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Feelings of incompleteness as Linking Obsessive-Compulsive Disorder and Autism Spectrum Disorder: An Examination Using a Computerized Approach-Avoidance Task

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ABSTRACT

FEELINGS OF INCOMPLETENESS AS LINKING OBSESSIVE-COMPULSIVE DISORDER AND AUTISM SPECTRUM DISORDER: AN EXAMINATION USING A COMPUTERIZED APPROACH-AVOIDANCE TASK

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This dissertation examines the construct of incompleteness as it relates to both Obsessive-Compulsive Disorder (OCD) and Autism Spectrum Disorder (ASD). Incompleteness is a construct which was developed to describe symptoms of OCD that are not accounted for using a traditional, harm-avoidance and fear-based conceptualization. Unlike harm-avoidance-based OCD, in which an individual engages in compulsions to prevent some feared outcome, individuals with incompleteness-based OCD engage in compulsions to resolve an internal feeling that their experience is uneven, asymmetrical, incomplete, or not-just-right.

Recently, researchers have begun to examine feelings of incompleteness in the context of other disorders, such as ASD. This dissertation expands upon that literature and aimed to investigate whether incompleteness may be one construct that links OCD and ASD, which demonstrate comorbidity in clinical populations. Additionally, this dissertation project aimed to generate behavioral tasks that could be used to model various symptoms of OCD and ASD in the laboratory, namely, through the development of novel computerized approach-avoidance tasks (AATs). Study limitations are considered in detail. Implications for the study of incompleteness in OCD and ASD are also considered.

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BY

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"If I have seen a little further, it is by standing on the shoulders of giants." – Newton

DEDICATION

For Mutti and Grandpa, and hoping you are proud

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CHAPTER 1

INTRODUCTION

Obsessive-Compulsive Disorder (OCD) is a heterogeneous and idiosyncratic disorder. Obsessions and compulsions vary thematically (e.g., contamination, harm) and several attempts have been made to organize OCD symptoms for research and clinical purposes based upon theme (McKay et al., 2004; Rachman, 2002; Williams, Mugno, Franklin, & Faber, 2013). However, Summerfeldt (2004) proposed that it may be more informative to organize symptoms based upon their function, or the feelings which motivate an individual's symptoms. To this end, she theorized that there are two tendencies that motivate OCD symptoms: harm avoidance and incompleteness. Whereas the traditional cognitive-behavioral model of OCD described compulsions as serving a harm-avoidance function, Summerfeldt argued that a focus on harm avoidance was not sufficient for conceptualizing or treating OCD. Subsequent research supports the assertion that incompleteness and harm avoidance are separable constructs (Summerfeldt, Kloosterman, Antony, & Swinson, 2014), that incompleteness relates more strongly to some symptom themes than to others (Taylor et al., 2014), and that incompleteness-based symptoms demonstrate different presentations and prognoses than do harm-avoidance-based symptoms (e.g., more symmetry/exactness symptoms, greater symptom severity; Sibrava, Boisseau, Eisen, Mancebo, & Rasmussen, 2016). However, only a few studies have examined whether incompleteness is related to disorders beyond OCD, as is harm avoidance.

A handful of these studies have researched incompleteness in the context of Autism Spectrum Disorder (ASD), which is phenotypically similar to OCD. Some of these studies suggest that incompleteness correlates with ASD symptoms (Kloosterman, Summerfeldt, Parker, & Holden, 2013; Lee & Wu, 2019), but others do not (Hellriegel, Barber, Wikramanayake, Fineberg, & Mandy, 2017). Overall, research regarding the extent of the relationship between the two conditions is mixed; however, they do consistently demonstrate elevated comorbidity rates as compared to the general population (van Steensel, Bögels, & Perrin, 2011) and may involve similar brain regions (Ameis et al., 2016). It is therefore informative to search for constructs which may explain the association observed between the two disorders. Pursuant to that goal, incompleteness has demonstrated some relationship to ASD in prior studies; additionally, the conceptually related construct "insistence on sameness" has been identified as a subset of the repetitive behaviors which occur in ASD (Barrett, Uljarević, Jones, & Leekam, 2018). The present project therefore aimed to investigate whether incompleteness may be one construct that links OCD to ASD.

Obsessive-Compulsive Disorder

OCD is a disorder characterized by the presence of obsessions and/or compulsions. Obsessions are persistent thoughts, urges, or images which are experienced by the individual as unwanted and intrusive; compulsions are repetitive overt or covert rituals which the individual feels compelled to perform, often in response to their obsessions (e.g., to increase feelings of safety or avoid some feared outcome). Without treatment, OCD tends to be a chronic condition

(American Psychiatric Association [APA], 2013). In an attempt to estimate the prevalence of OCD in the United States, Ruscio, Stein, Chu, and Kessler (2010) examined 2,073 respondents from the National Comorbidity Survey Replication (NCS-R). Their findings suggest that the lifetime prevalence of OCD is 2.3%; however, as many as 28.2% of respondents indicated experiencing obsessions or compulsions at some point in their lives. Due to the large percentage of people showing such subsyndromal symptoms, Ruscio et al. concluded that the disease burden of OCD is likely to be greatly underestimated. A previous report from the World Health Organization listed OCD among the leading causes of disability in young adults and adolescents (Kohn, Saxena, Levav, & Saraceno, 2004). The persistent and disabling nature of this condition demands continued efforts to better understand the mechanisms by which the disorder persists.

OCD research is complicated by the fact that OCD is a heterogeneous and often idiosyncratic condition. The themes of obsessions and compulsions vary widely, with some of the most common being checking, washing, harm, and ordering (McKay et al., 2004; Rachman, 2002). In a review paper on the subject of heterogeneity in OCD, several prominent OCD researchers concluded that there was strong evidence for the existence of a contamination/washing dimension, a checking dimension, a hoarding dimension, and a symmetry/ordering dimension (McKay et al., 2004). Further, the evidence suggested that checking symptoms may respond better to cognitive behavioral therapy (CBT) than do other symptoms (i.e., 33% of individuals with primary checking symptoms meeting “recovered” criteria versus 20% or less of individuals with other primary symptom types), leading the researchers to conclude that treatment must be tailored to different symptom types.

A more recent review also aimed to investigate OCD symptom dimensions and whether these dimensions respond differently to treatment (Williams et al., 2013). The researchers noted that the most reliable symptom dimensions to appear in structural analyses of OCD symptom measures are contamination/washing, checking, symmetry/ordering, and unacceptable thoughts/mental rituals. This largely is consistent with what the earlier review found (McKay et al., 2004); notable exceptions include the removal of hoarding as a dimension of OCD symptoms and the emergence of unacceptable thoughts/mental rituals as their own dimension. Williams et al. (2013) further noted that the evidence regarding treatment response generally indicated that each of these dimensions improved with exposure and response prevention (ERP), the gold-standard treatment for OCD, although the evidence for symmetry/ordering symptoms was based on a single study (i.e., Abramowitz, Franklin, Schwartz, & Furr, 2003). Of interest, Abramowitz et al. (2003) reported that the group of individuals with symmetry concerns demonstrated the highest proportion of individuals with clinically significant improvement following treatment (76%; i.e., symptom scores comparable to a normative sample and reliable change). However, Abramowitz et al.'s group of individuals with unacceptable thoughts demonstrated a relatively low proportion of clinically significant improvement (46%). Therefore, the evidence regarding whether different OCD symptoms respond differentially to treatment is mixed. However, Williams et al. (2013) concluded that modifications to treatment may be necessary for some types of symptoms. The construct of incompleteness as described by Summerfeldt (2004) may be helpful in illustrating why such heterogeneity exists in OCD symptoms and why some symptoms may not show as large a treatment response as others.

Incompleteness in OCD

Feelings of incompleteness in OCD first were described by Pierre Janet in 1903 (Pallanti, Barnes, Pittenger, & Eisen, 2017). However, beginning with Salkovskis's (1985) cognitive-behavioral model of OCD, much of the research in the field has focused on conceptualizations of symptoms that involve compulsions serving a harm-avoidance function (e.g., driving around the same spot repeatedly to make sure a pedestrian was not struck; Rachman, 2002). The cognitive-behavioral model of OCD was similar to models of other anxiety disorders in its focus on harm avoidance (e.g., Panic Disorder; Salkovskis, Clark, & Gelder, 1996). This construct informed the development of ERP, the front-line treatment for OCD; namely, the basis of this treatment is that through exposure the individual is exposed to irrationally feared situations until the felt anxiety in such situations decreases (Abramowitz, Deacon, & Whiteside, 2011). Through engaging in exposure, clients learn that their anxiety will decrease on its own and that the feared outcome will not occur. However, Summerfeldt (2004) argued that a harm-avoidance-based conceptualization was not sufficient to understand OCD. Summerfeldt proposed an alternative framework which posited that there were two constructs that motivate compulsive behaviors in OCD: harm avoidance and feelings of incompleteness.

Incompleteness is "the troubling and irremediable sense that one's actions or experiences are not 'just right'" (Summerfeldt, 2004, p. 1155). Defined in this manner, the construct of incompleteness is closely related to another construct in the OCD literature: not-just-right experiences, or NJREs, which are defined in the literature as "feelings of something not being just right or sensations of incompleteness" (Coles, Heimberg, Frost, & Steketee, 2005, p. 153).

For the purposes of the current project, Summerfeldt's construct of incompleteness will be conceptualized as the tendency that underlies state-like incidents of not-just-right experiences.

Summerfeldt (2004) theorized that incompleteness in OCD is (1) orthogonal to harm avoidance, (2) associated with some kinds of OCD symptoms (e.g., symmetry, counting) more than others, and (3) demonstrates a more complicated comorbidity profile as compared to harm avoidance, which would extend beyond anxiety disorders to include some "spectrum" disorders like skin picking or tic disorders. Furthermore, the prevailing cognitive-behavioral models were believed to exclude incompleteness (Taylor et al., 2014).

In the years since Summerfeldt's (2004) theoretical paper, research has partially supported her assertions. Several studies demonstrate that incompleteness and harm avoidance are separable constructs. For example, Pietrefesa and Coles's (2008) factor analysis of the Obsessive-Compulsive Trait Core Dimensions Questionnaire (OC-TCDQ; Summerfeldt, Kloosterman, Parker, Antony, & Swinson, 2001)—which was developed explicitly to include harm avoidance and incompleteness subscales—found that a two-factor solution demonstrated adequate fit (CFI = .90, SRMR = .06, RMSEA = .08) and was superior to a one-factor solution that collapsed harm avoidance with incompleteness (χ^2diff = 40.39, $p < .001$). However, contrary to expectations, the factors were highly correlated ($r = .76$; Pietrefesa & Coles, 2008). This finding poses a critical challenge to Summerfeldt's hypothesis that the two dimensions are orthogonal. A more recent series of factor analyses of the OC-TCDQ likewise offered support for a two-factor solution. Whereas the one-factor solution did not demonstrate adequate fit in the confirmatory factor analysis (CFA) performed on data from the clinical sample, the two-factor solution demonstrated adequate or better fit in a CFA performed on data from the nonclinical

(CFI = .986, SRMR = .048) and clinical (CFI = .998, SRMR = .090) samples and outperformed the one-factor solution which was tested in the clinical sample (CFI = .632, SRMR = .191; Summerfeldt et al., 2014). In the nonclinical sample, incompleteness and harm avoidance again were strongly correlated (r = .70); conversely, they correlated more moderately in the clinical sample (r = .36). Of note, the two factors demonstrated significantly different correlations with two of seven measured domains of obsessive-compulsive symptoms (ordering: z = -5.49, p < .007; obsessing: z = 6.55, p < .007) and three of six measured domains of perfectionism (doubts about actions: z = -5.02, p < .008; personal standards: z = -4.23, p < .008; organization: z = -5.22, p < .008; Pietrefesa & Coles, 2008). Although the constructs appear to not be orthogonal, repeated factor-analytic and correlational findings suggest that they are meaningfully separable.

Evidence also has been found for the second of Summerfeldt's (2004) hypotheses, that incompleteness will relate to some symptoms of OCD more strongly than to others. Taylor et al. (2014) conducted a meta-analysis (N = 5,940) of incompleteness and harm avoidance as they relate to a number of OCD symptoms. Across studies, incompleteness correlated most strongly with ordering symptoms (r = .64), whereas harm avoidance correlated more modestly with ordering symptoms among the measured OCD symptoms (r = .35). Harm avoidance correlated more strongly with obsessing symptoms (r = .57) than did incompleteness (r = .41). The two correlated similarly with checking symptoms (incompleteness: r = .51; harm avoidance: r = .48), mental neutralizing (incompleteness: r = .48; harm avoidance: r = .45), and washing symptoms (incompleteness: r = .39; harm avoidance: r = .39). However, even for those symptoms within which there were absolute differences in the magnitude of incompleteness versus harm

avoidance correlations (i.e., ordering, obsessing), Taylor et al. did not examine whether these correlations were statistically significantly different.

A recent study conducted on a sample of 238 college students replicated Taylor et al.'s findings regarding ordering symptoms. Incompleteness correlated more strongly with ordering (r = .58) than did harm avoidance (r = .40; Lee & Wu, 2019). As in Taylor et al.'s meta-analysis, checking symptoms again correlated similarly with both (incompleteness: r = .62; harm avoidance: r = .65); contamination symptoms demonstrated modestly divergent correlations (incompleteness: r = .36; harm avoidance: r = .23). Each of these bivariate correlations was significant at $p < .001$. When the correlation pairs were compared, only ordering symptoms demonstrated a significantly stronger correlation with incompleteness than with harm avoidance ($z = 2.59$, $p = .010$); this was the only significant difference between the strength of incompleteness and harm avoidance correlations (Lee & Wu, 2019). In a study conducted on a sample of 534 nonclinical adults, results indicate that incompleteness as measured by the OC-TCDQ correlated significantly with ordering (r = .36) and washing (r = .20) symptoms as measured by the Obsessive-Compulsive Inventory—Revised (OCI-R; Foa et al., 2002) after partialling out the effect of harm avoidance (Taylor et al., 2014). Taken together, these results suggest that incompleteness tends to correlate most strongly with OCD ordering symptoms, as compared to other symptoms.

Relating to Summerfeldt's (2004) idea that incompleteness would demonstrate different comorbidity patterns than would harm avoidance, Sibrava et al. (2016) compared individuals with high levels of incompleteness against those with low levels of incompleteness (total N = 307 adults diagnosed with OCD) on a variety of symptoms and clinical outcomes. Results were

that 22.8% of the sample demonstrated clinically significant incompleteness. “Clinical significance” was determined based on responses during a structured clinical interview; that is, if participants indicated that their compulsions were not aimed at reducing anxiety due to a feared consequence, and/or participants indicated that they felt unable to move on from their compulsions without “feeling right,” this was considered to be indicative of clinically significant incompleteness. Compared to participants without clinically significant incompleteness, those with clinically significant incompleteness endorsed significantly higher OCD symptom severity ($p < .012$) and greater symmetry/exactness/ordering symptoms ($p < .001$); greater obsessive-compulsive personality disorder symptoms, including preoccupation with details ($p < .001$) and perfectionism ($p < .005$); and higher rates of unemployment ($p < .002$), increased disability ($p < .001$), and decreased quality of life ($p < .004$). These findings not only support the idea that incompleteness may be most strongly related to OCD ordering symptoms but also begin to explore the idea that incompleteness OCD may demonstrate differential comorbidity patterns. However, further research that examines incompleteness as it relates to other disorders more explicitly is needed.

Research exploring Summerfeldt’s (2004) assertion that incompleteness would demonstrate specificity to OCD only recently has begun. Initial attempts have examined the applicability of incompleteness to disorders with either empirical or phenotypical relationships with OCD, such as Autism Spectrum Disorder.

Autism Spectrum Disorder

The DSM-5 defines Autism Spectrum Disorder (ASD) as a disorder involving deficits of social communication and interaction, as well as behaviors or interests that are restricted and repetitive. Recent estimates are that 1% of the population meets criteria for ASD, and although not degenerative, it is a lifelong condition (APA, 2013). Therefore, interventions for this condition are a high priority.

Although both social deficits and repetitive behaviors are hallmark symptoms of ASD, repetitive behaviors have, until recently, received far less attention than social symptoms (Cuccaro et al., 2003). As with compulsive behaviors in OCD, investigations have revealed that there is a great deal of heterogeneity in the repetitive behavior symptoms of ASD. The diagnostic criteria list an insistence on sameness, routines, or rituals or stereotyped repetitive movement, such as hand flapping (APA, 2013). On a conceptual level, these descriptions allow for overlap between the repetitive behaviors observed in individuals with ASD and the overt compulsions observed in individuals with OCD.

One of the earliest empirical investigations of repetitive behaviors in ASD (Cuccaro et al., 2003) was a principal component analysis (PCA) conducted on the Autism Diagnostic Interview—Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994), a semi-structured interview used for individuals with a possible diagnosis of a pervasive developmental disorder. The symptom content assessed by the ADI-R maps onto DSM-IV criteria. Performed on a sample of 207 children and adolescents with ASD, the PCA extracted two interpretable components (e.g., repetitive motor actions and resistance to change). However, scales based on the two retained

components demonstrated relatively low alpha coefficients (.62 and .52) and accounted for only 32% of the variance in repetitive behaviors. This model may not fully capture the variety of repetitive behaviors displayed by those with ASD. However, the emergence of a "resistance to change" factor is of interest to the current study, and this finding has been repeated in more recent investigations reviewed below.

Barrett et al. (2018) noted that restricted and repetitive behaviors in ASD typically fall into two categories: repetitive sensory and motor behaviors (RSMB) and insistence on sameness. In their study, they aimed to determine if those findings could be replicated using PCA on the Adult Repetitive Behavior Questionnaire-2 (RBQ-2A; Barrett et al., 2015) in a sample of high-functioning adults with ASD. The RBQ-2A is a 20-item self-report questionnaire that asks how often the individual engages in certain repetitive motor actions (e.g., "Spin yourself around and around"), takes interest in sensory experiences (e.g., "Have a special interest in the feel of different surfaces"), or insists on consistency (e.g., "Insist on things at home remaining the same"). The PCA resulted in two components—which the researchers determined mapped onto RSMB and insistence on sameness—that demonstrated acceptable internal consistency (αs = .70 and .81). These components are similar to those found by Lord et al. (1994), despite being obtained using quite different means (e.g., among children versus adults, using an interview versus self-report questionnaire). These findings confirm previous results suggesting the existence of a resistance to change/insistence on sameness subtype of repetitive behaviors and suggest that this construct generalizes across samples and methodologies.

Additional research has investigated whether insistence on sameness may have utility in creating ASD symptom "subtypes." One such study involved reanalysis of the Broad Autism

Phenotype Questionnaire (BAPQ; Hurley, Losh, Parlier, Reznick, & Piven, 2007)—a measure designed to tap the milder constellation of ASD symptoms typically present within first-degree relatives of individuals with ASD. The BAPQ originally was designed with three subscales to span the range of behaviors affected by ASD: deficits in social interaction (Aloof, e.g., "I prefer to be alone rather than with others"), deficits in communication (Pragmatic Language, e.g., "People ask me to repeat things I've said because they don't understand"), and the presence of restricted or repetitive behavior (Rigid, e.g., "I feel a strong need for sameness from day to day"). In the initial validation study, Hurley et al. (2007) found that significant differences emerged between parents of children with ASD and parents of children without ASD or a related developmental disorder on all three subscales of the measure (Aloof: $F[2, 147] = 22.81$, $p < .001$; Pragmatic Language: $F[2, 123] = 10.58$, $p < .001$; Rigid: $F[2, 136] = 5.45$, $p = .005$), suggesting that it has utility in measuring lower levels of ASD in those who do not meet full criteria.

Esler, Stronach, and Jacob (2018) examined the structure of ASD symptoms and levels of insistence on sameness within families via an exploratory factor analysis (EFA) of the BAPQ. Esler et al.'s (2018) reanalysis of the measure via EFA, which was not originally developed through factor-analytic methods, suggests that four factors (not five- or six-factor solutions) provide the best fit to the data ($\chi^2(492) = 7053.43$, $p < .001$). The four factors were determined to represent Aloof, Insistence on Sameness (which contains 11 items from the original Rigid scale), as well as Pragmatic and Pragmatic-Conversation (both of which are derived from Pragmatic Language). This supports other assertions that insistence on sameness is an important and separable dimension of ASD symptoms. Further, Esler et al. (2018) found that parental scores on BAPQ Insistence on Sameness correlated with their children's scores on Insistence on Sameness

as measured by both the ADI-R (mother: $r = .10$, $p < .001$; father: $r = .09$; $p < .001$) and the Repetitive Behavior Scale—Revised (RBS-R; Bodfish, Symons, Parker, & Lewis, 2000; mother: $r = .16$, $p < .001$; father: $r = .12$, $p < .001$). The authors believe this indicates that, whether through shared genetics or learning, this construct is correlated within family members. However, these correlations are small and replication is needed to increase confidence in their findings.

Incompleteness in ASD

Although incompleteness as a construct was developed in the OCD literature, efforts have been made to see whether it may be useful for explaining what motivates repetitive "insistence on sameness" behaviors in ASD. One of the earliest efforts to investigate the question of incompleteness in ASD was a study that compared scores of parents with multiple children with ASD (P-MC) against parents with a single child with ASD (P-SC) on the Incompleteness scale of the OC-TCDQ (Kloosterman et al., 2013). Results showed that P-MC demonstrated significantly higher scores than did P-SC, $F_{(1, 226)} = 3.96$, $p < .005$, $\eta^2 = .02$. Further, in a combined sample of P-SC and P-MC, parents' incompleteness scores predicted increased repetitive movements and increased resistance to change in their children with ASD, $F_{(4, 896)} = 3.24$, $p < .05$, $\eta^2 = .02$. The researchers speculate that these findings suggest that greater incompleteness is related to increased repetitive behaviors in those with ASD. This study was limited by the fact that the children were not assessed directly for their levels of incompleteness.

In a sample of 25 individuals with OCD, Hellriegel et al. (2017) assessed incompleteness, harm avoidance, and levels of autistic traits (the latter via the Autism Quotient, AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). Results did not support the assertion that incompleteness would be correlated with autistic traits (r = .14, p = .500). These results cast some doubt as to the relatedness of incompleteness and symptoms of ASD; however, the study is limited by its small sample size. Of note, incompleteness and harm avoidance correlated, r = .34; this finding is consistent with Pietrefesa and Coles (2008), who reported a correlation of .36 in their clinical sample.

Lee and Wu (2019) examined correlations between incompleteness and symptoms of ASD using Hurley et al.'s (2007) BAPQ. In a sample of 238 undergraduate students, results were that two of the BAPQ subscales correlated significantly with incompleteness at the zero-order level (Pragmatic Language: r = .33; Rigid: r = .44), but the Aloof subscale did not (r = -.01). These results may indicate that certain types of ASD symptoms correlate more strongly with incompleteness than do others, as is the case with different OCD symptom dimensions.

Jiujias, Kelley, and Hall (2017) performed a review of the research on repetitive behaviors in ASD and OCD, with the goal of examining how harm avoidance and incompleteness contribute to these symptoms. They noted that the development of repetitive behaviors follows a similar trajectory in both disorders. In both ASD and OCD, repetitive behaviors become more complex as the individual gets older. In ASD, the progression is from more sensory motor behaviors to more insistence on sameness behaviors; in OCD, from more compulsions to more obsessions. Jiujias et al. explain that compulsions may become more manageable as individuals with OCD get older and become better at suppressing their urges to

compulse. Of note, these findings regarding OCD may also be related to increases in insight with age. However, this similarity in increases in observed complexity may contribute to confusion. Jiujias et al. also discussed how different constructs (e.g., anxiety, executive functioning, sensory phenomena) contribute to the development of these behaviors and noted that the role of anxiety differs in the development of repetitive behaviors between ASD and OCD. Namely, anxiety has a more prominent role in the development of compulsions in OCD. Their conclusions suggest that OCD may be more related to harm avoidance than is ASD. That is, anxiety may have more of a role in OCD than it does in ASD.

Research on OCD and ASD

Epidemiological Studies

Much of the research on OCD and ASD has been devoted to understanding the extent of the comorbidity between these two conditions, as a way to examine whether any specific relationship exists. In one such study, researchers attempted to create a gold-standard diagnostic interview for children and adolescents with developmental disorders. To this end, the Kiddie Schedule for Affective Disorders and Schizophrenia was modified to include more behavioral descriptions and specific language which accounted for the presence of developmental disorders (Leyfer et al., 2006). A combined sample of 109 children diagnosed with ASD from two research sites was used to test the revised instrument. Results were that 37% of the sample met criteria for OCD, which is comparable to comorbidity rates between OCD and other anxiety disorders (e.g.,

Generalized Anxiety Disorder: 30% lifetime comorbidity; Panic Disorder: 13-56% comorbidity; Pallanti, Grassi, Cantisani, Sarrecchia, & Pellegrini, 2011). Some of the most common compulsions among children with developmental disorders included routines involving other people or needing to ask/tell the same statements repeatedly (Leyfer et al., 2006). Findings suggest that the prevalence of OCD within such a sample is much higher than in the general population (e.g., 2.3% lifetime prevalence; Ruscio et al., 2010). These findings do not necessarily suggest a specific relationship between OCD and ASD; however, they provide compelling evidence of an association between the two. A comorbidity rate of 37% is comparable to comorbidity rates between OCD and anxiety-based disorders, a category of conditions to which OCD formerly belonged. Therefore, Leyfer et al.'s findings suggest a moderate to strong relationship between OCD and ASD.

Other researchers also have identified elevated rates of OCD within samples of individuals with ASD. Van Steensel et al. (2011) conducted a meta-analysis of 2,121 individuals with ASD under the age of 18 who had been assessed for anxiety disorders (i.e., OCD, Social Anxiety Disorder, Specific Phobia, Generalized Anxiety Disorder, Separation Anxiety Disorder, Panic Disorder, Agoraphobia, or any combination of these) in order to determine which anxiety disorders were most common among this population. To meet criteria for inclusion in the meta-analysis, the presence of anxiety disorder had to have been assessed using a standardized method (e.g., a structured anxiety disorder interview, a questionnaire with established clinical cutoff scores). Findings were that 39.6% of children with ASD had at least one comorbid anxiety disorder. The most frequent of these was Specific Phobia (29.8%), followed by OCD (17.4%) and then Social Anxiety Disorder (16.6%; van Steensel et al., 2011). Whereas this supports that

OCD occurs among individuals with ASD at a rate far higher than in the general population, it challenges the idea that the relationship between ASD and OCD is specific or privileged; that is, ASD appears to be commonly comorbid with other anxiety-relevant conditions.

Weidle, Melin, Drotz, Jozefiak, and Ivarsson (2012) examined rates of ASD in a sample of 105 children with OCD as compared to a general comparison group of 108 nonclinical children. The study aimed to answer the question of whether ASD should be considered an Obsessive-Compulsive Spectrum Disorder (OCSD). The researchers reasoned that, if ASD were a type of OCSD, ASD symptoms would occur early in childhood, show stability into later development, and occur in a large proportion of cases of pediatric OCD. Results were that ASD symptoms were elevated in the OCD sample, $t_{(211)} = 6.38$, $p < .001$; however, the rate of children meeting full ASD criteria was low (i.e., only one child in each group). Additionally, the researchers noted that most ASD symptoms noted in the sample were those which may be confused with OCD symptoms or tics. For example, “complex body mannerisms” were endorsed in 21.0% of children with OCD and “compulsions and rituals” were endorsed in 77.1% of children with OCD, whereas social symptoms such as “inappropriate facial expressions” (7.6% of children with OCD) were endorsed at lower rates. These results led the researchers to conclude that OCD is not strongly related to ASD, although a subgroup of children with OCD also demonstrates subclinical ASD.

Other researchers have examined patterns of comorbidity and outcomes in OCD and compared those against individuals with ASD or individuals with both disorders concurrently. If OCD and ASD are similar, then there should be similarity in their patterns of comorbidity with other conditions, as well as symptom severity and outcome. One such study compared 35

children with comorbid ASD and OCD to 35 children with only OCD, matched on age and gender (Lewin, Wood, Gunderson, Murphy, & Storch, 2011). They found that comorbidity patterns differed between these groups. Compared to children with only OCD, children with comorbid OCD and ASD were more likely to meet criteria for separation anxiety ($F_{(1, 68)} = 23.4$, $p < .001$) and social anxiety disorder ($F_{(1, 68)} = 32.1$, $p < .001$), as well as display symptoms of inattention and hyperactivity ($F_{(1, 68)} = 13.0$, $p = .001$). Importantly, mean clinician-rated OCD symptom severity did not differ significantly between the OCD only group ($M = 25.9$, $SD = 5.7$) and the OCD and ASD comorbid group ($M = 26.5$, $SD = 8.4$). Interestingly, the OCD-only group reported significantly more sexual obsessions ($F_{(1, 68)} = 4.3$, $p = .04$), checking compulsions ($F_{(1, 68)} = 10.2$, $p = .002$), washing compulsions ($F_{(1, 68)} = 8.2$, $p = .006$), and repeating compulsions ($F_{(1, 68)} = 4.2$, $p = .04$) than did the group with comorbid OCD and ASD. The researchers concluded that OCD with comorbid ASD was phenotypically different from OCD alone.

Another epidemiological study examined the occurrence of ASD symptoms in 257 children and adolescents (age 7-17) with OCD and whether ASD symptoms correlated with OCD symptom severity (Arildskov et al., 2016). The study utilized questionnaire data from parent reports of the Autism Spectrum Screening Questionnaire (ASSQ; Posserud, Lundervold, & Gillberg, 2006). Results were that individuals with pediatric OCD demonstrate elevated ASD symptoms (Mdn = 5) as compared to previous samples of ASSQ data for normally developing children (Mdn = 0). ASD communication and social symptoms were not found to relate with OCD symptom severity; however, ASD repetitive behaviors did ($F_{(1,244)} = 14.686$, $p < .001$). These findings are interesting in that they demonstrate that certain symptoms of ASD (e.g., repetitive behaviors) may show stronger associations with OCD symptoms than do other ASD

symptoms (e.g., social impairments). This general finding has led to research that compares repetitive behaviors within ASD and OCD to examine whether these symptoms demonstrate similarity.

Symptom-Based Studies

Researchers also have examined self- and other reports of symptoms to determine whether compulsions within OCD and stereotypies within ASD are comparable. These investigations have yielded mixed findings. Chok and Koesler (2014) conducted a case study of two adolescents with ASD. One individual also was diagnosed with OCD and displayed repetitive behaviors more consistent with OCD (e.g., wiping surfaces, arranging items symmetrically, and putting loose items away). The other adolescent displayed stereotypies which were more consistent with ASD (e.g., twirling a string). The researchers wished to examine whether compulsions versus stereotypies would be differentially associated with physiological and treatment outcomes. Results supported the separability of these phenomena. The boy with OCD demonstrated heart rate patterns consistent with a "building urge" to engage in compulsions, whereas the boy without OCD did not. Further, the boy without OCD improved in a treatment which used his stereotypy as a reinforcer; the boy with OCD did not, but he did improve with exposure and response prevention (ERP) treatment for OCD. Although these findings require confirmation in a sample of more than two individuals, they suggest that compulsions and stereotypies are different phenomena.

McDougle et al. (1995) examined self-reported repetitive behavior in 50 adults with ASD and 50 adults with OCD, matched on age and sex. Discriminant function analyses revealed that the groups could be distinguished based on the types of repetitive behaviors and thoughts they experienced. Adults with ASD demonstrated significantly more ordering behaviors ($F_{(1, 98)}$ = 6.26, p = .01), hoarding ($F_{(1, 98)}$ = 13.07, p < .001), touching/tapping/rubbing ($F_{(1, 98)}$ = 24.42, p < .001), and self-mutilating repetitive behaviors ($F_{(1, 98)}$ = 19.06, p < .001) than did adults with OCD. Adults with OCD demonstrated significantly more cleaning ($F_{(1, 98)}$ = 12.96, p < .001), checking ($F_{(1, 98)}$ = 29.90, p < .001), and counting behavior ($F_{(1, 98)}$ = 6.53, p = .01), and aggressive ($F_{(1, 98)}$ = 41.49, p < .001), religious ($F_{(1, 98)}$ = 10.28, p = .002), sexual ($F_{(1, 98)}$ = 9.33, p = .003), contamination-based ($F_{(1, 98)}$ = 13.30, p < .001), symmetry-based ($F_{(1, 98)}$ = 22.81, p < .001) or somatic obsessions ($F_{(1, 98)}$ = 13.31, p < .001) than did adults with ASD (McDougle et al., 1995). Results from this study suggest that although individuals with ASD and OCD both experience repetitive thoughts and behaviors, the symptom presentation differs, whether in content or severity.

Another group of researchers compared repetitive behaviors among adults with ASD to those with OCD (Russell, Mataix-Cols, Anson, & Murphey, 2005). Forty adults with ASD were compared against 45 gender-matched adults with OCD. Participants were compared using the Y-BOCS and the Y-BOCS Symptom Checklist (Y-BOCS-SC), which is a gold-standard instrument for the measurement of severity of obsessions and compulsions (Goodman et al., 1989). It should be noted that the original Y-BOCS is meant only to be completed for individuals who already carry an OCD diagnosis; therefore, although Y-BOCS-SC results are interpretable, results from the Y-BOCS may be invalid in this sample. Results indicate that in this sample of adults with

ASD without intellectual disabilities (i.e., IQ > 70), one-fourth also met criteria for OCD. The types of symptoms experienced mostly were the same; the only differences were that individuals with OCD experienced significantly more somatic obsessions ($\chi^2_{(1)} = 13.63$, $p < .001$) and checking ($\chi^2_{(1)} = 5.16$, $p = .023$) and repeating compulsions ($\chi^2_{(1)} = 6.00$, $p = .014$). These results differ from McDougle et al. (1995) in that they suggest greater similarity, rather than difference, in repetitive behaviors displayed by individuals with OCD versus ASD.

Previous findings from adult samples were somewhat mixed when Zandt, Prior, and Kyrios (2007) compared the rates and types of repetitive behavior in children with ASD ($n = 19$), children with OCD ($n = 17$), and typically developing children ($n = 18$). Parent reports indicated that the OCD group demonstrated significantly higher compulsions ($M = 5.12$, $SD = 3.08$) than the ASD group ($M = 2.26$, $SD = 1.72$, $p < .01$). The OCD group also demonstrated significantly higher obsessions ($M = 5.94$, $SD = 2.90$) than the ASD group ($M = 2.68$, $SD = 1.97$, $p < .01$). Both groups demonstrated significantly ($p < .05$) more compulsions and obsessions than typically developing children (compulsions: $M = .56$, $SD = .98$; obsessions: $M = 1.00$, $SD = .91$). Both clinical groups demonstrated similar levels of sameness behavior ($t_{(34)} = 1.21$, $p = .23$, $d = .21$) and repetitive motor movements ($t_{(34)} = -.10$, $p = .92$, $d = .07$). Parent reports further suggested that the repetitive behaviors among children with ASD generally were less sophisticated than in children with OCD (e.g., involved more simple behavior, like ordering; Zandt et al., 2007). As with findings in adults, these results were mixed. The study suggests that there is both overlap *and* divergence among repetitive symptom profiles in those with ASD and OCD.

Biological Studies

Researchers have attempted to compare individuals diagnosed with ASD and OCD using genetic and brain-imaging techniques to (a) determine underlying mechanisms by which these disorders may be related and (b) explain the contradictions within other lines of research into the ASD-OCD association. Jacob, Landeros-Weisenberger, and Leckman (2009) reviewed prior research regarding obsessive-compulsive behaviors (OCBs) within samples with ASD. Conclusions were that (1) ASD is more heterogeneous than was formerly believed; (2) the OCBs found within individuals with ASD vary based on mental age, chronological age, and the etiology of the ASD; and (3) ASD and OCD both appear to be polygenic and as such may share "generalist genes" while also having some specific genes related to the development of each. Their conclusions suggest that OCD and ASD demonstrate at least partial overlap in genetic vulnerability.

Based on research which had demonstrated a shared genetic vulnerability among Attention-Deficit/Hyperactivity Disorder (ADHD), ASD, and OCD, Ameis et al. (2016) used diffusion tensor imaging to examine structural differences in white matter among 200 children and adolescents: 31 with ADHD, 36 with OCD, 71 with ASD, and 62 control participants without a history of neurodevelopmental, psychological or neurological disorders. Results suggest that disruptions in the corpus callosum were shared among those with ADHD, OCD, and ASD. However, disruptions in white matter were more widespread among those with ADHD and ASD as compared to those with OCD. In general, increased disruptions were associated with lower adaptive functioning across all disorders (Ameis et al., 2016). These findings suggest that

OCD and ASD may demonstrate some shared neurological underpinnings, specifically, white matter connectivity, although the type of disruption may vary.

Carlisi et al. (2017) examined the brains of individuals with ASD and OCD during decision-making tasks, with the hypothesis that there may be abnormalities in brain activation during decision making which motivates repetitive behaviors. This study used fMRI to compare 24 boys with ASD, 20 boys with OCD, and 20 control boys without a history of any psychological disorder during a gambling task. Results were that boys with ASD and OCD made choices that were insensitive to reinforcement. Both patient groups demonstrated underactivation in the dorsolateral and inferior frontal brain areas during the task as compared to control participants. During receipt of rewards, boys with ASD showed increased activation in inferior frontal and insular regions related to boys with OCD and control participants. The authors concluded that this indicates both shared and disorder-specific abnormalities in decisional skills. One important limitation of this study was that the researchers did not include a comparison group of boys with a psychological disorder hypothesized to be unrelated to ASD or OCD; this would have increased the strength of the assertion that the observed overlap in brain functioning was specific to the two disorders. Additionally, replication is needed to examine other age groups and females. The use of fMRI was a strength of this study as it allowed for precise imaging of the working brain, and findings suggest that association exists between these disorders in the brain, although it is not complete.

A recent publication from the Enhanced Neuroimaging Genetics through Meta-Analysis (ENIGMA) Consortium compared subcortical and cortical features of individuals with ASD, OCD, and ADHD (Boedhoe et al., 2020). This is the largest comparative study to date,

consisting of neuroimages from 723 individuals with ASD, 140 with OCD, 709 with ADHD and 1,590 healthy control individuals worldwide. Researchers found differences in thickness of the frontal cortex between adults with ASD and healthy controls. They were also interested in whether there would be shared differences in cortical/subcortical features across these disorders; however, they found no structural differences that were shared by all three. Furthermore, the researchers could not find structural differences shared by any pair of disorders that was robust to correction for multiple comparisons. These findings cast doubt on whether OCD and ASD share biological processes.

Treatment Studies

Treatment studies have been conducted with two general goals: (1) examining whether individuals with both ASD and OCD can be treated using typical methods for treating OCD alone (e.g., antidepressant medication, ERP) and (2) determining whether this comorbidity reduces the effectiveness of such treatments. While less informative about the extent of the association between ASD and OCD, these studies are helpful for determining whether, and to what extent, the clinical outcome of individuals with both disorders differs from those with OCD alone.

Research regarding whether pharmacological treatments effective for OCD (e.g., selective serotonin reuptake inhibitors [SSRIs]) is effectiveness in the treatment of ASD is somewhat mixed. Williams, Wheeler, Silove, and Hazell's (2011) meta-analysis included seven RCTs (total $N = 271$), five conducted in samples of children aged 3-17, the other two conducted

in samples of adults aged 18-53. All studies investigated the effects of SSRIs on individuals with ASD. SSRIs are prescribed commonly for comorbidities of ASD, including depression, OCD, and anxiety. The goals were to determine whether SSRIs help with any symptoms that are characteristic of ASD, help with any noncore symptoms, improve quality of life in children with ASD or their caregivers, or cause any harm. Based on findings with children (e.g., no ASD symptoms appeared to decrease significantly in response to SSRIs following 12 weeks of treatment, all *p*s > .36), the authors concluded that there is no evidence of positive effects of SSRIs in children, and there may even be evidence of harm (e.g., social withdrawal, sadness, and weight loss were observed). Among findings regarding adults, the authors also concluded that studies of SSRIs in adults with ASD are small at present, although at the time of the review, these studies suggested effectiveness. This particular area of research is thus rather mixed as to whether pharmacological treatments for OCD also are effective in the treatment of ASD.

Other studies have investigated whether psychotherapies used to treat OCD also may be helpful in treating symptoms of ASD. A case-controlled study matched 22 children with comorbid ASD and OCD to 22 children with OCD only on OCD symptom severity, age, and gender (Murray, Jassi, Mataix-Cols, Barrow, & Krebs, 2015). The primary aim was to discover whether remission rates differed between these groups following a typical course of ERP treatment. Symptoms decreased to a lesser extent in the ASD+OCD group (38% symptom reduction) versus the OCD group (48% symptom reduction). Additionally, fewer children in the ASD+OCD group (9%) met criteria for remission at posttreatment than in the OCD group (46%). Findings suggest that although ASD+OCD children experienced improvements following treatment, ASD may present extra challenges in ERP treatment for OCD, that children with ASD

and OCD may differ in clinically significant ways from children with only OCD, and that treatment may need to be tailored for children presenting with this comorbidity pattern.

Two RCTs also have been conducted. Storch et al. (2013) recruited 45 children (aged 7-11) with ASD and a primary diagnosis of separation anxiety disorder, social phobia, generalized anxiety disorder, or OCD. All children had to meet several inclusion criteria, including an IQ > 70. They also could not be enrolled in any other therapy, excluding speech, occupational, or social skills groups. Twenty-four children were randomized to receive CBT; 21 children received treatment as usual (TAU; in this sample, individual psychotherapy for ASD or anxiety symptoms, medication management, assessment, or group social skills training). Results from this RCT indicate that more children in the CBT arm were treatment responders (75% versus 14%), and they typically showed larger effect sizes following treatment (e.g., large clinician-rated decrease in anxious symptoms in CBT condition, $d = 1.03$; large difference in symptom severity decrease between CBT and TAU favoring CBT, $d = 1.06$). The treatment protocol included specific modifications for children with ASD and other developmental disorders, including addressing low motivation for treatment, non-anxiety-related problem behaviors, and other comorbid conditions. This suggests that modified CBT can be successful for children with ASD and comorbid anxiety disorders, although this study was not specific to OCD.

The other RCT is OCD specific (Russell et al., 2013). In the study, 46 adolescents and adults diagnosed with both OCD and ASD were randomized to receive CBT or anxiety management (a control treatment). Both groups received therapy for 20 sessions. The primary outcome was symptom severity scores. Both groups demonstrated a significant reduction in OCD symptom mean scores per the Y-BOCS at posttreatment (CBT: pretreatment $M = 24.8$, *SD*

= 3.7; posttreatment *M* = 17.8, *SD* = 8.4; anxiety management: pretreatment *M* = 25.1, *SD* = 5.1; posttreatment *M* = 20.8, *SD* = 7.8). Controlling for pretreatment Y-BOCS scores, there were no statistically significant differences in posttreatment Y-BOCS scores between those who received CBT and those who received anxiety management, $F_{(1, 37)} = 1.13$, $p = .295$. However, more individuals in the CBT group could be classified as treatment responders (45% versus only 20%). The authors concluded that both treatments were effective in treating OCD among adolescents and adults with ASD. Although helpful in demonstrating the utility of CBT in this group, the study did not include a control group without ASD for comparison to determine whether comorbid ASD interfered with treatment.

To help answer this question, Kose, Fox, and Storch (2018) conducted a review of research on cognitive-behavioral treatment for individuals with ASD and comorbid OCD. The review included three RCTs as well as one case-controlled study, five case studies, and two single-subject experimental studies. One of the RCTs was the Russell et al. (2013) RCT reviewed above; the other two RCTs demonstrated CBT and function-based CBT to be superior to treatment as usual. In reviewing these studies, the researchers concluded that CBT for individuals with this comorbidity is promising, especially when protocols are modified to take into account the unique challenges presented by this pattern. Some recommendations for treatment based on their findings include the involvement of parents, provision of clear instructions and personalized treatment metaphors, and increased reliance on visual learning and positive reinforcement (Kose et al., 2018). These findings are interesting in two ways. First, in demonstrating that ASD with comorbid OCD can be treated by the same methods as OCD alone, the findings may suggest that the disorders overlap to some extent. Second, they suggest that

treatment effectiveness need not be hindered by the presence of comorbid ASD, which is encouraging from a clinical perspective.

A more recent investigation suggests that, although treatment for OCD with comorbid ASD may still be effective, its effectiveness may be tempered by the comorbidity. A sample of children aged 4-17 who had been treated at a clinic in South London was analyzed to compare clinical presentations for children presenting with OCD only, ASD only, and OCD+ASD (Martin et al., 2020). The sample was large, consisting of 1,010 children with OCD, 6,577 children with ASD, and 335 children with OCD+ASD. Researchers noted that the children with OCD+ASD demonstrated greater functional impairment at the time of diagnosis than children who presented with either condition in isolation. Children with OCD+ASD were as likely as children with OCD to receive CBT but utilized treatment for longer and to lesser effect. These findings suggest that, while CBT is helpful for individuals with the OCD+ASD comorbidity, the presence of these disorders together may present specific challenges to treatment.

Limitations of Past Research and New Directions

As is evident from the reviewed literature, much research has been conducted on the relationship between ASD and OCD. A majority of these studies rely on self- and other reports of behavior, rather than on direct observations of behavior. To date, no behavioral studies have been completed examining mechanisms by which the association between ASD and OCD may exist. This likely is the case because there is no standardized method for evoking or modeling ASD-related behavior in humans in a laboratory setting. This makes it impossible to institute the

level of control required for experimental investigations of ASD, let alone of ASD and OCD together. Lacking a precedent in human research, one can turn to nonhuman animal research.

Rodents have been used to model various symptoms of ASD for many years, and there now are standardized methods. For example, the repetitive behavior found in individuals with ASD is examined in mice using simple behaviors they are likely to repeat, such as marble burying or grooming (Holmberg et al., 2016; Wöhr & Scattoni, 2015). Social behaviors typically are modeled using a preference paradigm in which the animal is given a choice between exploring an area occupied by a "stranger" mouse whose movement is restricted by a wire cage (social) or an area containing an empty wire cage (nonsocial). Importantly, because the stranger mouse is restricted in its movements, individual differences in the stranger mouse's behavior do not affect the outcome of the behavioral test. Animals modeling ASD tend to show a preference for the nonsocial situations and will spend more time in an empty space than one occupied by another mouse; this is atypical in social rodents such as mice (Holmberg et al., 2016; Wöhr & Scattoni, 2015).

One of the criticisms of animal models such as the social preference paradigm is whether such a task oversimplifies a complex construct such as ASD. In fact, rodent "asocial" behavior such as assayed by the social preference paradigm also has been used to model negative symptoms in schizophrenia. Researchers caution that this particular behavioral paradigm may be unable to distinguish between ASD-asocial behaviors and schizophrenia-asocial behaviors and may be understood better as representing general social dysfunction rather than symptoms of a particular disorder (Wilson & Koenig, 2014). However, an animal model need not be specific to a certain disorder in order to be useful. Animal researchers assert that to be useful, a good animal

model need demonstrate: (a) construct validity, in that the animal model of a disease has similar causes to the actual disease in humans; (b) face validity, in that the animal model obviously mimics some characteristic of the disease in humans; and (c) predictive validity, in that the animal model can be used to identify symptoms or treatments in humans (Holmberg et al., 2016).

To this end, the social preference task meets criteria for a good animal model of asociality in human ASD. (a) As evidence of its construct validity, some researchers have attempted to breed mice deficient in oxytocin receptors, as disruption of the oxytocin system is one of the theorized mechanisms behind the development of ASD in humans. Mice with these oxytocin receptor "knockouts" demonstrate abnormal behavior in the social preference task; that is, they spend the same amount of time with the stranger mouse as with the empty cage (Sala et al., 2011). (b) The face validity of the social preference task is clear. That is, the animal is showing a behavior that involves a nonsocial preference. (c) The social preference task also demonstrates predictive validity. When oxytocin-deficient mice were treated with an oxytocin injection, their behavior normalized such that they spent significantly more time with the stranger mouse than the empty cage, $F_{(4, 90)} = 6.37$, $p < .001$ (Sala et al., 2011). These findings were predictive of similar results in humans. Individuals with ASD demonstrated improved social behavior in the form of gaze fixation on social stimuli following administration of intranasal oxytocin (from 41.2% to 52.3% of time, $p = .03$). Furthermore, oxytocin was superior to the placebo in improving gaze fixation ($d = .55$, $p = .018$; Yamasue et al., 2018). Standards such as these from animal research can be useful in that they may suggest ways of modeling analogous behaviors in the laboratory among humans.

Approach-Avoidance Tasks

One way to translate rodent models of ASD into human research designs may be using a paradigm that has been used in anxiety research since Rinck and Becker (2007) developed it to study spider phobia – the approach-avoidance task (AAT). The AAT was developed as a computer task using pictures to mimic the behavioral avoidance shown by individuals who are fearful of an in vivo stimulus. The idea is that individuals who would not want to approach a stimulus in real life also would prefer to "avoid" such a stimulus when presented as a computer image by pushing it away (e.g., with a joystick). Rinck and Becker (2007) compared 25 individuals with spider fears against 22 nonanxious controls on this task, which involved eight pictures with spiders in them and eight of the same pictures modified so that there was no spider. Theirs was a within-subjects design; during one half of the experiment, the instructions were to pull spider-free pictures close and push spider pictures away. For the other half of the experiment, the instructions were reversed. The AAT was followed by a BAT involving a live spider. On average, all individuals responded more quickly to spider pictures than spider-free pictures. However, while individuals with spider fears were quicker to push spiders away than to pull them close, there was no difference among nonanxious controls. The time difference to push versus pull spider pictures on the AAT correlated with how quickly participants would approach real spiders on the BAT ($r = .48$, $p = .001$); that is to say, the faster an individual pushed a spider away in the AAT, the slower they approached it in the BAT. This led the authors to conclude that the AAT was a valid paradigm for modeling avoidance using computers (Rinck & Becker, 2007).

Najmi, Kuckertz, and Amir (2010) modified the AAT for the study of OCD-relevant phenomena, and specifically for use in analogue OCD samples using contamination-relevant stimuli. Contamination-relevant and control pictures were presented on a computer, and subjects were instructed to use a joystick to pull or push images away from them. Twenty individuals with high self-reported contamination concerns were compared to 21 individuals with low self-reported contamination concerns. Participants were given instructions to pull pictures with green borders toward them and push pictures with blue borders away. Results indicated that there were no differences in how quickly the groups pushed contaminated pictures away. However, among high-contamination participants, the latency to pull contaminated pictures closer (M = 889 ms, SD = 141 ms) was significantly higher than the latency to pull neutral pictures (M = 866 ms, SD = 125 ms, $t[19] = 2.51$, $p = .02$). This suggests that high-contamination individuals may have a tendency to avoid contaminated stimuli which has to be overcome to "pull" them closer (Najmi et al., 2010).[1] Other studies have used the AAT to examine whether these automatic tendencies in OCD can be overcome (Amir, Kuckertz, & Najmi, 2013), and the AAT has been adapted using a computer mouse instead of a joystick (Weil, Feist, Moritz, & Wittekind, 2017).

There are data to support the use of the AAT in modeling approach and avoidance

[1] Although the difference of 23 ms may seem to lack clinical significance at first glance, this magnitude is similar to other effect sizes observed in reaction time research. For example, Woods, Wyma, Yund, Herron, and Reed (2015) observed an increase in response latency to visual stimuli of 22 ms when comparing their youngest (aged 18-24) to their oldest (aged 59-65) groups of participants. Similarly, Pascual-Leone et al. (1992) discovered that the use of transcranial magnetic stimulation (TMS) of the motor cortex shortened reaction times to visual stimuli by a maximum of 30.8 ms (as compared to non-TMS trials). Additionally, 23 ms may be considered significant in the context of the speed at which neural impulses travel, which has been estimated at 89.41 meters per second in some cases (Myers, 1995), as well as within the context of more recent research that has demonstrated visual information can be processed in as little as 13 ms (Potter, Wyble, Hagmann, & McCourt, 2013). These findings would support the assertion made by Najmi et al. (2010) that the difference of 23 ms indicates the slightest increase owing to an automatic avoidance tendency which must be overcome to pull contaminated, but not neutral images, closer to oneself.

behavior as occurs in OCD in the laboratory. AATs may be useful in modeling ASD for two reasons. First, use of social stimuli could be used to model the social symptoms of ASD, and this would be in keeping with how social symptoms of ASD are modeled among rodents. Second, because it already is a method used in OCD research, use of an AAT to model ASD could provide a way to compare the two disorders using the same method and allow for the behavioral research that, until the current study, was missing from the extant literature.

Research into Mechanisms

Another void in the literature examining ASD and OCD involves investigating mechanisms by which the relationship exists. Although the reviewed biological studies suggest potential areas of brain under- or overactivation, the majority of studies have been limited to single-timepoint, correlational investigations. Because ASD and OCD demonstrate overlap only for some symptoms or some methodologies, a better understanding is needed of where they are linked and where they diverge.

Incompleteness is a potential mechanism by which this relationship may exist; however, until the current study, incompleteness, OCD, and ASD had not yet been examined jointly in one study. Incompleteness may explain why certain symptoms (e.g., OCD ordering, ASD repetitive behaviors) overlap more than others do. These are the same symptoms which show the strongest correlations with incompleteness (Kloosterman et al., 2013; Taylor et al., 2014). Although not longitudinal in nature, the current study allowed for an investigation of incompleteness as a mechanism by gathering baseline ratings of incompleteness prior to the approach-avoidance task.

The Current Study

The current study made use of the methodology described by Najmi et al. (2010). However, this study expanded upon their methods, with the inclusion of three picture sets taken from the IAPS and, in the case of not-just-right images, a broader online search: (a) a contamination set with matched neutral pictures, (b) a not-just-right set with matched neutral pictures, and (c) a social set with matched neutral pictures. The contamination and not-just-right sets were expected to provide models for OCD contamination and incompleteness symptoms, respectively. I attempted to obtain the same contamination set as used by Najmi et al. (2010) for use in the current study; however, Najmi et al.'s team was unresponsive, and I eventually created a contamination set from scratch. The social and not-just-right sets were expected to provide models for ASD social and insistence on sameness symptoms, respectively. As a brief note, the "not-just-right" set was so named, because these images were to elicit not-just-right experiences, the state manifestation of underlying incompleteness concerns.

This study made use of a pilot testing sample to confirm that the social and not-just-right stimulus sets would work to model ASD in a nonclinical sample. Had the stimulus sets worked as expected, this would have been an important step in broadening the field of ASD research to include nonclinical samples to collect ASD-relevant data. Finally, this study made use of an AAT paradigm. This was chosen because it is a simple and widely disseminable way of comparing approach and avoidance behaviors in those with symptoms of OCD and ASD. If supported, findings from this kind of study would be useful for beginning to study the relationship between OCD and ASD from the perspective of in-lab behaviors.

Hypotheses

Four hypotheses were proposed for this project. Hypothesis 1a is that higher obsessive-compulsive contamination symptoms will predict increased reaction time to pull contaminated pictures, as compared to neutral pictures, in the contamination set. This is consistent with findings that individuals with higher contamination concerns show increased latency to respond when instructed to approach contaminated images in an AAT (Najmi et al., 2010).

Hypothesis 1b is that higher obsessive-compulsive ordering symptoms will predict increased reaction time to pull not-just-right pictures, as compared to neutral pictures, in the not-just-right set. Modeling OCD ordering symptoms using the AAT would be an extension of findings from Amir et al. (2013), Najmi et al. (2010), and Weil et al. (2017), who all successfully modeled OCD contamination symptoms using the AAT paradigm.

Hypothesis 1c is that higher total scores on a measure of obsessive-compulsive symptoms will not predict increased reaction time to pull social pictures, as compared to neutral pictures, in the social set. If supported, this would provide evidence of the discriminant validity of the social picture set in modeling ASD (but not OCD) symptoms.

Hypothesis 2 is that self-reported levels of incompleteness concerns will mediate the relationship between self-reported obsessive-compulsive ordering symptoms and latency to approach not-just-right pictures. If found, this would be consistent with results from other investigations that have suggested incompleteness correlates moderately to strongly with ordering symptoms (Pietrefesa & Coles, 2008; Taylor et al., 2014). This also would suggest that

it is incompleteness, rather than OCD symptoms per se, that motivates avoidance of disordered environments.

Hypothesis 3a is that higher scores on a measure of ASD social symptoms will predict increased reaction time to pull social pictures, as compared to neutral pictures, in the social set. This is consistent with animal models of ASD, in which ASD-model animals demonstrate preference for nonsocial over social situations (Holmberg et al., 2016).

Hypothesis 3b is that higher scores on a measure of ASD rigidity/repetitiveness symptoms will predict increased reaction time to pull not-just-right pictures, as compared to neutral pictures, in the not-just-right set. Modeling ASD symptoms using the AAT would be an extension of findings from Najmi et al. (2010) and Rinck and Becker (2007), who successfully modeled symptoms of other conditions (e.g., OCD, spider phobia) using the AAT paradigm.

Hypothesis 3c is that higher total scores on a measure of ASD symptoms will not predict increased reaction time to pull contaminated pictures, as compared to neutral pictures, in the contamination set. If supported, this would provide evidence of the discriminant validity of the contamination picture set in modeling OCD symptoms, but not ASD symptoms.

Hypothesis 4 is that self-reported levels of incompleteness concerns will mediate the relationship between self-reported ASD rigidity/repetitiveness symptoms and increased latency to approach not-just-right pictures. If found, these results would support the assertion that incompleteness may partially explain the association between OCD and ASD (Esler et al., 2018; Kloosterman et al., 2013).

CHAPTER 2

METHOD

Pilot Testing

In order to develop contamination, not-just-right, and social picture sets, I reviewed the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 1997) for images that represented those three domains. After learning that there were relatively few IAPS images potentially representative of not-just-right, I then turned to picture-based internet forums using the terms “drive you crazy” and “infuriating” for additional images that would potentially elicit feelings of not-just-right. The resulting picture sets were presented to a pilot testing sample in order to gain objective ratings of how contaminated, how not-just-right, and how social the target images were perceived to be by a nonclinical sample. The goal of the pilot testing was to arrive at a set of the 12 most contaminated images, a set of the 12 most not-just-right images, and a set of the 12 most social images. These were “matched” to neutral images in a matter described below to comprise the final picture sets for the main phase of data collection.

Participants

Participants for the pilot study were drawn from Amazon's Mechanical Turk (MTurk) website. Recommended sample sizes for pilot data vary, but the current study gathered data from 21 participants (Connelly, 2008; Hill, 1998). An MTurk sample was proposed for pilot testing because this (a) allowed for rapid data collection and (b) ensured minimal overlap with the student sample from which the main phase of data collection drew.

The MTurk platform allows for multiple specifications regarding which individuals are allowed to participate in a given study. To increase the likelihood that the data would be of high quality, only MTurk "workers" (platform users) with high approval ratings (> 95%) were allowed to participate in the pilot testing. This restriction has allowed previous researchers to collect data of similar quality to data that have included attention check questions (Peer, Vosgerau, & Acquisti, 2013). To prevent "bots" from completing the pilot testing, MTurk workers were asked to complete a V2 Completely Automated Public Turing Test to Tell Computers and Humans Apart (CAPTCHA), which asked workers to select target images from a series of images based on a category.

Measures

Demographic Questionnaire

To characterize the sample as to basic demographic variables, participants were presented

with several questions regarding age, sex, and racial/ethnic identification. The pilot sample self-identified as 61.9% male and 9.5% African American or Black, 19.1% Asian or Asian American, 57.1% Caucasian or European American, 4.8% Native American, and 9.5% multiracial. Nineteen percent of the sample identified as ethnically Hispanic/Latino. The average age of participants was 37.14 years (*SD* = 11.86), which is older than most student samples, including the student sample used for the main data collection phase of the current study. See Appendix A for demographic questionnaire.

Picture Ratings

Participants were asked to rate each of 200 pictures on a 0-10 scale. For the pool of 55 contaminated pictures, participants were asked: "Rate the level of 'contaminated'-ness of the following images. 'Contaminated' here indicates that one or more aspects of the image are anxiety-provoking or disgusting in the sense that they depict decay, disease, or contagion." The following anchors were used: 0 (*not contaminated at all*) to 10 (*the most contaminated*). For the pool of 80 not-just-right pictures, participants were asked: "Rate the level of 'not-just-right'-ness of the following images. 'Not-just-right' here indicates that one or more aspects of the image are troubling or irksome in the sense that they are off-balance, disorganized, or otherwise incomplete." The following anchors were used: 0 (*not not-just-right at all*) to 10 (*the most not-just-right*). For the pool of 65 social pictures, participants were asked: "Rate the level of 'social'-ness of the following images. 'Social' here indicates that one or more aspects of the image are pleasing or approachable in the sense that they would encourage participation or

conversation." The following anchors were used: 0 (*not social at all*) to 10 (*the most social*).

Procedure

Participants were asked to read and complete a consent page before beginning testing. Those participants who consented to participate completed ratings through the MTurk platform on their personal devices. Participants were presented with the selected IAPS and internet pictures in random order, with the relevant rating scale beside the image. Upon completion, participants were compensated with $3.00 through the platform.

Results

Participant responses were reviewed. The 12 items with the highest mean ratings in each category (contamination, social, not-just-right) were selected to comprise the target sets. Please see Table 1 for average ratings of picture sets nominated by the pilot sample.

Table 1. Pilot Sample Mean Ratings of Picture Set Items

	Observed range of means (min-max)	Grand mean (*SD*)
Contamination set	6.86 - 8.00	7.44 (0.35)
Social set	7.23 - 7.90	7.57 (0.19)
Not-just-right set	5.38 - 7.28	5.85 (0.50)

Note. Possible range of item means is 0.00 – 10.00 for all picture sets.

Picture Matching Phase

Materials

The 12 most contaminated, the 12 most not-just-right, and the 12 most social images as rated by the pilot sample were matched to neutral images drawn from the IAPS.

Procedure

Neutral images were matched based on color and orientation to noncontaminated, non–not-just-right, and nonsocial images, respectively. Per the recommendations of the committee, other methods of matching were also considered. A broad literature search revealed that in addition to orientation and color, images also can be matched based on lines, complexity, gradient, and resolution. No resources were found suggesting which of these methods are preferred. After consulting with a departmental faculty member familiar with the use of images in research (Brad Sagarin, PhD), it was decided that if the literature offers no insight into preferred matching methods, then matching methods should be consistent with the literature the present study aims to extend. Therefore, it was decided that orientation and color would remain the basis of image matching in the present study.

Orientation matching was accomplished by ensuring that a neutral image is landscape if the target image is landscape and portrait if the target image is portrait. Color matching was accomplished using Image J, a program developed at the National Institutes of Health for the

purpose of analyzing images (Rasband, 1997). Image J was used to create histograms depicting the color distribution of all images from the pilot testing phase, as well as the images pulled from the IAPS. The histograms of target and nontarget images were compared and "matched" so as to create a final contaminated picture set comprising 12 target images and 12 matched neutral images. The same approach was used to create a final set for all three domains. The purpose of the matching procedure was to provide neutral images that closely approximate the content of the target images, with the main difference being only the construct of interest.

Main Data Collection Phase

Participants

Participants for this study were drawn from undergraduate students enrolled in introductory psychology courses at Northern Illinois University. The average age of sample participants was 19.76 years (*SD* = 2.87). The sample was 56.4% female. Racially, participants self-identified as: 36.4% African American or Black, 10.9% Asian or Asian American, 40.0% Caucasian or European American, 1.8% multiracial and 10.9% another race. 20.0% of participants self-identified as ethnically Hispanic/Latino. Of the total sample, 58.2% indicated a need for corrective eyewear, such as glasses or contacts; however, only 41.8% of the total sample was wearing corrective eyewear for the study session. The remaining nine individuals were included in the analyses, as other methods of error detection were used in reviewing reaction time data. Finally, no individuals reported the presence of a movement disorder.

Sample Size

Prior to data collection, a power analysis was conducted in G*Power (Faul, Erdfelder, Buchner, & Lang, 2009) with alpha level set to .05 and power set to .80. Results suggested that a sample of 68 participants would be needed to detect the medium effect sizes found in the study upon which the present methods are based; in this study, a factorial ANOVA comparing the interaction effect of group (high versus low contamination) and picture type (contaminated versus neutral) generated an effect size of $\eta^2 = .12$ (Najmi et al., 2010). For this study, I therefore aimed to obtain a valid $N = 70$. However, due to the COVID-19 pandemic and the closure of the NIU campus for the final two months of the academic year 2019-2020, in-person data collection for the current study was suspended. After deliberation with the committee, it was determined that there was no reasonable way to move the study to an online format for a short-term attempt at data collection. The final valid $N = 55$.

Measures

Demographic Questionnaire

The study made use of the same demographic questionnaire as was used for the pilot study.

OCD Symptoms

The Schedule for Compulsions, Obsessions, and Pathological Impulses (SCOPI; Watson & Wu, 2005) is a 47-item questionnaire with response options ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The SCOPI was developed via factor-analytic methods and consistently demonstrates five subscales: Compulsive Rituals, Obsessive Checking, Obsessive Cleanliness, Hoarding, and Pathological Impulses. As hoarding no longer falls under the diagnostic category of OCD (APA, 2013), and the Pathological Impulses subscale was intended to measure disorders of impulse control (e.g., kleptomania), only the Compulsive Rituals, Checking, and Cleanliness subscales were scored for the proposed analyses. In the present study, these three subscales demonstrated moderate intercorrelations (*r*s = .34-.50). The total scale demonstrated good internal consistency estimates (α = .93, average inter-item correlation [AIC] = .28). The Compulsive Rituals (α = .89, AIC = .51), Checking (α = .93, AIC = .47), and Cleanliness subscales (α = .87, AIC = .37) also demonstrated adequate internal consistency in the present sample. The scale did not demonstrate problems with range restriction in the current, unselected sample of NIU students. However, a surprising number of students (*n* = 13, 23.6%) reported total scores on the SCOPI that were at or above the mean total score reported by a clinical sample of individuals being treated for OCD (Watson & Wu, 2005). Notably, another recent unselected sample of NIU students also demonstrated clinically elevated SCOPI scores at unexpected rates (30.4% of students in Lee & Wu, 2019). This may indicate a higher than expected level of OCD-related pathology among the participants of the current study. As a trend, this may suggest increasing mental health concerns among college students more generally. Of

course, another consideration is that psychopathology questionnaires are susceptible to overestimating the prevalence of clinically relevant problems, at least in comparison to structured interviews (e.g., Thombs et al., 2018). See Table 2 for descriptive statistics for all independent variables.

Table 2. Descriptive Statistics

	M	*SD*	Observed range min-max	α	AIC
SCOPI Total	95.33	21.76	53.00 - 142.00	.93	.28
SCOPI Checking	40.75	12.19	16.00 - 65.00	.93	.47
SCOPI Contamination	33.82	8.28	15.00 - 52.00	.87	.37
SCOPI Compulsive Rituals	20.76	6.99	8.00 - 37.00	.89	.51
BAPQ Total	2.99	.53	1.67 - 4.53	.86	.15
BAPQ Social Deficits	3.01	.84	1.58 - 5.17	.88	.38
BAPQ Social Language Deficits	2.83	.60	1.67 - 4.08	.65	.14
BAPQ Stereotyped Repetitive Behaviors	3.13	.70	1.42 - 4.83	.80	.24
OC-TCDQ Harm Avoidance	24.72	9.12	10.00 - 45.00	.93	.58
OC-TCDQ Incompleteness	27.35	8.50	12.00 - 48.00	.92	.52

Note. SCOPI = Schedule of Compulsions, Obsessions, and Pathological Impulses.
SCOPI Total derived from summing Checking, Contamination, and Compulsive Rituals.
BAPQ = Broad Autism Phenotype Questionnaire.
OC-TCDQ = Obsessive-Compulsive Trait Core Dimensions Questionnaire.
AIC = Average inter-item correlation.

ASD Symptoms

The Broad Autism Phenotype Questionnaire (BAPQ; Hurley et al., 2007) is a 36-item questionnaire with response options ranging from 1 (*very rarely applies*) to 6 (*applies very often*). The BAPQ has three 12-item subscales: Social Deficits, Social Language Deficits, and

Stereotyped Repetitive Behaviors. The total score is calculated by averaging across all 36 items; subscale scores are calculated by averaging across the 12 items for that subscale.

Two of the BAPQ subscales demonstrated adequate internal consistency in the present sample – Social Deficits (α = .88, AIC = .38) and Stereotyped Repetitive Behaviors (α = .80, AIC = .24) – as did the total scale (α = .86, AIC = .15). The Social Language Deficits subscale demonstrated low reliability estimates (α = .65, AIC = .14); however, this particular subscale was not used in isolation for any of the primary analyses for the current study. Additionally, none of the BAPQ subscales nor the total scale demonstrated problems with range restriction in the current study. However, a surprising number of students (*n* = 22; 40.0%) scored at or above the cutoff identified by Hurley and colleagues (2007) for maximum sensitivity and specificity in identifying the Broad Autism Phenotype, which may indicate a higher than expected level of expression of this phenotype in the current sample of students. Finally, the subscales demonstrated moderate correlations with one another in the current sample, *r*s = .31 - .34. Compared to other measures of autistic traits, the BAPQ shows higher levels of internal consistency than the Autism Spectrum Quotient (AQ; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001); it also was superior to the Social Responsiveness Scale for Adults (SRS-A; Constantino & Todd, 2005) in differentiating ASD symptoms from general psychopathology (Ingersoll, Hopwood, Wainer, & Donnellan, 2011). Furthermore, self-report scores on the BAPQ are significantly related to individual differences in performance on an eye-tracking task measuring joint attention (Swanson & Siller, 2014) and to self-reported frequency of sensory processing problems ($r = .78$, $p < .001$; Robertson & Simmons, 2013), both of which are often researched as covariates or markers of ASD.

Incompleteness and Harm Avoidance

The Obsessive-Compulsive Trait Core Dimensions Questionnaire (OC-TCDQ; Summerfeldt et al., 2001) was developed to measure two theorized motivations contributing to obsessive-compulsive symptoms: feelings of incompleteness and desire for harm avoidance. This measure is a 20-item self-report questionnaire with response options ranging from 1 (*never applies to me*) to 5 (*always applies to me*). The OC-TCDQ has two 10-item scales: Incompleteness and Harm Avoidance.

Both the Harm Avoidance ($\alpha = .93$, AIC = .58) and Incompleteness ($\alpha = .92$, AIC = .52) demonstrated adequate internal consistency estimates in the current study. The AICs may indicate that some items of each scale are redundant. Research has shown that the scales are correlated strongly in student samples (*rs* = .70-.76) but are separable via factor analysis (Pietrefesa & Coles, 2008; Summerfeldt et al., 2014). In the present sample, the subscales were again highly correlated with one another, $r = .71$, $p < .05$.

Validity Questions

As an attention check, two validity questions were embedded among the other questionnaires. For validity questions used, please see Appendix B.

Procedure

As reviewed, Najmi et al. (2010) developed a modified AAT using contamination-related pictures for an analogue OCD sample. The current study drew upon their method. Participants completed the in-laboratory study in the presence of a trained research assistant. They were presented with a printed informed consent document and given the opportunity to read and ask questions. After providing written informed consent, all participants completed baseline measures, including a demographic questionnaire, SCOPI, BAPQ, and OC-TCDQ. Next, participants completed the AAT.

The AAT included 16 practice trials consisting of neutral images not used in any of the three test sets. The three test sets included images taken from the IAPS and screened from the internet: (a) a social set, (b) a contamination set, and (c) a not-just-right set. The social set was drawn from the images used in the pilot study. It comprised the 12 most socially relevant pictures from the pilot study and 12 control pictures, matched on color and shape. The contaminated set comprised the 12 most contamination-relevant pictures drawn from the pilot study and 12 control pictures, matched on color and shape. Finally, the not-just-right set comprised 12 images which depicted the most not-just-right pictures as rated in the pilot testing phase, matched to 12 control pictures on color and shape. All participants viewed all three picture sets; the order of presentation was randomized.

Pictures were presented on a computer screen in either blue or green frames. For an example of what the framed images look like, please see Appendix C. Half of the target (e.g., social, not-just-right) pictures were blue framed and half green framed. The nontarget pictures

also appeared half in blue and half in green frames. Participants were given directions to pull (push) the picture toward (away from) them with the mouse if the picture is in a blue (green) frame. To begin the practice set and test sets, participants clicked the mouse and the first image appeared on the screen. In each trial, the picture became larger if participants pulled the mouse toward them and smaller if participants pushed the mouse away from them. After participants made a choice, they were instructed to return the mouse to a neutral position; once the mouse was in the neutral position, the participant could click for the next image to be presented. Reaction time was calculated as the length of time the picture was on the screen before it disappeared.

CHAPTER 3

RESULTS

Data Cleaning

Prior to performing the main analyses, a systematic approach to data cleaning and preliminary evaluation was conducted. First, individuals were removed from the dataset if they showed invalid responses to both of the two validity questions imbedded within the questionnaires. This resulted in the removal of one individual. As proposed, the original data analysis plan included the removal of individuals from the dataset if they indicated on the demographic questionnaire that they use contact lenses or eyeglasses but did not have them for the study or if they indicated that they suffer from a movement disorder. In the raw dataset, no individuals indicated the presence of a movement disorder; nine individuals indicated that they use contact lenses or eyeglasses but did not have either for the study. Due to the need to suspend data collection early and in consultation with the committee, it was determined that these nine individuals would be retained in the dataset, as cleaning procedures for raw reaction times would remove any errors or significantly fast/slow reaction times resulting from visual or motor impairments.

Second, patterns of missingness within the remaining dataset were analyzed using Little's MCAR test. Little's MCAR test revealed that the missing data within the set was missing completely at random, $\chi^2(1287) = 0.00$, $p = 1.000$. Participants with more than 5% of their data

missing from a given questionnaire were to be excluded from analyses using that questionnaire (Schafer, 1999); however, such a result was not observed within the dataset. When fewer than 5% of data were missing on a given questionnaire, the missing values were imputed using multiple imputation, a method by which multiple likely values are estimated from the remaining dataset, and these likely values are averaged (Rubin, 1987). Based on guidelines established by Shafer and Olsen (1998), 10 imputations were used for this dataset. A total of eight missing values (.07%) were imputed using this method.

Raw reaction time data were examined next, and invalid reaction times were omitted from the primary analyses. Reaction times were considered invalid if (a) the participant's direction of responding (i.e., push, pull) was incorrect per task instructions; (b) the reaction time was extremely fast (i.e., greater than 3.0 SD faster than average for the trial); or (c) the reaction time was extremely slow (i.e., greater than 3.0 SD slower than average for the trial; Baayen & Milin, 2010). A total of 1,472 (18.6%) responses were invalid due to directional errors; an additional 1,418 (17.9%) responses were invalid due to extremely fast or slow reaction times.

Next, average reaction times were calculated for all participants from the raw reaction time data that remained after invalid responses were deleted. Reaction times were calculated separately for each picture set (e.g., contaminated, not-just-right, social). Within each set, participant average reaction times to pull the target pictures, to pull the nontarget pictures, to push target pictures, and to push nontarget pictures were calculated separately by summing reaction times for all target/nontarget pull/push pictures in the set (i.e., sum reaction times for six contamination-pull images, divide by 6). Therefore, each participant had six average pull reaction times (set x target/non) for use in the primary analyses.

The dataset next was examined for outliers by plotting all continuous measures using box plots. In addition, standardized total scores for all measured variables and subscales were examined. Absolute standardized values greater than 3.29 were to be deemed outliers (Field, 2005), but no outliers of that magnitude were identified within the dataset.

The normality of the data was examined using the Kolmogorov-Smirnov and Shapiro-Wilk tests of normality. If either test was significant, this would be an indication that the data are nonnormal. Of note, both tests are highly sensitive to violations of normality; an alpha level of .01 was chosen a priori. The Checking subscale of the SCOPI was the only subscale which was non-normal using these guidelines, and then only per the Kolmogorov-Smirnov test (p = .003) and not per the Shapiro-Wilk test (p = .039). The skew and kurtosis of the data were examined. The data were to be considered significantly skewed and/or kurtotic if standardized scores for skew and kurtosis exceeded 2.58 (Field, 2005). Per this cutoff, none of the subscales demonstrated significant skew or kurtosis in the current dataset. Therefore, and because results from the normality tests were equivocal for SCOPI Checking, no data transformations were conducted for analyzing the current dataset.

Preliminary Analyses

The primary outcome measure is the difference in reaction time to follow "pull" instructions on target (contaminated, not-just-right, and social) versus nontarget (neutral) images. Difference in reaction time was calculated for each individual as follows. Difference in reaction time in the contamination set consists of average reaction time to pull contaminated pictures

minus average reaction time to pull the matched neutral pictures in the contamination set. Difference in reaction time in the not-just-right set consists of average reaction time to pull not-just-right pictures minus average reaction time to pull not-just-right–matched neutral pictures. Difference in reaction time in the social set consists of average reaction time to pull social pictures minus average reaction time to pull social-matched neutral pictures.

Once reaction time differences were calculated, the data were checked to confirm that they conform to the other assumptions of linear regression. First, linearity was examined by creating scatter plots for all bivariate relationships of interest. This included (1) contamination-pull reaction time difference and SCOPI Contamination scores, (2) social-pull reaction time difference and BAPQ Social Deficits scores, (3) not-just-right–pull reaction time difference and SCOPI Compulsive Rituals scores, and (4) not-just-right–pull reaction time difference and BAPQ Stereotyped Repetitive Behavior scores. Per this method, all examined relationships appeared to be linear.

The multicollinearity assumption was tested by running a dummy regression including all variables of interest. Variance inflation factor (VIF) and Tolerance statistics were calculated based upon this dummy regression. If results indicate that VIF > 10 and/or Tolerance < .1, this would be taken as evidence that multicollinearity exists within the variables and that this assumption has not been met. However, all VIF and Tolerance statistics fell within acceptable range.

The homoscedasticity assumption also was tested using results from the dummy regression. Residuals for all variables were examined using scatter plots. If visual examination of this scatter plot revealed a distinct conical shape in the residuals, this would be taken as evidence

that the homoscedasticity assumption was not met. Examination of the residuals revealed no distinctly conical shapes.

Finally, before data analysis proceeded to hypothesis testing, the zero-order correlations among all measures of interest (i.e., SCOPI, BAPQ, and OC-TCDQ) were calculated. Per these correlations, all of the subscales of the SCOPI were moderately to strongly intercorrelated with one another (*r*s = .34 - .50), as expected. The subscales of the BAPQ also were moderately intercorrelated (*r*s = .31 - .34). The two scales of the OC-TCDQ were very strongly correlated (.71), consistent with its performance in other student samples (Lee & Wu, 2019). Regarding correlations between measures, the Social Deficits subscale of the BAPQ was not significantly correlated with any subscale of the SCOPI or OC-TCDQ. This too was consistent with the performance of this scale in another student sample (Lee & Wu, 2019) and may indicate that this subscale of the BAPQ taps into symptoms that show the least overlap with symptoms of OCD. Rather unexpectedly, the BAPQ Social Language Deficits subscale was significantly correlated with SCOPI Checking (*r* = .47). This relationship was as strong as the intercorrelations among the SCOPI subscales (*r*s = .34 - .50). Finally, both scales of the OC-TCDQ demonstrated moderate to strong correlations with all SCOPI (*r*s = .31 - .74) and BAPQ subscales (*r*s = .31 - .49), except the BAPQ Social Deficits subscale (r_{INC} = -.05; r_{HA} = -.11). Excepting the situations noted above, the pattern of correlations largely is what was expected; the subscales of the SCOPI intercorrelate at least moderately strongly with one another, as do the subscales of the BAPQ. Subscales from both correlate with the OC-TCDQ at a level consistent with previous studies (Lee & Wu, 2019). Please see Table 3 for full results.

Table 3. Zero-Order Correlations

	Checking	Contamination	Rituals	Social Deficits	Language Deficits	Repetitive Behaviors	Harm Avoidance
SCOPI Checking	.--						
SCOPI Contamination	.34*	.--					
SCOPI Rituals	.50***	.46***	.--				
BAPQ Social Deficits	-.12	-.08	-.09	.--			
BAPQ Language Deficits	.47***	.14	.20	.31*	.--		
BAPQ Repetitive Behaviors	.31*	.32*	.44**	.32*	.34*	.--	
OC-TCDQ Harm Avoidance	.72***	.31*	.45**	-.11	.42**	.31*	.--
OC-TCDQ Incompleteness	.69***	.41**	.74***	-.05	.48***	.49***	.71***

Note. SCOPI = Schedule of Compulsions, Obsessions, and Pathological Impulses.
BAPQ = Broad Autism Phenotype Questionnaire.
OC-TCDQ = Obsessive-Compulsive Trait Core Dimensions Questionnaire.
*$p < .05$. **$p < .01$. ***$p < .001$.

Primary Analyses

Hypothesis 1

Hypothesis 1a was that SCOPI Contamination scores would correlate significantly ($p < .05$) positively with the difference between reaction time to pull contaminated pictures and to pull neutral pictures. Hypothesis 1a was tested using a bivariate correlation. Results indicate that Hypothesis 1a was not supported, as the observed correlation was positive but not statistically significant, $r = .14$, $p = .295$.

Hypothesis 1b was that SCOPI Compulsive Rituals scores would correlate significantly ($p < .05$) positively with the difference between reaction time to pull not-just-right pictures and to pull neutral pictures. Hypothesis 1b was tested using a bivariate correlation. Results indicate that Hypothesis 1b was not supported, as the relationship was negative, $r = -.29$, $p = .036$.

Hypothesis 1c was that SCOPI Total scores would not correlate significantly ($p > .05$) with the difference between reaction time to pull social pictures and to pull neutral pictures. Hypothesis 1c was tested using a bivariate correlation. Results indicate that Hypothesis 1c was supported, $r = .00$, $p = .989$.

Hypothesis 2

Hypothesis 2 was that self-reported OC-TCDQ Incompleteness scores would mediate the relationship between SCOPI Compulsive Rituals scores and latency to approach not-just-right pictures. Hypothesis 2 was tested via mediational analysis using the PROCESS macro (Hayes,

2017). SCOPI Compulsive Rituals scores served as the independent variable, OC-TCDQ Incompleteness scores as the mediator, and not-just-right–pull reaction time difference as the dependent variable. Hypothesis 2 was not supported, as the regression model containing both SCOPI Compulsive Rituals and OC-TCDQ Incompleteness was not significant (R = .31, p = .082), and the indirect effect of SCOPI Compulsive Rituals through OC-TCDQ Incompleteness was zero [Effect = 1.93, 95% CI (-2.99, 7.96)].

Hypothesis 3

Hypothesis 3a was that scores on BAPQ Social Deficits would correlate significantly (p < .05) positively with the difference between reaction time to pull social pictures and to pull neutral pictures. Hypothesis 3a was tested using a bivariate correlation. Results indicate that Hypothesis 3a was not supported, as the relationship was significant but negative in valence, r = -.32, p = .019.

Hypothesis 3b was that scores on BAPQ Stereotyped Repetitive Behavior would correlate significantly (p < .05) positively with the difference between reaction time to pull not-just-right pictures and to pull neutral pictures. Hypothesis 3b was tested using a bivariate correlation. Results indicate that Hypothesis 3b was not supported, as the relationship was neither, r = -.26, p = .056.

Hypothesis 3c was that BAPQ Total scores would not correlate significantly (p > .05) with the difference between reaction time to pull contaminated pictures and to pull neutral pictures Hypothesis 3c was tested using a bivariate correlation. Results indicate that Hypothesis

3c was not supported, as the relationship was negative and significant, $r = -.30$, $p = .027$.

Hypothesis 4

Hypothesis 4 was that self-reported OC-TCDQ Incompleteness scores would mediate the relationship between BAPQ Stereotyped Repetitive Behavior scores and latency to approach not-just-right pictures. Hypothesis 4 was tested via mediational analysis using the PROCESS macro (Hayes, 2017). BAPQ Stereotyped Repetitive Behavior scores served as the independent variable, OC-TCDQ Incompleteness scores as the mediator, and not-just-right–pull reaction time difference as the dependent variable. Hypothesis 4 was not supported, as the regression model containing both BAPQ Stereotyped Repetitive Behavior and OC-TCDQ Incompleteness was not significant ($R = .26$, $p = .162$), and the indirect effect of BAPQ Stereotyped Repetitive Behavior through OC-TCDQ Incompleteness was zero [Effect = -0.85, 95% CI (-26.35, 26.24)].

Most of the hypotheses that were proposed for the current study were not supported. However, there were several hypotheses that predicted a positive correlation between two variables, for which the results reflected a significant, negative correlation. Among these were SCOPI Compulsive Rituals and reaction time difference to pull not-just-right versus neutral images; BAPQ Social Deficits and reaction time difference to pull social versus neutral images; and BAPQ Total score and reaction time difference to pull contaminated versus neutral images. In the latter case, it was hypothesized that BAPQ Total score would be unrelated to performance on a contaminated picture task, as contamination concerns are not an essential feature of ASD symptoms. In the first two cases, it was hypothesized that increased reported symptoms would

predict longer latency to approach target (versus nontarget) images. The reality is that individuals with greater compulsive ritual concerns actually performed relatively similarly on not-just-right versus neutral pictures; individuals with greater social deficit concerns performed similarly on social versus neutral pictures.

CHAPTER 4

DISCUSSION

The purpose of the current study was twofold. First, the current study aimed to model not-just-right symptoms of OCD and social avoidance in ASD using a lab-based behavioral task akin to one which historically has been used to study OCD contamination concerns – namely, a computerized approach-avoidance task (AAT). Second, the current study aimed to test whether incompleteness, a construct with origins in the OCD literature, could partially explain the apparent overlap between the diagnostic categories of OCD and ASD. A potential implication of the current study was the development of a simple laboratory task to study ASD in humans, which heretofore has been lacking. A standardized laboratory task would significantly ease future attempts to study ASD behaviorally or experimentally in humans. As the current study attempted to study incompleteness as a mechanism by which OCD and ASD are related to one another, a second potential implication of the current study was the ability to move the research in this field beyond descriptive studies of the OCD-ASD relationship and into studies of how this relationship may exist.

It was hypothesized that participants' self-reported levels of OCD contamination concerns would be related to their performance in the contamination AAT, that their self-reported levels of ASD-like social deficits would be related to their performance in the social AAT, and that their self-reported levels of both OCD ritual concerns and ASD-like repetitive behaviors would be related to their performance in the not-just-right AAT. Further, it was

hypothesized that incompleteness would mediate the relationships between OCD ritual concerns (ASD-like repetitive behaviors) and performance in the not-just-right AAT.

Overall, results indicate that *some* ASD-like experiences are related to some OCD concerns. ASD-like repetitive behaviors correlated with all assessed OCD concerns at the zero-order level. These findings support past research demonstrating that symptoms of OCD and ASD often correlate with one another at statistically significant levels. Results also suggest that ASD-like social deficits are not related to OCD concerns at the zero-order level. On a conceptual level, these findings make sense. The repetitive behaviors associated with ASD are diagnostically similar to the compulsions associated with OCD, whereas the social difficulties associated with ASD do not appear to have a diagnostic analogue in OCD. Conversely, approximately 14% of individuals with OCD also meet criteria for Social Anxiety Disorder (Lochner et al., 2014), and social difficulties in individuals with OCD are not uncommon. Although social difficulties are not *essential* to a diagnosis of OCD as they are in ASD, social difficulties appear to coincide with OCD at notable rates. As an interesting reminder, 13 individuals (23.6%) in the present dataset scored at or above the average SCOPI score of individuals diagnosed with OCD from a previous study (Watson & Wu, 2005) and 22 individuals (40.0%) scored higher than established sensitivity/specificity cutoffs on the BAPQ (Hurley et al., 2007). Of these, six individuals (10.9% of full sample) met both sets of cutoff scores.

Perhaps most surprisingly, ASD-like social language deficits correlated strongly with OCD checking concerns at the zero-order level – as strongly as the various types of OCD concerns intercorrelated with one another. Given the state of the current literature, which mostly compares OCD and ASD symptoms broadly, this finding is difficult to explain. This finding may

suggest that different OCD concerns correlate with different ASD symptoms in varied ways. This also may explain why different studies arrive at such varied estimates of comorbidity rates between OCD and ASD; it may be an issue of level of analysis or the way in which each disorder is measured. Future research that compares symptom types or clusters between these disorders is needed to determine whether this is the case.

Looking to the relationship between incompleteness and symptoms of OCD and ASD, zero-order correlations from the current study largely support previous findings; that is, incompleteness correlated with all assessed OCD concerns and ASD-like symptoms except for ASD-like social deficits. The same pattern held for harm avoidance, suggesting that both phenomena may play a role in symptoms of OCD and ASD (Lee & Wu, 2019). Of interest, the relationship between OCD ritual concerns and incompleteness was very strong in the current sample (r = .74; for comparison, it was .58 in Lee & Wu, 2019, which used the same measures). These findings support previous conclusions that, whereas both incompleteness and harm avoidance are related to many OCD concerns and ASD-like symptoms, incompleteness may be more strongly linked to some of these symptoms than others, especially those related to rituals and repetitiveness.

Turning to performance on the AAT, results indicate that self-reported OCD contamination concerns did not predict performance in the contaminated picture set. Further, self-reported ASD-like social deficits were negatively related to reaction time difference between social and nonsocial pictures in the social picture set. This suggests that as individuals report more social difficulties consistent with ASD, they had less difficulty approaching social images. This is the opposite of what was hypothesized. Regarding the not-just-right picture set, results

indicate that self-reported ASD-like repetitive behaviors did not predict performance, whereas self-reported OCD ritual concerns were negatively related to reaction time difference between not-just-right and non–not-just-right pictures. Again, the latter finding suggests that as individuals reported more ritual concerns consistent with OCD, they had less difficulty approaching not-just-right images, which is the opposite of what was hypothesized. Finally, the hypotheses that the effects of OCD ritual concerns and ASD-like repetitive behaviors on performance in the not-just-right picture set would be mediated by self-reported levels of incompleteness concerns were not supported. This pattern of findings, which either were non-significant or opposite of what was hypothesized, is difficult to explain. Cronbach and Meehl's (1955) classic discussion of construct validity provides several possibilities.

The first case outlined by Cronbach and Meehl (1955) regarding negative evidence is that the test does not measure the construct variable. In the current study, there are multiple ways in which this could have occurred. One possibility is that the picture sets were poorly defined and did not tap into the constructs of interest. However, attempts were made to minimize this possibility, including providing the unselected pilot sample with definitions of "contaminated-ness," "social-ness," and "not-just-right-ness." The pilot sample ratings of the most contaminated, social, and not-just-right images were used to construct the sets. Although "not-just-right-ness" in particular may have suffered from lack of definitional clarity (e.g., it is necessarily broad and may be particularly idiographic in nature), provision of a definition should have helped narrow the construct for the pilot sample participants. Therefore, definitional clarity alone seems an unlikely reason for the observed pattern of findings. A related possibility is that the picture stimuli that comprised the AATs were insufficiently salient for their intended

purpose; that is, the target images were not sufficiently contaminated, social, or not-just-right in nature. This is a strong possibility; according to the pilot sample, grand mean ratings of target items from the picture sets ranged from 5.92 to 7.57 on a scale of 0 to 10. This indicates that the "dosage" of images as contaminated, social, or not-just-right may need to be increased, which may have contributed to null findings. It may be necessary to attempt creation of picture sets that demonstrate higher mean ratings. Future research will need to look outside of the IAPS for other picture stimuli, as the current exhaustive search of the IAPS appears to have been insufficient.

The second case described by Cronbach and Meehl (1955) is one in which the theoretical network that generated the hypotheses was incomplete. In the current study, this means that there could be other third variables affecting performance on AATs to a stronger extent than self-reported OCD and ASD-like symptoms in undergraduates. For example, the participants could have been inattentive or unmotivated toward the task at hand; in these cases, it is difficult to know whether reaction time would increase or decrease, although it seems likely that accuracy would decrease. In any case, the validity of results would be compromised. Alternatively, variables such as familiarity with computer-based lab tasks or other reaction time-based tasks (i.e., video games) could have the effect of either improving overall performance (e.g., due to practice effects) or decreasing accuracy (e.g., due to making assumptions about the task rather than attending to the rules). Another possible problem with the theoretical network is that the assertion of a special relationship between OCD and ASD may itself be incorrect, given the highly mixed findings from this body of research as a whole. Finally, if there is some special relationship to be found between OCD and ASD, then it may be due to something other than a sense of incompleteness. Future research is needed to determine (a) whether a special

relationship exists between OCD and ASD and, if so, (b) through which mechanisms this relationship exists.

A third case outlined by Cronbach and Meehl (1955) is the case in which the experiment has failed to test the hypothesis properly. In the current study, the expected effects may have been suppressed due to the use of an unselected undergraduate sample. Per Lee and Wu (2019), it was believed that each of the survey measures used in the current sample was valid for an unselected undergraduate sample. The current sample evidenced good internal consistency estimates for almost every measure, and no problems with range restriction were identified. It is possible that the AAT is not valid for use in an unselected sample. Although undergraduates as a group may self-report a wide range of levels of OCD and ASD-like symptomatology, perhaps their symptoms are, on the whole, not extreme enough to affect behavior, including reaction time to picture-based stimuli. This possibility seems less likely to have produced the current pattern of results, given that other in-lab, OCD-relevant tasks seem capable of eliciting behavioral responses in undergraduate samples (see Conley, 2015; Pietrefesa & Coles, 2009; Rachman, Radomsky, Elliot, & Zysk, 2012, for examples). Given the success of these other studies in using an undergraduate sample, and the aforementioned problem with salience of the stimuli in the current study, it is my opinion that stimulus saliency, rather than sample selection, likely played a large role in the current pattern of findings.

Another way in which the experiment may have incorrectly tested the hypotheses is that the study may have been underpowered to detect the hypothesized effects, resulting in a combination of Type 1 and Type 2 errors. The power analysis for the study originally suggested that a valid *N* of at least 70 would be needed to detect the hypothesized effects. Because effect

size shrinkage often occurs in replication, it would have been ideal to collect more than 70 individuals. Due to the necessity of suspending in-person data collection due to the Coronavirus outbreak, this study collected a final *N* of only 55 individuals. Additionally, although the survey data suffered from very few missing data points, a full 36.5% of the AAT reaction time data points were omitted due to directional errors or extremely fast/slow responding. The possibility that the study was underpowered seems unlikely to be a major consideration, however, as the effects that were detected were quite small and at times in the opposite direction as expected.

Returning to the issue of omitted reaction time data points, this partially could have been due to aforementioned attentional or motivational issues among participants. There also may have been an error on my part in designing the study; that is, although vision-related variables were assessed, participants were not asked about color-blindness. Successful task completion in the AAT depends upon intact color vision, yet, based upon the base rate of color-vision problems in the population (males: 8%, females, .05%; Colour Blind Awareness Community Interest Company, 2015), it is likely that at least one or two participants in the current sample exhibit some level of color-blindness, which would have drastically increased their rate of errors. Whatever the reason, this level of errors and data point omission was unexpected.

Rather than a problem of being underpowered, the current study may have suffered from a problem of bad data. In fact, “bad data” seems to be a likely way in which the study incorrectly tested the hypothesis. There are several signs that the data provided by participants were less than optimal. Among these were lack of necessary glasses/contact use, the fact that color-blindness was not assessed, the presence of four individuals who answered one of the two check questions incorrectly, and the 36.5% of reaction time data points that were omitted due to

erroneous, fast, or slow responses. A study is only as good as the data that are gathered; therefore, future research may seek to attempt this study again, when enough participants can be collected that participants providing potentially poor data need not be retained.

Limitations and Future Directions

This study was among the first to examine a potential mechanism for the overlap between OCD and ASD, namely, incompleteness. Additionally, this study attempted to create a method by which not-just-right experiences in OCD and social avoidance symptoms in ASD could be studied behaviorally. Up to this point, the options for both have been limited, thus limiting research into these symptoms. It was believed that the AAT, which has been used successfully in the study of OCD contamination symptoms, could be modified for both uses. The current study largely was unsuccessful in these goals. There are a number of limitations which may have contributed to the observed pattern of findings.

First, these data were collected from an unselected sample of undergraduates. This approach was chosen due to data collection feasibility issues and because past research efforts suggest that the self-report measures used in this study are valid for use in an unselected sample. However, it is unclear whether the AAT also is valid for use in an unselected sample. Future research should attempt to replicate the current methods in clinical or clinical-analogue samples to determine whether results vary based on level of symptomatology. Additionally, the final sample size for the current study fell below recommendations from the power analysis; therefore,

this study was underpowered to detect true effects. Future research should attempt to replicate the current method on an appropriately powered sample, as this may change the results.

Measurement issues with the social language deficits subscale of the BAPQ also deserve consideration. The relatively low internal consistency estimates for this subscale in the current sample indicate that results using this subscale should be interpreted with caution.

Although the hypotheses for this study largely were unsupported, the current investigation still produced useful information. For example, this study confirmed previous findings that both harm avoidance and incompleteness, constructs derived from the OCD literature, are related to a variety of OCD symptoms as well as ASD-like experiences. Therefore, the continued study of the role of harm avoidance and incompleteness in ASD is one potential avenue for future research. Current findings suggest that these constructs are related to some symptoms of ASD (social language deficits, repetitive behaviors) and not others (social deficits). Future research should attempt to replicate these findings. Current results notwithstanding, this may be one avenue by which ASD is related to OCD or other anxiety disorders.

Additionally, findings suggest that some symptoms of ASD and OCD are related to one another, but not others. For example, ASD-like repetitive behaviors appeared to be related to all of the assessed OCD concerns; ASD-like social language deficits were related only to OCD checking concerns; and ASD-like social deficits were not related to any OCD concerns. To our knowledge, few research efforts to date have examined ASD and OCD symptoms together at this more specific, granular level of analysis. Future research should aim to do so, as it may be that some ASD and OCD symptoms are consistently related to one another, whereas others are not. If this pattern emerges, it could partially explain why comorbidity estimates between these two

conditions vary so widely. The answer may depend upon the type of symptoms presented or the way in which those symptoms are assessed.

In conclusion, the major hypotheses of the current project were unsupported, and the current study did not demonstrate that incompleteness affects performance on behavioral picture tasks. However, the current study did affirm that some symptoms of OCD and ASD are related to one another and that incompleteness is related to both symptoms of OCD and symptoms of ASD. This, coupled with the aforementioned methodological limitations of the current study, suggests that further research into OCD-ASD, OCD-Incompleteness, and ASD-Incompleteness associations is warranted. Incompleteness may yet be a mechanism by which the OCD-ASD relationship exists. Further, the "special-ness" of this relationship has not been ruled out. Understanding the role which incompleteness plays in both disorders could illuminate therapy modifications to enhance treatment for this particularly treatment-refractory comorbidity.

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APPENDIX A

DEMOGRAPHIC INFORMATION QUESTIONNAIRE

Demographic Information Questionnaire

1. What is your age? _____

2. What is your sex?

    1=Male

    2=Female

    3=Other

3. What is your racial identification?

    1=African American/Black

    2=Asian/Asian American

    3=Caucasian/European American

    4=Native American

    5=Multiracial

    6=Other

4. What is your ethnicity?

    1=Hispanic/Latino

    2=Not Hispanic/Latino

5. Have you ever been diagnosed with a mental illness?

    1=Yes

    2=No

    If yes, what was the diagnosis? _____

6. Are you currently taking any psychiatric medications?

    1=Yes

    2=No

    If yes, what medication(s)? _____

7. Are you currently seeking therapy for any reason?

    1=Yes

    2=No

If yes, for what reasons?

8. Do you wear glasses or contacts?

1=Yes

2=No

9. If you answered yes to the previous question, are you wearing them now?

1=Yes

2=No

10. Have you been diagnosed with a disorder affecting movement?

1=Yes

2=No

APPENDIX B

VALIDITY QUESTIONS

The validity questions listed below will be given response options identical to the questionnaires in which they are embedded:

1. Please choose “agree” if you are paying attention right now.

2. I sometimes have fatal heart attacks while watching television.

APPENDIX C

FRAMED IMAGES

Pictured below are examples of two potential “target” images from the social picture set. One is framed in green; this color will be associated with directions to “push” the image away. The other is framed in blue; this color will be associated with directions to “pull” the images toward the participant.