the relationship between autism symptom scores and depression scores, and partially explained the relationship between autism symptom scores and rejection sensitivity.

Post-hoc Analysis

Because hypothesis 2 (that AQ would moderate the relationship between PTQ and RRS) was not supported, we sought to explore if the reverse may be so: we tested if PTQ (general perseverative thinking) moderated the relation between AQ (autism symptoms) and RRS (depressive rumination); this was similarly not significant ($p = .13$).

As both RSQ (rejection sensitivity) and PTQ (perseverative thinking) independently mediated the relationship between AQ (autism quotient) and PHQ-9 (depression), and they likewise exhibited bivariate correlation, the possibility of serial mediation was probed. First, a serial mediation model was built in which AQ (autism quotient) predicted PTQ (perseverative thinking), which in turn predicted RSQ (rejection sensitivity), which then predicted PHQ-9 (depression; see Figure 2). The total effect was significant and the direct effect was nonsignificant. The indirect effect was significant, with a small effect size (see Table 4). Examination of the coefficients determined that the variables were all positively related: so, more autism symptoms predicted more perseverative thinking, which was associated with more rejection sensitivity, which predicted more depression symptoms. Contrasts revealed that perseverative thinking had a larger indirect effect than either the serial pathway or rejection sensitivity alone, while the serial pathway and the pathway through rejection sensitivity along did not differ in magnitude (Table 5). This suggests that perseverative thinking is a primary pathway through which ASD symptoms lead to depression; however, it also suggests that one more elaborated route by which this sequence takes places is via the serial pathway of ASD symptoms causing perseverative thinking, which when associated with rejection sensitivity causes greater depression.

Second, a serial mediation model was built in which the mediators were reversed (rejection sensitivity causing perseverative thinking). Though the total effect was significant and the direct effect was nonsignificant (see Table 4), contrasts revealed no significant difference in the size of any of the indirect effects (i.e., rejection sensitivity alone, perseverative thinking alone, or the serial pathway between them; see Table 5). Thus, while modeled in this sequence, serial mediation explains no more variance than each model separately. Overall, probing of these serial pathways highlights the crucial and specific role that perseverative thinking plays in the relationship between ASD symptoms and depression.

Discussion

This study examined the role of repetitive cognition in the development of depression across people with varying degrees of manifestation of ASD symptomatology. It was found that a measure of perseveration exhibited convergent validity with rumination, depression, and rejection sensitivity across individuals representing a distribution of ASD symptoms, and that perseveration mediated the relationship between ASD symptoms and depression.

Our first hypothesis, that the PTQ would exhibit convergent and divergent validity, was supported, establishing that the Perseverative Thinking Questionnaire functions similarly across AQ scores in this sample (Ehring et al., 2011). ASD symptoms were associated with repetitive cognition (both perseveration and rumination), depression, and rejection sensitivity. Perseveration was also associated with rumination, depression, and rejection

sensitivity. Notably, the correlation between ASD symptoms and perseveration was weaker than the correlation between perseveration and these other factors. This is possibly related to the fact that the instrument used to measure perseveration (the PTQ) was created for and normed on typically developing samples, and thus is not a measure of ASD-specific perseveration.

Whether or not this measure captures ASD-related perseveration remains unclear. As our sample was not recruited from a clinical population, it may be that these individuals did not evince ASD-related perseveration. Alternatively, it may be that the PTQ captures something distinct from ASD-related perseveration; for example, although the items are content-neutral, they may still capture rumination but not ASD-related perseveration. Future studies should examine the content validity of the PTQ in individuals with ASD.

Our second hypothesis, that perseveration and rumination would converge more strongly in high AQ individuals, was not supported. As AQ did not impact the strength of the relationship between rumination and perseverative thinking measures, this might indicate that individuals with higher AQ scores exhibit the same close relationship between rumination and perseveration as those with lower AQ scores (higher AQ does not correlate with a dissociation between rumination and content-neutral perseveration). Interestingly, both rumination and perseveration were associated with higher AQ, which aligns with previous findings of higher prevalence of rumination in individuals with ASD (Crane et al., 2013). That the relationship between rumination and perseveration measures did not vary by AQ score may again indicate a lack of ASD-related perseveration in our sample or, in fact, it may indicate that different types of repetitive cognition (“positive” cognitions such as special interests, and “negative” cognitions such as depressive rumination) are highly correlated with each other in individuals with ASD, thus perhaps illustrating a sort of generalized perseverative cognitive style (Gotham et al., 2014). Future research might evaluate whether generalized perseveration is elevated in individuals with depression who have high rumination.

Our third hypothesis, that perseveration would predict depression regardless of AQ score, was supported, as ASD symptoms did not impact the relationship between perseverative thinking and depression. Thus, this may illustrate that the PTQ functions similarly to predict depression regardless of AQ score. Regardless of autism symptoms, the PTQ predicted depression; this provides further evidence to support the idea of a perseverative cognitive style in adults with ASD. This finding might affirm the usefulness of administering the PTQ measure to individuals with ASD in future research.

This finding also has clinical implications. Previous studies have shown increased rumination and depression in adults with ASD (Gotham et al., 2014). Indeed, if there is a perseverative cognitive style exhibited by adults with ASD, this may impact how depression is evaluated and treated in this population; for example, if there is an increase in perseveration (including “positive” repetitive cognitions such as special interests) associated with depression, this could be taken into account when evaluating adults with ASD for depression (as opposed to a loss of interests, which is typically associated with depression).

Our results reaffirm the importance of considering repetitive cognition in evaluating and treating depression across AQ scores.

Our fourth hypotheses, that that differences in perseveration would explain the relationship between higher autism symptoms and a) depression or b) rejection sensitivity, were also supported. PTQ explained the relationship between AQ and depression measures, which means that the positive association between depression and higher degrees of ASD symptoms might be explained by the relationship between ASD symptoms and perseveration. Since we found a relationship between ASD symptoms and perseveration, this might partially explain the pattern of comorbidity between ASD and depression (Buck et al., 2014). ASD symptoms were similarly associated with rumination as they were with perseveration. As the perseveration measure used was content-neutral, this might indicate that repetitive cognition in ASD functions similarly to rumination regardless of content. Further research is needed to investigate this idea in clinical samples. We speculate that individuals with ASD experience changing forms of repetitive behavior, shifting into increasingly internalized cognitive perseveration (more IS behaviors compared to more overt repetitive sensorimotor behaviors, for example) as they become adults, particularly in those with higher IQ. Depression similarly becomes more common with age in this population.

Similarly, perseveration partially explained the relationship between ASD symptoms and rejection sensitivity, another internalizing construct. This may indicate that the impact of repetitive cognition extends beyond depression, and may include other internalizing constructs, such as anxiety. Indeed, anxiety is also associated with rumination in TD populations (Nolen-Hoeksema, 2000), and is highly prevalent (though perhaps uniquely manifested) in ASD (Kerns & Kendall, 2012). It may also be that rejection sensitivity, which involves a nervous preoccupation with rejection (Downey & Feldman, 1996), may itself be closely related to both anxiety and repetitive cognition.

This is the first study to examine rejection sensitivity in ASD as the construct is typically studied in relationship research, despite some previous work examining it neutrally using paradigms like Cyberball (Masten et al., 2011). Rejection sensitivity may be another way high-functioning adults internalize ASD-related difficulties (namely, social challenges). This idea may be counterintuitive according to theory of mind explanations of ASD, and may contradict some social motivation theories.

The most current evidence does not support uniform impairment on theory of mind tasks (Senju, 2012) in high-functioning adults with ASD; even so, while there may be differences, the present study recruited a sample from the general (college) population, who are not expected to show such deficits. Further, empathizing deficits in ASD may be limited to cognitive empathy, as studies have shown affective empathy to remain intact in this population (Dziobek et al., 2008). We suspect that this lack of cognitive empathy, while affective empathy remains intact, may actually fuel rather than hinder heightened rejection sensitivity (interestingly, individuals with borderline personality disorder show this same pattern of empathizing deficits; Harari et al., 2010).

Perseveration may be related to rejection sensitivity; indeed, we found them to be correlated in our sample, and in adults with ASD we speculate that perseveration on previously failed social interactions may result in both heightened rejection sensitivity and heightened depression. Figure 2 supports the idea that perseveration may lead to rejection sensitivity and, in turn, lead to depression for those with greater levels of ASD symptoms. It is common for individuals exhibiting depressive rumination to fixate on various failings (Nolen-Hoeksema, 2000); for those with greater ASD symptomatology, who experience relatively more social difficulties, these failings are likely to be social in nature. Thus, they may facilitate heightened rejection sensitivity as well as depression.

Post-hoc analyses showed one specific pathway through which perseverative thinking may cause depression, which is through rejection sensitivity. Contrasts revealed that this is one mechanism through which perseverative thinking acts, but it is not the only such pathway. These results suggest that rejection sensitivity could play a causal role in cognitive processes in relation to depression in individuals with ASD. It may be that, in fact, rejection sensitivity is a form of repetitive cognition centered on rejection. Further research should clarify the relationship between repetitive cognition and rejection sensitivity.

There were several features of this study that limit interpretation of the findings. First, this study recruited a non-clinical sample, recruited from a college campus. Thus, implications for individuals with clinically-significant symptoms of ASD are limited. Future studies should examine this pattern of relations in well-validated ASD samples. Second, our sample was primarily female, whereas ASD is more common in males. It is possible that skewed distribution of gender may affect findings. Consideration of gender effects (including recruiting samples matched in distribution to the ASD population) would be valuable, even in non-clinical samples such as the one recruited in this study. Third, as this was an initial exploration of cognitive factors relating to ASD symptoms and depression, our study made use of cross-sectional mediation models, for which interpretation within a causal framework is inconsistent (Maxwell et al., 2011). Future research should examine the constructs examined here via longitudinal designs to maximize any causal inferences. Fourth, this study relied solely on self-report measures of these constructs, which may be impacted by patterns of shared method variance (including reporting bias). Future studies should use additional reporters and direct measures of the target constructs examined here. Fifth, rumination is known to be associated with anxiety as well as depression (Nolen-Hoeksema, 2000); thus, as we did not collect information on anxiety, future studies should address the relationship between perseveration and anxiety in ASD. Finally, this study used a wide (but somewhat skewed) age range of adult participants, precluding interpretation of earlier (or developmentally variant) manifestations of depression. Future studies should consider these effects in adolescent samples, wherein risk of first-onset depression is relatively high. Another limitation of this study was the inability to consider effects of IQ and precise age, as well as ethnic/racial background.

The implications of this study extend to the treatment of depression in ASD. Cognitive-behavioral and mindfulness-based approaches have both shown promise in treating depression in individuals on the spectrum (Anderson & Morris, 2006; Spek et al., 2012). These findings, which highlight the importance of cognitive processes in the development of

depression in individuals with ASD, support these approaches as both of them are concerned with maladaptive cognitions. Perseveration, which may be related to IS behaviors in the symptom domain of restricted and repetitive behavior in ASD, explained the relationship between ASD symptoms and depression symptoms; thus, it may be that a facet of ASD symptomatology (RRBs) are uniquely related to the development of depression in adults with ASD. Future studies should probe this idea further, and examine these effects across development (as RRBs seem to change in nature and frequency over the lifespan; Chowdhury et al., 2010).

We speculate that DBT and mindfulness-based approaches may be especially promising for treating depression in individuals with ASD. While CBT asks the individual experiencing rumination to redirect their repetitive negative thoughts, this may prove especially difficult for individuals on the spectrum, for whom perseveration may be a more pervasive cognitive style; rather, attempts to actively redirect repetitive cognitions may result in more repetitive cognitions. Thus, the methods employed in DBT, which direct the individual to accept their repetitive cognitions nonjudgmentally and then move past them rather than attempting to modify them, may prove beneficial for individuals with ASD.

Thus, it is important to consider cognitive factors when considering both the etiology and the treatment of depression in ASD. Though individuals with ASD were once considered to be universally and markedly different from TD individuals in their cognitive functioning, research has come to show that there are actually many similarities in cognitive processes between ASD and TD populations; for example, that rumination is associated with depressive symptoms in both ASD and TD individuals (Gotham et al., 2016). It may be that considering such key similarities can provide greater insight into ASD, as well as how to improve the lives of individuals with ASD.

Acknowledgments

This work was supported by a grant from the Autism Science Foundation. The sponsors of the study had no role in study design, data interpretation, or writing of the report.

References

- Anderson S, & Morris J (2006). Cognitive Behaviour Therapy for People with Asperger Syndrome. *Behavioural and Cognitive Psychotherapy*, 34, 293–303. 10.1017/S1352465805002651
- Austin EJ (2005). Personality correlates of the broader autism phenotype as assessed by the Autism Spectrum Quotient (AQ). *Personality and Individual Differences*, 38(2), 451–460. 10.1016/j.paid.2004.04.022
- Ayduk O, Downey G, & Kim M (2001). Rejection Sensitivity and Depressive Symptoms in Women. *Personality and Social Psychology Bulletin*, 27(7), 868–877.
- Baron-Cohen S, Wheelwright S, Skinner R, Martin J, & Clubley E (2001). The Autism-Spectrum Quotient (AQ): Evidence from Asperger Syndrome/High-Functioning Autism, Males and Females, Scientists and Mathematicians. *Journal of Autism and Developmental Disorders*. 10.1023/A:1005653411471
- Bishop SL, Hus V, Duncan A, Huerta M, Gotham K, Pickles A, ... Lord C (2013). Subcategories of restricted and repetitive behaviors in children with autism spectrum disorders. *Journal of Autism and Developmental Disorders*. 10.1007/s10803-012-1671-0

- Boonstra AM, Oosterlaan J, Sergeant JA, & Buitelaar JK (2005). Executive functioning in adult ADHD: A meta-analytic review. *Psychological Medicine*, 35(1996), 1097–1108. 10.1017/S003329170500499X [PubMed: 16116936]
- Buck TR, Viskochil J, Farley M, Coon H, McMahon WM, Morgan J, & Bilder DA (2014). Psychiatric Comorbidity and Medication Use in Adults with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders*. 10.1007/s10803-014-2170-2
- Carcani-Rathwell I, Rabe-Hasketh S, & Santosh PJ (2006). Repetitive and stereotyped behaviours in pervasive developmental disorders. *Journal of Child Psychology and Psychiatry and Allied Disciplines*. 10.1111/j.1469-7610.2005.01565.x
- Chowdhury M, Benson BA, & Hillier A (2010). Changes in Restricted Repetitive Behaviors with age: A study of high-functioning adults with Autism Spectrum Disorders. *Research in Autism Spectrum Disorders*. 10.1016/j.rasd.2009.09.006
- Crane L, Goddard L, & Pring L (2013). Autobiographical memory in adults with autism spectrum disorder: the role of depressed mood, rumination, working memory and theory of mind. *Autism*, 17(2), 205–219. [PubMed: 21975036]
- Dent J, & Teasdale JD (1988). Negative Cognition and the Persistence of Depression. *Journal of Abnormal Psychology*, 97(1), 29–34. [PubMed: 3351108]
- Downey G, & Feldman SI (1996). Implications of Rejection Sensitivity for Intimate Relationships. *Journal of Personality and Social Psychology*, 70(6), 1327–1343. [PubMed: 8667172]
- Dziobek I, Rogers K, Fleck S, Bahnemann M, Heekeren HR, Wolf OT, & Convit A (2008). Dissociation of cognitive and emotional empathy in adults with Asperger syndrome using the Multifaceted Empathy Test (MET). *Journal of autism and developmental disorders*, 38(3), 464–473. [PubMed: 17990089]
- Ehring T, Zetsche U, Weidacker K, Wahl K, Schönfeld S, & Ehlers A (2011). The Perseverative Thinking Questionnaire (PTQ): Validation of a content-independent measure of repetitive negative thinking. *Journal of Behavior Therapy and Experimental Psychiatry*. 10.1016/j.jbtep.2010.12.003
- Gadow KD, Guttman-Steinmetz S, Rieffe C, & DeVincent CJ (2012). Depression symptoms in boys with autism spectrum disorder and comparison samples. *Journal of Autism and Developmental Disorders*. 10.1007/s10803-011-1367-x
- Ghaziuddin M, Ghaziuddin N, & Greden J (2002). Depression in Persons with Autism: Implications for Research and Clinical Care. *Journal of Autism and Developmental Disorders*. 10.1023/A:1016330802348
- Gosling SD, Rentfrow PJ, & Swann WB (2003). A very brief measure of the Big-Five personality domains. *Journal of Research in Personality*. 10.1016/S0092-6566(03)00046-1
- Gotham K, Unruh K, & Lord C (2015). Depression and its measurement in verbal adolescents and adults with autism spectrum disorder. *Autism*, 19(4), 491–504. 10.1177/1362361314536625 [PubMed: 24916450]
- Harari H, Shamay-Tsoory SG, Ravid M, & Levkovitz Y (2010). Double dissociation between cognitive and affective empathy in borderline personality disorder. *Psychiatry research*, 175(3), 277–279. [PubMed: 20045198]
- Hoza B (2007). Peer functioning in children with ADHD. *Journal of Pediatric Psychology*. 10.1093/jpepsy/jsm024
- Ingersoll B, Meyer K, & Becker MW (2011). Increased rates of depressed mood in mothers of children with ASD associated with the presence of the broader autism phenotype. *Autism Research*. 10.1002/aur.170
- Kerns CM, & Kendall PC (2012). The Presentation and Classification of Anxiety in Autism Spectrum Disorder. *Clinical Psychology: Science and Practice*. 10.1111/cpsp.12009
- Kroenke K, Spitzer RL, & Williams JBW (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine*. 10.1046/j.1525-1497.2001.016009606.x
- Masten CL, Morelli SA, & Eisenberger NI (2011). An fMRI investigation of empathy for ‘social pain’ and subsequent prosocial behavior. *Neuroimage*, 55(1), 381–388. [PubMed: 21122817]
- Maxwell SE, Cole DA, & Mitchell MA (2011). Bias in Cross Sectional Analyses of Longitudinal Mediation Partial and Complete Mediation Under an Autoregressive Model. *Multivariate Behavioral Research*, 46(5), 816–841. [PubMed: 26736047]

- Mayes SD, Calhoun SL, Murray MJ, & Zahid J (2011). Variables Associated with Anxiety and Depression in Children with Autism. *Journal of Developmental and Physical Disabilities*. 10.1007/s10882-011-9231-7
- Nijmeijer JS, Minderaa RB, Buitelaar JK, Mulligan A, Hartman CA, & Hoekstra PJ (2008). Attention-deficit/hyperactivity disorder and social dysfunctioning. *Clinical Psychology Review*. 10.1016/j.cpr.2007.10.003
- Nolen-Hoeksema S (2000). The role of rumination in depressive disorders and mixed anxiety/depressive symptoms. *Journal of Abnormal Psychology*, 109(3), 504–11. 10.1037/0021-843X.109.3.504 [PubMed: 11016119]
- Nolen-Hoeksema S, Wisco BE, & Lyubomirsky S (2008). Rethinking Rumination. *Perspectives on Psychological Science*, 3(5), 400–424. 10.1111/j.1745-6924.2008.00088.x [PubMed: 26158958]
- Patel S, Day TN, Jones N, & Mazefsky CA (2016). Association between anger rumination and autism symptom severity, depression symptoms, aggression, and general dysregulation in adolescents with autism spectrum disorder. *Autism*, 1–9.
- Pearson KA, Watkins ER, & Mullan EG (2011). Rejection sensitivity prospectively predicts increased rumination. *Behaviour Research and Therapy*. 10.1016/j.brat.2011.06.004
- Pearson KA, Watkins ER, Mullan EG, & Moberly NJ (2010). Psychosocial correlates of depressive rumination. *Behaviour Research and Therapy*. 10.1016/j.brat.2010.05.007
- Piven J, Palmer P, Jacobi D, Childress D, & Arndt S (1997). Broader autism phenotype: Evidence from a family history study of multiple-incidence autism families. *American Journal of Psychiatry*. 10.1176/ajp.154.2.185
- Ruzich E, Allison C, Smith P, Watson P, Auyeung B, Ring H, & Baron-Cohen S (2015). Measuring autistic traits in the general population: a systematic review of the Autism-Spectrum Quotient (AQ) in a nonclinical population sample of 6,900 typical adult males and females. *Molecular Autism*, 6(2). 10.1186/2040-2392-6-2
- Senju A (2012). Spontaneous theory of mind and its absence in autism spectrum disorders. *The Neuroscientist*, 18(2), 108–113. [PubMed: 21609942]
- Smith CJ, Lang CM, Kryzak L, Reichenberg A, Hollander E, & Silverman JM (2009). Familial associations of intense preoccupations, an empirical factor of the restricted, repetitive behaviors and interests domain of autism. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*. 10.1111/j.1469-7610.2009.02060.x
- Spek AA, van Ham NC, & Nyklí ek I (2013). Mindfulness-based therapy in adults with an autism spectrum disorder: A randomized controlled trial. *Research in Developmental Disabilities*. 10.1016/j.ridd.2012.08.009
- Sterling L, Dawson G, Estes A, & Greenson J (2008). Characteristics associated with presence of depressive symptoms in adults with autism spectrum disorder. *Journal of Autism and Developmental Disorders*. 10.1007/s10803-007-0477-y
- Treynor W, Gonzalez R, & Nolen-Hoeksema S (2003). Rumination Reconsidered: A Psychometric Analysis. *Cognitive Therapy and Research*, 27(3), 247–259.
- Troyb E, Knoch K, Herlihy L, Stevens MC, Chen CM, Barton M, ... Fein D (2016). Restricted and Repetitive Behaviors as Predictors of Outcome in Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*. 10.1007/s10803-015-2668-2
- Uljarević M, Evans DW, Alvares GA, & Whitehouse AJO (2016). Short report: relationship between restricted and repetitive behaviours in children with autism spectrum disorder and their parents. *Molecular Autism*, 7(29). 10.1186/s13229-016-0091-y
- White SW, Ollendick TH, & Bray BC (2011). College students on the autism spectrum: Prevalence and associated problems. *Autism*, (5). 10.1177/1362361310393363

Figure 1.

A. Mediation model of perseverative thinking as a mediator in the relationship between autism symptoms and depression symptoms. B. Mediation model of rejection sensitivity as a mediator in the relationship between autism symptoms and depression symptoms. *** $p < .001$.

Figure 2.

Serial mediation model of the relation between autism symptoms and depression symptoms. In this model, this relation (c) is fully mediated by autism symptoms predicting perseverative thinking (a), which in turn predicted rejection sensitivity (e), finally leading to depression symptoms (d). *** $p < .001$.

Table 1.**Demographic variables.**

Self-reported demographic information for gender, annual household income, current undergraduate grade point average, and Autism Quotient score for study participants (N =200).

<u>Gender</u>	<u>Number</u>	<u>%</u>
Male	59	29.5
Female	139	69.5
Other	1	.5
<u>Household income</u>		
Declined to answer	31	15.5
Less than \$30,000	43	21.5
\$30,000 - \$60,000	27	13.5
\$60,000 - \$90,000	29	14.5
\$90,000 - \$120,000	35	17.5
More than \$120,000	34	17.0
<u>GPA</u>	<u>Mean</u>	<u>Std. Deviation</u>
	3.09	.59
<u>AQ</u>		
	18.68	6.46

Table 2

Correlations between AQ, RSQ, PTQ, PHQ-9, and RRS (N = 200).

Measure	AQ	RSQ	PTQ	PHQ	RRS
AQ	—				
RSQ	.386***	—			
PTQ	.324***	.488***	—		
PHQ	.262***	.434***	.595***	—	
RRS	.321***	.531***	.763***	.762***	—

Note: AQ = Autism Quotient. RSQ = Rejection Sensitivity Questionnaire. PTQ = Perseverative Thinking Questionnaire. PHQ = Patient Health Questionnaire. RRS = Rumination Response Scale.

 $p < .001$.

Table 3.

Summary of regression analysis for perseverative thinking predicting depression with and without controlling for Autism Quotient scores (N=200).

Variable	Model 1			Model 2		
	<i>B</i>	<i>SE B</i>	β	<i>B</i>	<i>SE B</i>	β
AQ	.249	.065	.262	.074	.057	.078
PTQ				.277	.029	.569
R^2		.069			.359	
R^2		.069 ***			.290 ***	
F for R^2		14.61			89.19	

Note: AQ = Autism Quotient. PTQ = Perseverative Thinking Questionnaire.

 $p < .001$.

Table 4.

Serial multiple mediation models of mediators in the relationship between Autism Quotient (X) and PHQ-9 (Y; N=199).

Model	M1	M2	R ²	F	Total effect	Direct effect	Indirect effect
1	PTQ	RSQ	.07	15.77***	.26***	.04	Total: .22 [^]
							Ind1: .15 [^]
							Ind2: .02 [^]
							Ind3: .04 [^]
							Total: .26 [^]
2	RSQ	PTQ	.07	15.77***	.26***	.04	Ind1: .07 [^]
							Ind2: .07 [^]
							Ind3: .08 [^]

Note: PTQ = Perseverative Thinking Questionnaire. RSQ = Rejection Sensitivity Questionnaire. Ind1 = $X \rightarrow M1 \rightarrow Y$; Ind2 = $X \rightarrow M1 \rightarrow M2 \rightarrow Y$; Ind3 = $X \rightarrow M2 \rightarrow Y$.

p < .001.

[^] The 95% Bias Corrected CI indicates a significant indirect effect because it does not include zero.

Table 5.

Contrasts between mediators in serial multiple mediation models of the relationship between Autism Quotient (X) and Patient Health Questionnaire (Y; N=199).

Model	M1	M2	(Ind1 – Ind2)	(Ind1 – Ind3)	(Ind2 – Ind3)
1	PTQ	RSQ	.13 [^]	.11 [^]	-.02
2	RSQ	PTQ	-.01	-.01	-.01

Note: PTQ = Perseverative Thinking Questionnaire. RSQ = Rejection Sensitivity Questionnaire. Ind1 = $X \rightarrow M1 \rightarrow Y$; Ind2 = $X \rightarrow M1 \rightarrow M2 \rightarrow Y$; Ind3 = $X \rightarrow M2 \rightarrow Y$.

[^] The 95% Bias Corrected CI indicates a significant indirect effect because it does not include zero.