Chapter 11
The Role of Anxiety Symptoms in Understanding Restricted, Repetitive Behaviours and Interests in Autism Spectrum Disorders

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While repetitive and restrictive behaviors (RRBI) is a core symptom domain in ASD, anxiety-related disorders (ARDs) are considered to be co-ocurring. About 40% of children and adolescents with ASD meet criteria for at least one ARD (van Steensel, Bögels, & Perrin, 2011), with 63–87% of them having clinical anxiety symptoms and "atypical" anxiety symptoms (Kerns et al., 2014; Muris, Steerneman, Merckelbach, Holdrinet, & Meesters, 1998; Williams, Leader, Mannion, & Chen, 2015). These anxiety rates are higher than those reported among typically developing peers (Gadow, DeVincent, Pomeroy, & Azizian, 2004; Guttmann-Steinmetz, Gadow, DeVincent, & Crowell, 2010) or those with intellectual disabilities (Brereton, Tonge, & Einfeld, 2006). Co-occurring anxiety symptoms in ASD are linked with functional and health impairments, including increased self-injurious behavior (SIB), depressive symptoms, gastrointestinal difficulties, sleep problems, parental/family stress, and additional healthcare needs (Ahmedani & Hock, 2012; Bellini, 2006; Kerns et al., 2015; Williams et al., 2015). Anxiety can lead to greater stress, exacerbation of core ASD symptoms, and disruptive behaviors (Bos, Diamantopoulou, Stockmann, Begeer, & Rieffe, 2018). Anxiety and RRBI have been found to be interrelated in psychopathology, leading scholars to investigate the nature and underlying mechanisms of this association.

Anxiety symptoms and related disorders are often unidentified or misdiagnosed in ASD (Kerns et al., 2014; MacNeil, Lopes, & Minnes, 2009). This can be attributed to common negative affectivity indicators of both ARD and ASD such as distress, avoidance and withdrawal as well as obsessions and compulsions which are characteristics of both.

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Further challenging differential diagnosis of ASD from ARD is the fact that both children and adults with high anxiety symptoms have elevated scores on autism symptom measures (South, Carr, Stephenson, Maisel, & Cox, 2017; Van Steensel, Bögels, & Wood, 2013). This demonstrates how the interplay between core autism symptoms and anxiety occurs for individuals with ARDs and those with elevated anxiety symptoms and not only for those with ASD. Hence, it can be challenging to differentiate social avoidance associated with ASD versus social anxiety in ARD or to differentiate RRBI from obsessive compulsive disorder (OCD: Gjevik, Eldevik, Fjæran-Granum, & Sponheim, 2011; MacNeil et al., 2009).

RRBI are disruptive and provoke distress and anxiety (Wood & Gadow, 2010), limiting social participation (Ludlow, Skelly, & Rohleder, 2012) and learning (Leekam, Plissrior, & Uljarevic, 2011), and can therefore be extremely challenging for individuals with ASD and their families. Nevertheless, RRBI are addressed much less in ASD intervention programs than are social communication deficits. Understanding the role of anxiety in RRBI can advance our understanding of distinct clinical phenotypes in ASD and guide the search for common etiologies and for interventions that consider the interaction between core ASD symptoms and anxiety.

The specific aims of this chapter are to:

1. Characterize the **relation** between Anxiety and RRBI in ASD.
2. Outline **explanations** for the interplay between anxiety and RRBI in ASD.
3. Describe RRBI in **other ARDs**.
4. Discuss challenges in **identifying and differentiating** anxiety from RRBI in ASD.

RRBI in ASD

The DSM-5 (APA, 2013) classifies the RRBI domain into four types of symptoms: (1) Repetitive and stereotyped speech, movement or use of objects; (2) Routines, rituals and resistance to change; (3) Circumscribed and restricted interests, and (4) Hypo- or hyper-reactivity[1] to sensory input, including unusual sensory interests (hereafter referred to as sensory symptoms). Evidence (Bishop et al., 2013; Lidstone et al., 2014) demonstrates the distinction between two types of RRBI in ASD, Insistence on Sameness (IS, i.e., types (2) and (3) in the DSM-5) and Repetitive Sensory and Motor Behaviors (RSMB, i.e., types (1) and (4) in the DSM-5). IS refers to behavioral rigidity, resistance to change, practicing routines and rituals, and circumscribed and narrow areas of interest. RSMB[2] refer to body mannerisms, atypical sensory responses, and repetitive manipulation of objects.

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[1] The term sensory hyper-reactivity will be used throughout the chapter to refer to atypical over-response to sensation. This type of RRBI has different terms in the literature such as sensory over-responsivity, sensory avoidance, sensory defensiveness, and sensory sensitivity.

[2] The RSMB construct in some measures does not include hypo- or hyper-reactivity symptoms rather focuses on repetitive movements and unusual exploration and seeking of stimulation. In

Anxiety Symptoms in ASD

Manifestations of anxiety symptoms in ASD can be classified as traditional or atypical. Traditional anxiety symptoms conform to DSM-5 ARD criteria (e.g., selective mutism, separation anxiety disorder, specific phobia, social anxiety disorder, panic disorder, agoraphobia, general anxiety disorder). These more traditional symptoms are characterized by elevated physiological arousal, which create a predisposition to anxiety (Bellini, 2006), and are associated with higher language abilities, anxious cognitive styles and sensory hyper-reactivity (considered part of the RRBI domain). Atypical anxiety is a maladaptive coping strategy (Hartley, Sikora, & McCoy, 2008; Spiker, Lin, Van Dyke, & Wood, 2012) which is also associated with an anxious cognitive style as well as ASD symptoms (Kerns et al., 2014), such as excessive worry around circumscribed interests (rather than generalized worry), fear related to novelty and change, social anxiety without fear of negative evaluation and unusual phobias (e.g., beards, toilet bowls). Note that in this chapter, in line with the reviewed literature, ARD will also refer to additional disorders which were excluded from the Anxiety Disorder section in the DSM-5, i.e., PTSD and OCD.

Evidence suggests that levels of anxiety symptoms in ASD change over development. Using cross-sectional data with individuals from 17 months to 65 years-of-age, Davis III et al. (2011) found a rise in anxiety from toddlerhood to childhood, reduced anxiety into early adulthood, and rising anxiety into older adulthood. Longitudinal investigations showed no significant changes in anxiety over short-term durations, such as one year (May, Cornish, & Rinehart, 2014), while a long-term follow-up study of individuals ages 6 through 24 years found a linear relation between age and anxiety with a significant interaction with biological sex. Females with ASD initially had less anxiety than males but by age 24 years, there was no significant difference between them (Gotham, Brunwasser, & Lord, 2015). Closer investigation of the course of anxiety in ASD throughout development at the population and individual levels can shed light on the path of their emergence.

The Association Between Symptoms of Anxiety and RRBI in ASD

Increased anxiety symptoms have been associated with more severe ASD symptoms (Wood & Gadow, 2010), and specifically with the RRBI core domain (e.g., Rodgers, Glod, Connolly, & McConachie, 2012). Some researchers show associations with anxiety across types of RRBI (Stratis & Lecavalier, 2013), while others focus on specific types of RRBI in relation with specific types of anxiety (e.g., Rodgers et al., 2012). The following reviewed evidence attests to differences in the nature of the association between anxiety and specific types of RRBI. Among RRBI, IS in

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such cases the term repetitive movements will be used.

particular has been consistently associated with higher levels of anxiety (Gotham et al., 2013; Rodgers et al., 2012; Spiker et al., 2012; Stratis & Lecavalier, 2013). Individuals with both ASD and an ARD versus those with ASD but without ARD, had significantly greater severity of IS and repetitive movement symptoms. For the anxious subgroup of ASD, IS was specifically associated with separation anxiety and peer physical injury scores, but not with other types of anxiety symptoms (i.e., panic/agoraphobia, social phobia, OCD, generalized anxiety disorder) (Rodgers et al., 2012).

Another type of RRBI which is associated with anxiety in ASD across age groups is sensory hyper-reactivity (Ben-Sasson et al., 2008; Green, Ben-Sasson, Soto, & Carter, 2012). When comparing individuals with ASD who are anxious from individuals with ASD who are not anxious, for the non-anxious subgroup, more repetitive movements correlated with OCD symptoms but not with other types of anxiety (Rodgers et al., 2012). At the same time, it is important to understand whether the types of anxiety investigated can explain why in other studies repetitive movements were not associated with anxiety (Factor, Condy, Farley, & Scarpa, 2016; Stratis & Lecavalier, 2013).

The interaction between anxiety and RRBI in ASD appears to depend upon the type of anxiety and type of RRBI analyzed hence assessments should clearly define these types of symptoms. Although SIB are not part of the diagnostic criteria for ASD, they are thought of as repetitive behaviors in measures such as the Repetitive Behavior Scale-Revised (Lam & Aman, 2007). SIB occurs in 27% to 30% of individuals diagnosed with ASD and also appears in some cases of ARD (e.g., skin picking, hair pulling; Trepal & Wester, 2007). Evidence suggests that children with ASD who meet clinical cutoffs for ARD have significantly higher rates of SIB compared to children with ASD who do not meet criteria (Muskett, Capriola-Hall, Radtke, Factor, & Scarpa, 2019). Stratis and Lecavalier (2013) found that level of adaptive functioning moderated the association between SIB and anxiety in ASD. Specifically, more frequent SIB was predictive of higher anxiety among individuals with higher adaptive functioning, whereas SIB was predictive of less anxiety in the lower adaptive functioning group. Adaptive functioning is an important dimension to measure for fully understanding the interplay between RRBI and anxiety in ASD and its specific expression.

Explanations for the Association Between Anxiety and RRBI

Although the association between RRBI and anxiety in ASD is well-documented, the mechanisms explaining the direction of the effect are not agreed upon. Wood and Gadow (2010) questioned whether this association is a "true" comorbidity or "false". "True" comorbidity refers to one of the following options: (1) anxiety is phenotypically and etiologically identical in comorbid (ASD and ARD) and monomorbid conditions (ARDs); (2) anxiety symptoms in ASD are phenotypically altered by ASD pathogenic processes; or (3) anxiety in ASD is a derivative of the

core ASD symptomatology with potentially different etiology than monomorbid ARDs. "False" comorbidity refers to an inaccurate diagnosis, which will be discussed in the Section "Challenges in Identification."

Sensory motor symptoms similar to those included under the RRBI ASD domain are prevalent among several psychopathologies including ASD, ARDs, OCD and ADHD (Fig. 11.1). Scholars have called attention to the nonspecific nature of these symptoms and their prodromal appearance. As such, these symptoms are described as indicators of brain vulnerability that put the individual at risk for developing psychopathology (Levit-Binnun, Davidovitch, & Golland, 2013). The cross-syndromic nature of the relation between anxiety and RRBI clearly raises questions regarding the common mechanism of this relation across conditions, as opposed to specific to ASD.

Next, three possible explanations for the co-occurrence of anxiety and RRBI symptoms in ASD and their supporting evidence will be outlined: **1. Anxiety causes RRBI; 2. RRBI causes anxiety; 3. Common mechanisms** (Fig. 11.2).

1. *Anxiety causes RRBI*

The first explanation for the co-occurrence of anxiety and RRBI examined is controversial and suggests that anxiety motivates the emergence of RRBI. Within this explanation, the possibility that anxiety exacerbates RRBI will also be discussed. The mechanisms by which anxiety symptoms lead to RRBI also considers RRBI as a means for regulating emotional, social, and sensory experiences as described next.

Indeed, literature suggests that RRBI, particularly circumscribed interests and symbolic reenactment of restricted interests in play in ASD, serve as maladaptive coping mechanisms aimed to reduce anxiety (Rodgers et al., 2012; Spiker et al., 2012). This maladaptive cycle starts with RRBI providing immediate relief of anxiety by controlling the environment and creating predictable behavioral outcomes. As a result, the individual builds positive beliefs about the role and function of

Fig. 11.1 Overlapping disorders sharing anxiety, repetitive behaviors, and dysregulation
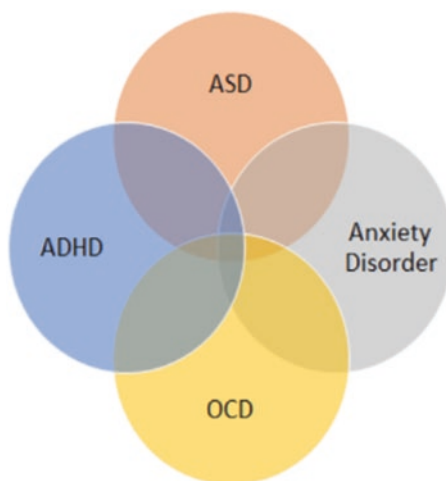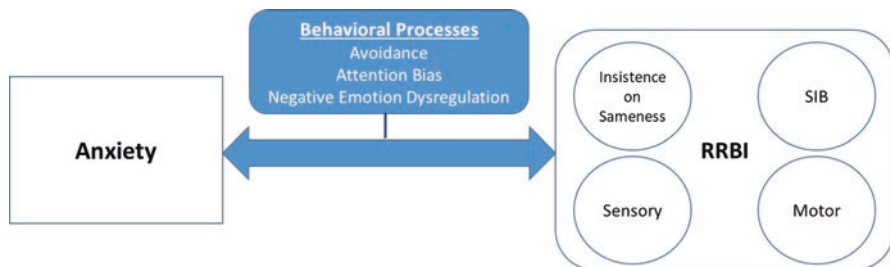
Fig. 11.2 The RRBI Anxiety Interplay Model

RRBI, further expanding and maintaining these behaviors. Consequently, the individual relies more on RRBI, further limiting his/her engagement, creating an anxiety cycle (Rodgers et al., 2012).

Anxiety can also explain the presence of sensory atypicalities that many people with ASD suffer from and are part of the DSM-5 definition of RRBI: Imagine yourself in a frightening situation in which all your senses are ready to fight or flight, you scan the area for potential threat and literally jump at any sound. According to this explanation, anxiety elicits sensory hyper-reactivity through hypervigilance (i.e., scanning the environment for threat-related stimuli) and attention biases. These, in turn, lead to focusing attention on stimuli and showing difficulty disengaging from it (Mobini & Grant, 2007).

In order to fully understand how anxiety can lead to RRBI, the behavioral manifestations of ARD must be examined. ARDs are also characterized by hyperarousal (i.e., elevated levels of autonomic responses) and poor regulation of negative emotions (Craske, 2003) which can lead to a dysregulated sensory reaction through attentional bias. Children who are hyper-aroused and constantly scan the environment for threat-related stimuli are more likely to notice sensory stimuli. This, coupled with poor emotional regulation, will exacerbate hyper-reactivity as the individual is more likely to attribute threat to these stimuli and will have difficulty disengaging from them and inhibiting negative affect (Green & Ben-Sasson, 2010). The path of anxiety leading to RRBI by hyperarousal and elevated attention to detail is supported by cluster analysis research pointing to a distinct subgroup of children with ASD who share sensory hyper-reactivity, excellent memory, over-focused and over-selective attention (Liss, Saulnier, Fein, & Kinsbourne, 2006). Sensory hyper-reactivity in this subgroup is conjectured to reflect increased likelihood of attending and disengaging from bothersome sensory stimuli.

Further support for the causal relation of anxiety leading to sensory hyper-reactivity comes from animal research. Mice, genetically inbred to be anxiety-prone showed poorer balance and postural control compared to non-anxious mice (Lepicard et al., 2003). These capacities are associated with poor proprioceptive and vestibular modulation observed in children with sensory hyper-reactivity (Miller, Anzalone, Lane, Cermak, & Osten, 2007). Examples from the auditory domain have been reported with mice genetically prone to anxiety, having stronger auditory startle reaction than non-anxious mice (Plappert & Pilz, 2002). Animal research

supports a directional relation between anxiety and sensory hyper-reactivity, whether it be through hyper-vigilance, attentional bias, hyper-arousal or dysregulation.

Furthermore, sensory avoidance was identified as mediating the influence of anxiety on RRBI among youth with ASD. Interestingly RSMB were not associated with anxiety, but with sensory avoidance (Lidstone et al., 2014). This finding supports earlier views of RRBI as an ongoing attempt to regulate arousal imbalance in ASD (Zentall & Zentall, 1983). In light of this, IS symptoms are understood as an attempt to minimize incoming sensory stimulation; however, leading to a maladaptive strategy by creating and/or maintaining anxiety. In contrast, RSMBs can be understood as an effective strategy for arousal regulation given their dissociation with anxiety.

C*lassical aversive conditioning* can account for the maintenance and exacerbation of sensory hyper-reactivity as opposed to its initiation. According to this mechanism, the aversive sensory stimulus (e.g., noise is the conditioned stimulus) is associated with a previously perceived neutral stimulus (e.g., bus). For instance, constantly scanning the environment for noise leads to a preference for attending to aversive, unexpected noise and a higher likelihood to over-react to noise (Green & Ben-Sasson, 2010). The conditioning can be strengthened by an individual's anxiety traits, physiological arousal and perceived uncontrollability over aversive events (Craske, 2003). Hence, a child with a pre-existing ARD is more likely to associate a physiological reaction with a sensory stimulus. This occurs when children with ARD regulate negative affectivity through avoidance of fear-eliciting stimuli (Craske, 2003). Such avoidance further decreases development of adaptive regulation of response. Therefore, sensory hyper-reactivity can result from hypervigilance, poor regulation, conditioning and avoidance; thus, maintaining and exacerbating the association.

2. *RRBI causes anxiety*

This approach views anxiety as a consequence of RRBI and can be demonstrated through various pathways. The pervasive challenges that individuals with ASD experience as a result of their cognitive, sensory and social-communication deficits can lead to RRBI such as resistance to change, insistence on sameness, circumscribed interests (Greenway & Howlin, 2010) and ultimately to anxiety. This explanation views RRBI as a factor of ASD challenges and anxiety as an outcome of both.

A more direct model in line with this explanation was suggested by Wood and Gadow (2010). According to this model, anxiety and mood dysregulation occur as a result of ASD-related stressors, including unpredictability of social encounters, peer rejection/victimization, aversive sensory experiences, and inability to engage in preferred repetitive behaviors. The model further suggests that anxiety may be a consequence of ASD-specific symptoms and act as a moderator in increased ASD symptomatology, including repetitive behaviors.

Among RRBI, sensory hyper-reactivity has been proposed to trigger specific phobia or generalized anxiety through conditioning. The aversive sensory stimuli are associated with certain objects or situations, leading to the conditioning of these

objects or situations. In turn, the conditioned stimuli can cause anxiety in the absence of the feared stimuli (Green & Ben-Sasson, 2010). This *classical conditioning* mechanism may explain the emergence of specific phobia, which are prevalent in ASD (Gadow et al., 2004) and fits the conditioning hypothesis. At the same time, conditioning can explain the relation between sensory hyper-reactivity and generalized anxiety. Generalized fear is likely to occur when the unconditioned stimulus does not consistently occur with the conditioned stimulus, known as *context conditioning* (Grillon, 2008). Context conditioning often leads to behavioral avoidance, as a situation or location triggers the conditional fear as opposed to a specific object. For instance, a child may avoid malls or birthday parties because s/he anticipates noise. The more generalized the anxiety, the greater the impairment (Green & Ben-Sasson, 2010). Various factors contribute to the strength of the conditioning of a particular situation, including the frequency, degree of controllability and predictability of the event (Craske, 2003). In addition, the language and cognitive deficits of people with ASD may challenge one's ability to predict and control stressful situations. Frequent, uncontrolled and unpredicted conditioned stimuli may cause a child to become generally hypervigilant to sensory stimuli and to maintain hyperarousal, leading to a general state of anxiety (Green & Ben-Sasson, 2010). This explanation is supported by longitudinal research of a large sample of toddlers with ASD, which demonstrated that early sensory hyper-reactivity significantly predicted anxiety symptoms 18 months later, while early anxiety did not predict later hyper-reactivity (Green et al., 2012). These findings suggest that atypical sensory responses contribute to the development of anxiety symptoms in ASD, warranting further testing over a longer period. Another longitudinal study also provided evidence of unidirectional influence of repetitive speech and stereotypical behaviors on later anxiety symptoms. However, this effect was completely attenuated once early anxiety symptoms were controlled for (Teh, Chan, Tan, & Magiati, 2017). Furthermore, intervention research in ASD shows that anti-anxiety medications reduce RRBI (Hollander et al., 2012), further supporting the effect of anxiety on RRBI.

While theoretically, the two directional explanations discussed seem to be contradictory, they can also co-exist given their applicability to different types of RRBI. For example, IS dominated the explanation that anxiety causes RRBI. Both explanations clearly do not pertain to all individuals with ASD, as not all individuals with ASD have hyperarousal or sensory hyper-reactivity. In addition, it is possible for the direction of causality to differ among subgroups of ASD. Although directional mechanisms have been presented, the direction of the relation may indeed be circular in that RRBI can lead to distress and promote anxiety, and heightened anxiety can further increase severity of ASD symptoms.

3. *Shared Mechanisms*

As opposed to one construct being secondary to the other, it is plausible that a third shared mechanism explains the expression of both constructs. Two potential shared mechanisms will be discussed, mechanisms that may explain both anxiety and RRBI, one relates to common mediators and the other to a neurobiological mechanism.

Third Party Factors

Some constructs were identified in the literature as mediators of the impact of RRBI and anxiety. Such a construct is intolerance of uncertainty (IU), which refers to the difficulty to endure uncertain situations. Underlying IU is the perception that uncertainty is stressful and upsetting and unexpected events are negative and should be avoided at all costs (Rodgers et al., 2012). Two key factors underlie IU: *desire for predictability*, which refers to disliking unexpected events and *uncertainty paralysis*, which refers to feeling stuck when experiencing uncertainty (Birrell, Meares, Wilkinson, & Freeston, 2011). Both factors resonate with the nature of ASD: rigidity, difficulty with changes, and need for sameness. Insistence on sameness has been hypothesized as a strategy to reduce distress caused by IU. This can explain findings of increased IS observed over time among individuals with ASD (Richler, Huerta, Bishop, & Lord, 2010). Within ASD, symptoms of worry, IU, and repetitive behaviors have been negatively associated with startle response during an uncertain potentiated startle task (Chamberlain et al., 2013). Furthermore, IU has been shown to mediate the association between broad autism symptoms and degree of anxiety in children and adolescents with ASD (Boulter, Freeston, South, & Rodgers, 2014), as well as in adults with or without ASD (Maisel et al., 2016). However, the exact contribution of IU as a specific mediator between RRBI and anxiety is less clear. Uljarević, Carrington, and Leekam (2016) report that IU partially mediated the association between sensory sensitivity and anxiety in mothers of children with ASD. Neil, Olsson, and Pellicano (2016) investigated these variables in children with and without ASD using a model of anxiety to mediate the link between sensory sensitivity and IU and found that anxiety acted as a partial mediator for the ASD group, but not in the typically developing group. This mediation supports the conjecture that the nature of the interplay between anxiety and RRBI is unique to ASD. Additional research is needed to illuminate the mediating role of IU in explaining the interplay of RRBI and anxiety.

Another ASD related factor which can explain both anxiety and RRBI is social motivation. Low social motivation is associated with elevated anxiety symptoms and emotion dysregulation (Swain, Scarpa, White, & Laugeson, 2015). Findings point that social motivation deficits in children and adolescents with ASD partially mediated the relation between anxiety and IS (Factor et al., 2016). This may occur through low social reward reducing social motivation, leading to seeking non-social rewards in the form of RRBI. This strengthens the differential mechanism of association between anxiety and IS versus RSMB and introduces the contribution of social deficits to the model (Fig. 11.2).

The Neurobiology of Anxiety in ASD

It is thought that individuals with ASD and anxiety symptoms constitute a unique ASD subgroup, which is biologically different from those with ASD but without anxiety (Wood & Gadow, 2010). This position views the comorbidity of anxiety

symptoms and ARDs in ASD as a distinct endophenotype. Herrington and colleagues investigated the role of the amygdala in individuals with ASD with and without significant anxiety symptoms. They found evidence for associations between anxiety and reduced amygdala volume (Herrington et al., 2017) and greater amygdala activation (Herrington et al., 2017). Basal ganglia regions have also been identified in repetitive motor behaviors in both people with OCD and ASD (Estes et al., 2011; Langen et al., 2014). In addition, deep brain stimulation of the nucleus accumbens in the basal ganglia has been shown to decrease anxiety symptoms in individuals with treatment-refractory OCD (Denys et al., 2010). This can explain the similarity between OCD and ASD symptoms and their high rate of co-occurrence.

There is also evidence of disrupted neural circuits in both anxiety and repetitive behaviors. The Pre-Frontal Cortex (PFC) is thought to be involved in down-regulation of amygdala activity during emotional regulation (Wager, Davidson, Hughes, Lindquist, & Ochsner, 2008) and abnormal (often reduced) amygdala-PFC connectivity has been implicated in ARDs (Makovac et al., 2016). Amygdala-PFC connectivity has been found to be reduced in one study (Swartz, Wiggins, Carrasco, Lord, & Monk, 2013) and increased in another (Monk et al., 2010) in ASD, and it is unclear whether this is due to upregulation or to a possible inability to down-regulate. Additional research is needed to better understand how brain systems are related to anxiety and repetitive behaviors in ASD, but the current literature indicates that underlying shared mechanisms are possible.

Genetic research reveals potential overlaps between anxiety and RRBI as well. Various adenosine A_{2A} receptor gene (*ADORA2A*) variants have been associated with anxiety and increased ASD symptoms (including repetitive behaviors; Freitag et al., 2010). Gadow, Roohi, DeVincent, Kirsch, and Hatchwell (2009) reported preliminary findings of a shared association between brain-derived neurotrophic factor (*BDNF*) polymorphisms and both social anxiety and repetitive (tic) behaviors in ASD. Glutamate transporter gene (*SLC1A1*) allelic variation was, however, associated with anxiety, but not with repetitive behaviors, in children with ASD (Gadow, Roohi, DeVincent, Kirsch, & Hatchwell, 2010), although *SLC1A1* polymorphisms have been associated with basal ganglia-mediated activity and repetitive behaviors in OCD (Zike et al., 2017) and may represent a shared risk-factor for anxiety and repetitive behaviors. Oxcytocin is a neuropeptide with hypothesized roles in the development of ASD (Kranz et al., 2016) but its role in RRBI is unclear as on one hand, Oxcytocin infusion has been associated with a decrease in repetitive behaviors in adults with ASD (Hollander et al., 2003), but on the other hand, no significant associations were reported between Oxcytocin and repetitive behavior severity in a recent meta-analysis (Kranz et al., 2016).

Repetitive Behaviors in Anxiety Related Disorders

This section reviews RRBI that characterize ARDs (e.g., general anxiety disorder, social phobia, panic disorder, PTSD) and specifically OCD. OCD is a family of disorders defined by obsessive recurrent thoughts and compulsive behaviors. The

compulsions often aim to reduce anxiety and avoid feared situation (APA, 2013). Individuals with ARDs do not typically present with the classical RRBI associated with ASD, rather anxious individuals show other forms of repetitive behaviors and thoughts. These are important to recognize, as their manifestation in ASD may alert professionals to consider the presence of anxiety. For example, abnormal sensory functioning is an RRBI commonly seen outside ASD in disorders such as OCD (Rieke & Anderson, 2009) and other ARDs (Conelea, Carter, & Freeman, 2014). Cognitive symptoms of anxiety can also assist in identifying anxiety in ASD. Cognitive inflexibility, is an example of a symptom which is present in ASD (Leung & Zakzanis, 2014), and plays a role in the development and maintenance of generalized anxiety disorder (Lee & Orsillo, 2014) hence can potentially distinguish those with ASD who also present with anxiety traits. In addition, individuals with ARDs suffer from perseverative negative thoughts, which can lead to negative affectivity and avoidance (Sorg, Vögele, Furka, & Meyer, 2012). Thus, signs of negative affectivity and avoidance in ASD may stem from repetitive thoughts associated with their anxiety.

ASD and OCD both have repetitive all-consuming thoughts that lead to functional impairment, engagement in rituals and repetitive actions, and sensory sensitivities. While 37.2% of individuals with ASD also meet criteria for OCD (Leyfer et al., 2006), 20% of individuals with OCD show autistic traits (Bejerot, Nylander, & Lindström, 2001). The similarity between ASD and OCD can lead to misdiagnosis of OCD among individuals with ASD (Bejerot et al., 2001).

One of the hurdles for accurate evaluation of RRBI which coincides with ARD is use of different terminologies across disciplines and populations to describe similar symptoms. Table 11.1 presents a comparison of RRBI terms used in the field of ASD and OCD versus other ARDs. For instance, while hyper- and hypo-reactivity to sensation as well as abnormal sensory cravings and interests are referred to in ASD (Ben-Sasson et al., 2019), sensory phenomena together with "Not Just Right Experiences" describe sensory abnormalities in those with OCD. Cross-syndromic research and training would advance the field by leading to unified terminology and raise awareness of parallel symptoms when careful differential diagnosis is warranted.

Therefore, it is of importance to identify common and differentiating features of RRBI in these disorders as it can facilitate distinct measurements and guide the discovery of common etiologies. Indeed, various researchers compared ASD, OCD, and anxiety symptoms between individuals with pure OCD or ASD (Cath, Ran, Smit, Van Balkom, & Comijs, 2008; Jiujias, Kelley, & Hall, 2017; McDougle, Kresch, Goodman, & Naylor, 1995; Russell, Mataix-Cols, Anson, & Murphy, 2005; Zandt, Prior, & Kyrios, 2007) and are reviewed in the following section:

ASD and OCD Similarities

1. Level of general anxiety symptoms (Cath et al., 2008).
2. High-level repetitive behaviors: obsessions, insistence on sameness, fixated interests; and low-level repetitive behaviors: compulsions, repetitive sensory and motor behaviors (Jiujias et al., 2017).

Table 11.1 Comparison of RRBI Terms between Disorders

RRBI Term	ASD	OCD	ARDs
Repetitive Thoughts	Insistence on sameness, restricted and fixated interests, rigid thinking patterns	Obsessions	Ruminative/ perseverative negative thoughts, cognitive rigidity
Repetitive Behaviors	Ritualized behaviors, strict adherence to routines, stereotypic movements, echolalia, idiosyncratic speech, nonfunctional play	Compulsions, tics, body-focused repetitive behaviors	Behavioral avoidance
Abnormal Sensory Functioning	Hyper- or hypo-reactivity to or abnormal interest in sensory stimuli	"Just right experiences", Sensory phenomena	Sensory-processing sensitivity; harm avoidance

3. The presentation of repetitive behaviors becomes more complex over time as well as possible decreases in low-level versus high-level behaviors (Zandt et al., 2007).
4. Children with OCD have similar levels of more traditional ASD-related repetitive behaviors as those with ASD, as measured by the RBQ, including sameness behavior and repetitive movements (Zandt et al., 2007).
5. A comorbid ASD and OCD group and a pure OCD group demonstrated similar degrees of increased deficits in social skills and attention to detail on the Autism Quotient (Cath et al., 2008).

ASD and OCD Differences

1. Higher severity of OCD symptoms in a pure OCD group than in a comorbid ASD and OCD group (Cath et al., 2008; Russell et al., 2005). Lower obsession scores in the comorbid group contributed to these findings (Cath et al., 2008).
2. A comorbid ASD and OCD group was differentiated by hoarding, touching, tapping, self-injurious behaviors (McDougle et al., 1995), somatic obsessions and repetitive rituals (Russell et al., 2005), and more sexual obsessions (Russell et al., 2005).
3. Absence of checking, counting, aggressive and symmetry-related repetitive thoughts in an ASD group (McDougle et al., 1995).
4. A comorbid ASD and OCD had lower communication, imagination, and attention switching scores than a pure OCD group did (Cath et al., 2008).

A few observations can assist in differentiating between ASD-based versus OCD-based RRBI. First, the child's associated emotional reactions as opposed to identifying the behavior itself should be examined: While in ASD, obsessive thoughts in a narrow area of interest pose a pleasant experience, in OCD they are usually unpleasant and associated with harm/threat. Second, it is important to

identify whether compulsive behavior is linked to a particular obsession, which is more characteristic of OCD than ASD.

Furthermore, similar to ASD, atypical sensory responses were reported in OCD (Lewin, Wu, Murphy, & Storch, 2015; Rieke & Anderson, 2009), and abnormal sensory phenomena have been specifically associated with repeated behaviors in OCD (Ferrão et al., 2012). However, no study has included a comparison of ASD and OCD samples in terms of their sensory abnormalities. In Fig. 11.3, the percentage of extreme scores on the Sensory Profile sensory symptom questionnaire are compared based on published data from two studies (Clince, Connolly, & Nolan, 2016; Rieke & Anderson, 2009). The largest gaps are in the lower rates of hyporeactivity (called low registration in measure) in OCD versus ASD and the higher rates of sensory seeking in OCD versus ASD. Further research can help determine whether the nature and interference rather than frequency of sensory aversions differ among groups.

There is scarce evidence which relates to comparing ASD and OCD conflicts, potentially due to variations in inclusion criteria for ASD. For example, some researchers focused on higher functioning individuals with ASD (Russell et al., 2005), while others included various IQ levels (McDougle et al., 1995). These methodological disparities between studies can explain the contrasting findings in repetitive behavior and anxiety between groups.

The comorbidity rates of ASD and OCD may be inflated by the similarity between symptoms reflecting RRBI and OCD (Wood & Gadow, 2010; Zandt et al., 2007). As OCD and ASD share features of repetition and compulsion, careful differentiation between these disorders is needed. The behavioral differences listed above can assist in such differentiation.
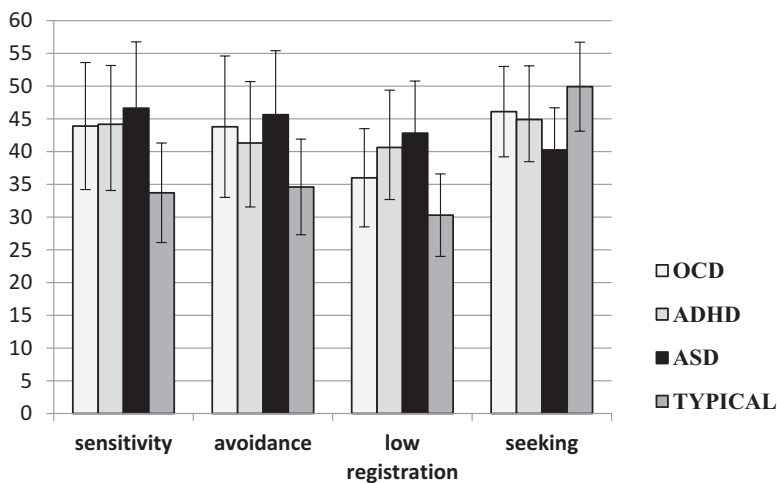

Fig. 11.3 Percentage of Extreme Sensory Profile Questionnaire Scores across Disorders

Challenges in Identifying and Differentiating RRBI from Anxiety in ASD

We next describe the challenges in measuring RRBI and ARDs in order to distinguish RRBI from ARDs in ASD, including: (1) Low language, communication and developmental levels. (2) Overlap between RRBI and anxiety symptoms among various scales. (3) Specificity of RRBI and anxiety measures. And (4) suitability of anxiety measures for evaluation in ASD. These measurement issues led scholars to postulate that the comorbidity of RRBI and ARDs is in some cases 'false' or artifactual due to inaccurate differential or dual diagnoses (Wood & Gadow, 2010). Furthermore, the overlapping symptoms between ASD and other psychiatric disorders reflect discontinuity in classification systems between child and adult psychiatry, leading to lack of awareness in adult psychiatry of the manifestations of psychiatric disorders in childhood (Cath et al., 2008).

1. *Low language, communication and developmental levels:*

Assessment of anxiety symptoms relies on identifying negative and obsessive thought patterns. Hence, it is difficult to identify cognitive features of anxiety in pre-verbal children or those with severe language and communication impairments. In the absence of the capacity to share their thoughts with the examiner, the assessment must rely on proxy reports and/or interpretation of the source(s) of distressed behavior. Furthermore, developmental delay in ASD hinders the collection of valid diagnostic information from the individual and separating anxiety symptoms from global delay. In addition, many individuals with ASD often experience difficulty in directed expression of emotions and others may find it difficult to interpret their emotional expressions (Davis, Saeed, & Antonacci, 2008). The difficulty parents or other observers have in reading behaviors in ASD may contribute to inaccurate identification of sources of distress.

2. *Overlap between symptoms of RRBI and anxiety in different scales:*

Evaluating the association between anxiety and RRBI is obscured by overlapping symptoms in measurement tools. Some scholars view anxiety indicators in ASD as a proxy of RRBI core symptoms. In a theoretical model of clinical anxiety in ASD, ASD-related stressors such as restricting engagement in repetitive behavior, social unpredictability, and sensory aversive experiences, are displayed as triggers of elevated anxiety symptoms. As such, specific ASD core symptoms may be misidentified as signs of an ARD rather than part of the ASD phenotype (Wood & Gadow, 2010). General descriptors of distress, avoidance, anger and hyperactivity are examples of behaviors described in both anxiety and RRBI. More specific indicators, such as lining-up objects and self-injury appear in scales of both domains. As a result, some indicators may be misidentified as anxiety symptoms when they are indeed a reflection of core ASD symptomatology and vice versa.

This measurement overlap may reflect conceptual differences among the various professions designing RRBI versus anxiety measures. Evidence indicates the tendency of professionals from different disciplines to interpret similar behaviors as

representing different constructs based on their training and expertise. In a study comparing views of occupational therapists and psychologists, they were asked to rate behaviors from early childhood standardized assessments as representing sensory versus anxiety symptoms. Findings showed that occupational therapists tended to rate items as representing sensory abnormalities, while psychologists tended to rate items as representing anxiety, regardless of the items' original construct (Ben-Sasson, Cermak, Orsmond, Carter, & Fogg, 2007). These findings highlight the need for interdisciplinary assessment to obtain an objective, accurate diagnosis of ARDs in ASD; one that doesn't depend on professional background or the measure used. This also calls for tools with strong divergent validity, demonstrating their utility for identifying 'true' comorbid ARD and RRBI in ASD.

3. *Specificity of RRBI and anxiety measures:*

   The types of anxiety and RRBI measures used in research shape the presence and nature of the association between these constructs. In one study, early sensory hyper-reactivity was found to predict later anxiety symptoms in ASD (Green et al., 2012). Duvekot, van der Ende, Verhulst, and Greaves-Lord (2018) did not find a relation between a broader RRBI score and later anxiety. These results may reflect that the measures of anxiety and RRBI in the latter did not distinguish between subtypes of symptoms within each construct. Research indicating differing patterns of association of anxiety with IS versus RSMB (Rodgers et al., 2012; Spiker et al., 2012) calls for their differentiation in measurement. Multifaceted measures of symptoms (rather than broad symptom measures/screens) in investigations of the relationship between RRBI and anxiety are needed.

4. *Suitability of anxiety measure for evaluation in ASD:*

   Traditional anxiety tools do not sufficiently quantify diffuse anxiety symptoms such as those associated with the atypical anxiety present in ASD. This may explain differences in rates of anxiety reported across ASD studies (Kerns et al., 2014). When selecting an anxiety tool for individuals with ASD, one should be aware of its suitability for quantifying anxiety in ASD as opposed to assessing the diathesis of social-communication ASD symptoms. Empirically using poorly differentiated tools requires understanding that some of the correlation between the constructs is accounted for by measurement overlap. There is a call to select anxiety measures that are suitable for evaluating anxiety in ASD by minimizing overlapping indicators (Wood & Gadow, 2010).

Summary

Looking at the interplay of anxiety and RRBI contributes immensely to understanding the functional impairments people with ASD experience. Recognizing the role of anxiety and RRBI in the emergence, maintenance and/or exacerbation of each other can inform research and clinical attempts to reveal their underlying

mechanisms. For some individuals with ASD anxiety can explain the nature of their RRBI, while for others RRBI causes anxiety. Common neurobiological indicators of anxiety and RRBI as well as shared mediating factors strengthen the notion of a common ground rather than coincidental co-occurrence. Such evidence is also promising when thinking of behavioral and pharmaceutical treatments for targeting both conditions. There is need to ensure that anxiety in young and non-verbal individuals with ASD is not misdiagnosed and to develop tools which can assist professionals' identification of underlying anxiety symptoms in ASD.

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