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The Relationship Between Hoarding and Distractibility

Julia Y. Carbonella
University of Miami, juliacarbonella@gmail.com

UNIVERSITY OF MIAMI

THE RELATIONSHIP BETWEEN HOARDING AND DISTRACTIBILITY

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Julia Y. Carbonella

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Julia Y. Carbonella

Approved:

Kiara R. Timpano, Ph.D. Assistant Professor of Psychology	Amishi Jha, Ph.D. Associate Professor of Psychology
Neena Malik, Ph.D. Scientist, Department of Pediatrics	M. Brian Blake, Ph.D. Dean of the Graduate School

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Hoarding is a debilitating disorder that has gained increasing interest in recent years, contributing to its re-classification as a discrete condition. However, much remains unclear about its underlying mechanisms of risk, though evidence implicates information processing deficits. In particular, the domain of inattention has been highlighted in extant clinical and phenomenological studies, though neuropsychological lab tests have produced largely mixed findings. The current study aimed to clarify the nature of attentional deficits by conducting a multi-method investigation, including an eye-tracking task designed to target distractibility, along with a sorting task as a behavioral measure of hoarding. Results indicated that self-reported attention deficit hyperactivity disorder symptoms significantly predicted self-reported hoarding symptoms, though associations did not hold after controlling for general mood and anxiety levels. Reaction time on the distractibility task was associated with both the time taken to sort commonly hoarded objects, and the urge to acquire trivial items. An interaction effect of image type by hoarding symptom group was also observed, such that participants high on hoarding spent longer viewing distractor images than did those low on hoarding, in comparison to viewing a blank control screen. Findings are discussed in light of potential explanations, in addition to implications for future research to help clarify underlying attentional deficits.

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Chapter 1: Introduction

Hoarding disorder is a condition that has attracted increasing attention in the research community in recent years, characterized by "persistent difficulties discarding or parting with possessions, regardless of their actual value" (American Psychiatric Association, 2013, p. 248). Hoarding is comprised of three core facets: excessive acquisition of possessions, difficulty discarding these items, and resulting clutter of living spaces (Frost, Steketee, & Grisham, 2004). The lifetime prevalence rate is estimated to be 2-5% in the general population (Timpano et al., 2011). Though hoarding has historically been associated with obsessive-compulsive disorder (OCD) (Mataix-Cols et al., 2010), recent evidence suggests that it is a separate disorder, and it is classified as such in the latest edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-V; American Psychiatric Association, 2013). Hoarding often causes distress and impairment across many domains, including physical health issues as well as social, financial, and emotional problems, the combination of which can be debilitating (Tolin, Frost, Steketee, Gray, & Fitch, 2008). Considering its typically chronic course, along with the high comorbidity with anxiety and mood disorders, hoarding is an important disorder of interest (Frost, Steketee, & Tolin, 2011; Tolin, Frost, Steketee, Gray, et al., 2008), as well as a substantial public health risk and economic burden (Frost, Steketee, & Williams, 2000; Tolin, Frost, Steketee, & Fitch, 2008). Unfortunately, hoarding patients are often resistant to treatment, due to low levels of insight and internal motivation, difficulty staying on task, and high dropout rates (Frost, Pekareva-Kochergina, & Maxner, 2011;

Tolin, 2011). Existing treatments tend to be both effort- and time-intensive, sometimes lasting 9-12 months or longer (Steketee & Tolin, 2011; Tolin, Frost, & Steketee, 2007). Although some light has been shed on the characteristics and possible mechanisms of hoarding in the past decade, there still remains much not understood about this phenomenon, particularly in regards to its risk and maintenance factors. Further research to elucidate the nature of hoarding is vital as it can help inform the development of targeted treatment and prevention efforts.

The current proposal will present an investigation designed to further our understanding of an information processing deficit in the attention domain, which has been implicated as a central feature underlying the phenomenology of hoarding. An overview of the cognitive behavioral conceptualization of hoarding will first be presented, followed by a review of the extant literature on the relationship between attention impairments and hoarding. Taking into account various limitations of past research, the current study will seek to clarify these likely attention deficits with a multi-modal investigation, incorporating a novel eye-tracking task as a powerful assessment of attention.

Cognitive Behavioral Model of Hoarding

Frost and Hartl's (1996) cognitive behavioral model of hoarding indicates a confluence of biological, cognitive, environmental, and emotional factors which interact to give rise to hoarding symptoms. One main component thought to underlie hoarding is an intense emotional attachment to objects, particularly one's own belongings. Hoarding patients often view possessions as an extension of themselves and derive a sense of comfort from their belongings (Frost & Hartl, 1996; Frost, Hartl, Christian, & Williams, 1995). Consequently, patients typically experience high levels of worry and negative affect when potentially discarding an item of sentimental value (Frost & Gross, 1993; Frost & Hartl, 1996). Hoarding is also linked with the tendency to endorse flawed beliefs about the nature of such possessions. For instance, hoarding patients are more likely to exaggerate the likelihood of objects being useful in the future, which can distort their judgments about saving and discarding (Frost & Hartl, 1996). Hoarding is also linked with a greater tendency to anthropomorphize items (Timpano & Shaw, 2013), and individuals often feel overly responsible for their belongings (Steketee, Frost, & Kyrios, 2003). Altogether, these cognitive distortions and hypersentimentality regarding personal objects can consequently affect decision-making processes and the severity of saving, sorting, and discarding behaviors.

Another central element to the cognitive-behavioral conceptualization of hoarding are information processing deficits, which may directly influence clutter and saving/acquiring decisions, and/or interact with the hoarding-specific cognitions discussed above. The information processing domains that have been most strongly implicated as risk and maintaining factors for hoarding include memory, executive functioning difficulties, and attention (Timpano, Shaw, Yang, & Cek, 2013). For example, patients tend to endorse low confidence in their memory while overvaluing the importance of remembering information, which can result in relying on visual cues and keeping objects in plain view to do so (Steketee & Frost, 2003). Decision making deficits are also associated with hoarding symptoms, along with greater levels of impulsivity (e.g., Grisham, Norberg, Williams, Certoma, & Kadib, 2010; Timpano et al., 2012). Finally, individuals with hoarding exhibit categorization deficits. Particularly with respect to personal objects, hoarding symptoms are associated with greater difficulties with sorting; patients create more categories that are under-inclusive, take a longer time to complete sorting tasks, and experience more distress than do other individuals (Grisham et al., 2010; Wincze, Steketee, & Frost, 2007).

Of primary interest to the present proposal are prominent information processing deficits in the area of attention, which may contribute to the development of the key hoarding behaviors of acquiring, sorting, and saving. Early clinical studies noted that individuals with hoarding often meet criteria for attention deficit hyperactivity disorder (ADHD). These patients tend to lack focus both in conversations and during tasks given in treatment sessions, which could contribute to their challenges with excessive acquiring, sorting or organizing, and discarding behaviors. Compared to the other neuropsychological deficits highlighted in the cognitive behavioral model of hoarding, the area of attention has the greatest relative level of evidence. However, the extant studies have produced somewhat mixed results making it difficult to draw definitive conclusions about the exact nature of potential attention impairments in hoarding patients. The following sections review the literature focused on attention and hoarding and evaluate the evidence to-date.

Clinical Observations of Attention Difficulties

In case studies and diagnostic interviews, clinicians have observed that patients with hoarding often display problems with attention. For example, patients generally find it hard to stay on task during sessions in general and discarding exercises specifically. It has been hypothesized that these difficulties may directly contribute to the relatively common challenges in implementing interventions for hoarding, as well as the effectiveness of these treatments (Frost & Steketee, 2010; Hartl, Duffany, Allen, Steketee, & Frost, 2005). Patients who struggle with hoarding are noted to be easily distracted, which can make the task of finding, organizing, or discarding their belongings an extremely challenging task. A tangential manner of speaking is also characteristic of many individuals with hoarding; for instance, Frost and Steketee (2010) described a patient who would continually interrupt himself by starting to tell a story about each successive possession he came across in his home, making it difficult to maintain focus and locate a particular object. In one case study of pediatric hoarding, Plimpton, Frost, Abbey, and Dorer (2009) found that four of six cases showed heightened symptoms of distractibility and/or ADHD. Observations in this vein implicate overarching attention difficulties as a likely factor in the expression of hoarding symptoms, though they do not provide detailed knowledge about the nature of such deficits. Moreover, these case studies do not elucidate which of the core features of hoarding has a stronger association with these potential attention disturbances.

Hoarding and ADHD Comorbidity Studies

Several comorbidity studies have also indicated a link between attention problems and hoarding symptoms. Based on their observations from interviewing hoarding participants, Hartl et al. (2005) first explored the overlap between "packrat" behavior and ADHD symptoms. In comparison to a control group, individuals with hoarding endorsed significantly more symptoms of both current and childhood inattention and hyperactivity. Grisham, Brown, Savage, Steketee, and Barlow (2007) corroborated this finding; their group of hoarding participants reported significantly more symptoms of inattention, impulsivity, and overall ADHD compared to both a community comparison group and a mixed clinical group of mood and anxiety disorders. More recently, Sheppard et al. (2010) found that 21.9% of a sample of OCD patients with hoarding symptoms met full criteria for a DSM-IV diagnosis of ADHD. Up to 40% of participants with hoarding met for ADHD using a more liberal definition not barring notable impairment or a clear age of onset. These individuals also had significantly more inattentive symptoms compared to ones with non-hoarding OCD, though the rates of hyperactive and impulsive symptoms did not differ between hoarders and non-hoarders. Torres et al. (2012) showed similar results, with 17.8% of their OCD with hoarding group meeting criteria for comorbid ADHD, in contrast to the only 9.1% of the OCD without hoarding group. In a broader epidemiological study, Fullana et al. (2013) found that individuals with hoarding symptoms endorsed more childhood ADHD symptoms than those without hoarding symptoms.

It is important to note that beyond an association with overall ADHD symptoms, evidence suggests that the inattentive subtype is most strongly linked with hoarding. Frost, Steketee, et al. (2011) examined adults who met criteria for hoarding disorder and diagnosed 27.8% of them with inattentive ADHD, a much higher proportion than was found in adults with non-hoarding OCD (3.2%). Yet, these two groups did not significantly differ in regards to hyperactive ADHD. Fullana et al. (2013) found no significant difference in hyperactivity symptoms among individuals with and without hoarding symptoms, but inattention symptoms were more common among those with hoarding symptoms. This association between inattention and hoarding remained significant even after controlling for other OCD symptoms (Fullana et al., 2013). Moreover, the severity of inattention has been shown to predict the severity of the three core features of hoarding (Tolin & Villavicencio, 2011b). The link between attention deficits and hoarding appears to exist above and beyond the disorganized nature that is often characteristic of ADHD. That is, the clutter criterion of hoarding cannot be fully explained by the trait of being "messy" or "scatterbrained" as seen in individuals with ADHD; there seems to be a specific quality associated with inattention that gives rise to not only acquiring and difficulty discarding, but also having a large number of items congesting one's living area (Fullana et al., 2013; Tolin & Villavicencio, 2011b).

Though fewer studies have examined the reverse comorbidity, evidence does suggest that there are also greater levels of hoarding in primary ADHD populations. In a sample of children diagnosed with ADHD, inattentive symptoms were shown to significantly predict overall hoarding symptoms, clutter, and also difficulty discarding (Hacker et al., 2012). Fullana et al. (2013) also found that lifetime hoarding symptoms were more common among participants endorsing childhood ADHD symptoms, compared to individuals without self-reported childhood ADHD. On the whole, these comorbidity studies suggest a strong association between attention difficulties and overall hoarding behaviors. This information processing deficit may therefore give rise to the range of hoarding symptoms, possibly underlying sorting/organizing and saving behaviors.

Neuropsychological Assessments of Attention Difficulties

To our knowledge, only seven studies to-date have examined the role of potential attention problems in hoarding, as assessed using neuropsychological tests. Results so far have been largely mixed, as summarized in Table 1. Researchers have investigated classic measures often used to assess ADHD in an attempt to narrow down the nature of the attention impairments in hoarding. One test often administered is the Wisconsin Card Sorting Task (WCST), which is thought to help assess potential deficits in attentional set shifting. The WCST utilizes stimulus and response cards of different shapes that vary in color and number. Participants are asked to sort the cards based on attribute rules that change unannounced throughout the task, requiring them to detect implicit rules and adjust their approach accordingly. Four studies have examined this task in relation to hoarding, and although they have differed in their sampling strategies and control comparisons, considered jointly they have largely failed to find support for a deficit. The first relevant study to use the WCST in the context of hoarding symptoms did not find any group differences between individuals with OCD and hoarding symptoms, compared to those with just OCD (without hoarding) and healthy controls (Lawrence et al., 2006). Another study compared a pure hoarding disorder sample to clinical OCD and healthy controls, and similarly found null results (Tolin, Villavicencio, Umbach, & Kurtz, 2011). McMillan, Rees, and Pestell (2012) again did not find any difference between participants with hoarding and ones with *comorbid* hoarding and OCD, though more perseveration errors and fewer categories completed were observed when hoarding individuals' performance was compared to general population norms. Most recently, Ayers et al. (2013) did find that hoarding participants made more total errors on the WCST than did healthy controls, though their sample was limited to geriatric patients.

Another neuropsychological task that has been used is the Continuous Performance Test (CPT), which is often given to assess ADHD symptoms (Epstein et al., 2003). Though the actual stimuli and modality of administration can often vary between different versions of the CPT, subjects are generally asked to attend to a series of repetitive stimuli (e.g. a set of horizontal and vertical lines) and are instructed to press a response key whenever a specific target occurs (e.g. when the lines form a numerical digit), but to refrain from responding in all other instances. In this way, the CPT is thought to assess sustained attention and impulsivity (i.e. ability to maintain focus on a tedious task and inhibit inappropriate responses), along with selective attention and distractibility (i.e. ability to hone in on relevant stimuli and avoid distracting stimuli). On the Conners' CPT, the version described above, Grisham et al. (2007) found that individuals with hoarding performed worse than did healthy and clinical controls with mood or anxiety disorders. The University of Pennsylvania CPT is another variation that asks participants to press the spacebar in response to any letter except when the letter "X" is presented. Using this variant of the task, Tolin et al. (2011) similarly found that individuals with hoarding exhibited poorer sustained attention in comparison with healthy controls; however, hoarding disorder patients did not differ from a clinical OCD control group. Although the varied clinical control groups and slightly different task versions may have played a role in the relative performance of hoarding individuals across these two studies, it appears that hoarding may be associated with a diminished attentional capacity, as assessed by the CPT paradigm.

Mixed results have also been found with several other laboratory tests of attention. The Stroop Color Word Test displays written color names in a variety of ink colors, resulting in congruent or incongruent stimuli. Participants are asked to name either the word or the color, with performance thought to demonstrate impulsive reactions, along with abilities of selective attention and cognitive flexibility. In one experiment, OCD patients with hoarding symptoms performed worse on the Stroop than did OCD patients without hoarding, suggesting attenuated attention in hoarding (Tolin et al., 2011). However, in another study, no group differences on the Stroop were found between a hoarding group with late life depression (LLD) and one with LLD without hoarding (Mackin, Areán, Delucchi, & Mathews, 2011). Additional tasks that have been considered include the Intra-Extra Dimensional Set Shift (testing the ability to shift attention) and the Affective Go/No-Go (which assesses response inhibition and also the ability to shift attention), though only one study has examined these in hoarding. No group differences were found on either comparing individuals with hoarding against a clinical mood or anxiety group and healthy controls (Grisham et al., 2010).

Finally, select subtests from the Wechsler Adult Intelligence Scale (WAIS-III; Epstein et al., 2003) have also been utilized, again producing mixed findings. On the Letter Number Sequencing and Digit Span subtests, which measure cognitive set shifting and focused attention, Mackin et al. (2011) did not find that the hoarding with LLD group significantly differed from the LLD without hoarding group. However, Ayers et al. (2013) found that geriatric patients with hoarding performed significantly worse than did older healthy controls on these same two subtests on the WAIS-IV (Frost, Steketee, Williams, & Warren, 2000). It is unclear the extent to which the older age of the samples exacerbated the differences between groups. McMillan et al. (2012) did not detect significant differences in performance on either the WAIS-III Digit Span or Spatial Span tests, when comparing a hoarding group with comorbid OCD to a pure hoarding group without comorbid OCD. This finding contradicts those of a prior study using the Wechsler Visual Memory Span subtest, which is meant to capture spatial attention and is nearly identical to the WAIS-III Spatial Span subtest. Specifically, Grisham et al. (2007) did not find any group differences on this task, though hoarding patients exhibited weaker response inhibition than did clinical mood or anxiety controls.

Limitations of Previous Studies

The research reviewed above provides suggestive evidence that attention deficits are associated with hoarding symptoms, but no definitive conclusions can yet be made about the nature of potential deficits. Previous comorbidity studies of ADHD and hoarding symptoms/disorder have utilized self-report and retrospective measures rather than a more objective measure of attention. This could produce unreliable information, particularly when participants are asked to recall the occurrence of childhood symptoms. Moreover, questionnaires assessing ADHD symptoms – whether current or past ones – remain a proxy measure for the actual neuropsychological domain of attention. For instance, an individual reporting that they often “misplace or have difficulty finding things at home or at work” (Adult ADHD Self-Report Scale, Adler et al., 2006) reveals no further indication of which specific component of attention is impaired. Prior studies have also relied exclusively on self-report indicators or clinical diagnostic status; a more objective behavioral measure of the acquiring, sorting, and saving behaviors characteristic of hoarding disorder may provide a better window for examining proposed deficits.

The neuropsychological studies conducted to date have similarly not been able to provide conclusive results about the exact type of attention impairments that may be associated with hoarding symptoms. Across the handful of studies conducted, there have been few replications; while it is possible this may be attributable to sampling differences, it also may be that task selection is partially to blame. The most prominent weakness of past tasks administered is their broad approach to assessing information processing deficits in general, and not specifically attention deficits. By using measures that require a multitude of executive functions, it is not possible to tease apart differences between groups (if any) are attributable to difficulties with attention in particular, versus with memory and/or decision-making.

For instance, as described above, the WCST has been administered several times in order to assess neuropsychological impairments in hoarding samples. However, though it may be thought of as a test of attentional set shifting, the nature of the task is best conceptualized as a measure of general executive functioning since it involves a range of abilities, including problem solving, strategic planning, and inhibition of impulsivity (Greve, Stickle, Love, Bianchini, & Stanford, 2005; Steinmetz & Houssemand, 2011). Likewise, though the Stroop Color Word Test can be construed as a measure of selective attention, it also taps into multiple processes including impulse control and cognitive flexibility (Van der Elst, Van Boxtel, Van Breukelen, & Jolles, 2006). Thus, a more “pure” measure of attentional difficulties is needed to help clarify the nature of impaired attention in hoarding individuals.

Another consideration is that the tasks that have been administered thus far have neglected to address whether context or type of stimuli plays a role in exacerbating potential attention deficits. As previously discussed, hypersentimentality regarding possessions is a key feature of hoarding in that patients experience strong emotional attachments to things and view them as sources of emotional comfort (Grisham et al., 2009). Given this unusual emotional response to objects, it is possible that differences in attention emerge or become more exaggerated when the material at hand involves hoarding-related concepts, rather than neutral or non-hoarding-related ones. This contextual importance may parallel the difference between emotion-dependent ("hot") versus emotion-independent ("cold") processing observed on various neuropsychological tasks. For instance, findings from the depression literature show that depressed patients are faster to respond to negative words on an affective go/no go task, show more interference on the Stroop task when negative words are presented, and demonstrate a bias towards negative words on a dot probe task (Roiser, Rubinsztein, & Sahakian, 2006). Similarly, individuals with hoarding may perform worse on tasks of attention when the stimuli are related to household items commonly hoarded.

Comparing the findings of past studies is also complicated by the different types of proband and comparison groups that have been examined. Out of the seven laboratory studies to our knowledge that have conducted neuropsychological tasks, a slightly different composition of hoarding and comparison samples has been used for each study, making it difficult to confirm results for each task that has been used. For instance, both Ayers et al. (2013) and McMillan et al. (2012) administered the WCST in their recent studies, but the former studied a hoarding group vs. a group with concurrent OCD and hoarding, while the latter compared two geriatric groups of hoarding patients vs. healthy individuals. As differences on the WCST were only found in the study of geriatric participants, it is unclear whether this discrepancy can be attributed to actual attention differences captured by the task, or to the dissimilar sample groups.

Considered as a whole, the extant literature provides reason to believe that inattention and hoarding are linked, though further investigation is needed to clarify the nuances of this underlying information processing deficit. In addition to considering more objective assessments of distractibility and the potential role of stimuli type, it is yet to be determined exactly how this impairment manifests differentially in the specific subtypes of hoarding behaviors, and whether various attention indices are associated with greater symptom severity.

Current Study

The present study attempts to address the above gaps in knowledge in a number of key ways. Importantly, the proposed investigation will incorporate eye-tracking technology with a task designed to measure inattention, which has not yet been implemented in regards to hoarding symptoms. As elaborated upon in the Methods section below, this task will allow us to more closely examine the construct of distractibility, by objectively capturing whether a participants' attention is focused upon a target region relevant to a cued instruction, or whether their gaze is drawn to an irrelevant or "distracting" region. As a real-time assessment of the specific stimuli that an individual is paying attention to, this eye-tracking methodology provides a more precise insight into participants' ability to stay on task. By incorporating auditory cues along with visual stimuli, the proposed task reflects an ecologically valid way of examining distractibility. As previously discussed, individuals who hoard are easily distracted while following verbal instructions during the process of sorting or discarding possessions. The present task operates as a laboratory analogue of this real-world difficulty of focusing on given instructions, which a passive viewing paradigm would not adequately capture. Eye-tracking also allows for a more “pure” measure of distractibility. By simply capturing where one’s gaze is drawn and whether that is in-line with the instructions/cue, the present task does not require many additional executive functioning processes such as learning of implicit rules.

An additional strength of the present task is that it is the first to our knowledge to consider the role of stimuli type. Specifically, we hope to investigate whether attention impairments are specific to hoarding-relevant objects, or whether they exist regardless of the nature of the stimuli. The study will also supplement the eye-tracking indicators of inattention with both a self-report measure of ADHD symptoms and behavioral performance indices (e.g. reaction time and error rate), allowing a more comprehensive examination of this potential deficit.

Contrary to past studies’ reliance on self-report measures of hoarding, the current investigation incorporates a behavioral measure of hoarding symptoms, as a more objective assessment of the core features of hoarding. As inattention has been shown to predict all three features of hoarding using self-report indices (Tolin & Villavicencio, 2011), the present behavioral task will assess sorting, acquiring and saving behaviors. The primary focus will be the indicators of sorting behaviors, as sorting appears to be especially pertinent to inattention as it is conceptualized by the attention task, i.e. ability to focus on the relevant information without being distracted by irrelevant material. As reviewed earlier, hoarding symptoms are associated with categorization difficulties, including the tendency to create more under-inclusive categories and longer completion time, which may be in part attributed to the attention deficits. The relationship between this distractibility and difficulties encountered during the behavioral sorting task could provide valuable information about the neuropsychological impairments that may underlie hoarding behaviors. For instance, gaining insight into the role of attention deficits may have implications for understanding the behavior of “churning” as is often observed in individuals who hoard, or the tendency to repetitively organize and re-sort belongings in different piles without actively discarding them, which helps contribute to clutter (Frost & Hartl, 1996).

An additional benefit to adopting the symptom-focused approach described above, is that the present study will not be constrained by diagnostic categorization. As hoarding symptoms have been found to be dimensionally distributed (Timpano, Broman-Fulks, et al., 2013), it may be informative to examine their relationship to underlying attention deficits within a sub-clinical population. Additionally, past research has shown that hoarding symptoms frequently onset prior to age 20 (Tolin, Meunier, Frost, & Steketee, 2010), making the proposed young adult population one of particular interest.The present investigation of how attention deficits and hoarding symptoms may be dimensionally associated could provide further insight into the extent of this underlying deficit across diagnostic categories.

Aims and Hypotheses

The current study aims to conduct a multi-method investigation of the relationship between attention deficits and hoarding symptoms, including a novel eye-tracking task of attention. Self-report and behavioral indices of hoarding will also be collected.

Aim 1: Association Between Different Attention Indicators and Self-Reported Hoarding Symptoms. Aim 1 will be to examine the overall relationship between multi-modal attention indicators and self-reported hoarding symptoms, in order to replicate past findings of the association between attention deficits and hoarding. The specificity of this relationship will also be investigated by controlling for general mood and anxiety symptoms, as affective disorders have been shown to be highly comorbid with both hoarding symptoms (Frost, Steketee, et al., 2011; Frost, Steketee, Williams, et al., 2000; Grisham et al., 2007) and attention difficulties (i.e., Biederman, 2004; Spencer, Biederman, & Mick, 2007).

Hypothesis 1.1. Controlling for general mood and anxiety symptoms, self-reported ADHD symptoms will predict self-reported hoarding symptoms. Specifically, the Inattentive subscale will be an independent predictor of self-reported hoarding.

Hypothesis 1.2. Controlling for general mood and anxiety symptoms, the primary behavioral indicator of attention on the distractibility task will predict self-reported hoarding symptoms.

Hypothesis 1.3. Controlling for general mood and anxiety symptoms, the primary eye-tracking indicator of attention on the distractibility task will predict self-reported hoarding symptoms.

Aim 2: Association Between Inattention and Behavioral Hoarding Indices. Aim 2 will be to examine the overall relationship between the two primary attention indicators (i.e., primary behavioral and eye-tracking indices) and a range of outcomes on the behavioral hoarding task.

Hypothesis 2.1. Primary attention indicators will be associated with longer Time to Sort

Hypothesis 2.2. Primary attention indicators will be associated with greater Number of Categories.

Hypothesis 2.3. Primary attention indicators will be associated with greater Number of Items Wished to Acquire.

Hypothesis 2.4. Primary attention indicators will be associated with fewer Number of Items Willing to Discard.

Aim 3: Potential Effects of Stimulus Type on Inattention as a Function of Hoarding Symptoms. Aim 3 will be to examine whether differences in each of the two primary attention indicators (i.e., primary behavioral and eye-tracking indices) will emerge as a result of a) different Image Types (Blank, Hoarding, and Nature), and/or b) Hoarding Group (low vs. high, based on whether score is below or above the sample mean of self-reported hoarding symptoms).

Hypothesis 3.1. There will be a difference in the attention indicator levels depending on Image Type, such that mean RT/IO/ACC/VT will significantly differ between trials showing Blank vs. Hoarding vs. Nature images (i.e., a main effect of Image Type).

Hypothesis 3.2. There will be a difference in the attention indicator levels depending on Hoarding Group classification, such that mean RT/IO/ACC/VT will significantly differ between those in the low vs. high hoarding symptom group (i.e., a main effect of Hoarding Group).

Hypothesis 3.3. The effect of Image Type will be different between the group high on hoarding and the one low on hoarding, revealing significant between-group differences in RT/IO/ACC/VT specifically for Hoarding Images. We predict that the high hoarding group will demonstrate greater inattention than the low hoarding group for Hoarding Images (i.e., an Image Type x Hoarding Group interaction).

Chapter 2: Method

Participants

The sample consisted of 81 undergraduate students at the University of Miami enrolled in Introductory Psychology courses, with ages ranging from 17 to 48 (*M* = 19.39, *SD* = 3.23). Participants received research familiarization credit for participation. The sample was over-selected for having high hoarding symptoms, for the purpose of observing a wider range of hoarding behaviors, in line with methodology used in previously published studies (Timpano & Shaw, 2013). Participants were recruited based on scoring at least one SD above the mean on Saving Inventory Revised (SIR) results from a prescreening battery of questionnaires. Students were recruited through an email invitation depending on their eligibility from pre-screening results, as well as with flyers posted throughout the psychology department.

Procedure

Upon coming in to the laboratory, informed consent was obtained. Participants were told that the study would be looking at the relation between attention and various behaviors, feelings, and thoughts. The Cued Distractibility Task (CDT) was first administered, followed by a behavioral object sorting task (OST), both of which are described below. Participants then completed a series of questionnaires on the computer and were debriefed about the purpose of the study upon completion. The study session took approximately 1.5-2 hours to complete.

Self-Report Assessments. Means and standard deviations for the primary self-report variables of interest are shown in Table 2.

ADHD Checklist *(ADHD-CL; Murphy & Barkley, 1995).* The ADHD-CL is an 18-item self-report inventory used to assess common ADHD symptoms. Participants are asked how often they have experienced a particular ADHD symptom over the past month on a four-point scale. The ADHD scale has demonstrated good reliability and validity (Murphy & Barkley, 1995). The ADHD scale showed good internal consistency in the present sample (α=.88).

Depression Anxiety Stress Scale-21 *(DASS-21; Henry & Crawford, 2005).* The DASS-21 is a condensed version of the original DASS scale with 42 items. It is a 21-item self-report questionnaire assessing depression, anxiety, and stress symptoms. Participants rate the extent to which they have experienced each symptom over the past week on a four-point scale. It includes three subscales of depression, anxiety, and stress. The DASS-21 has been found to have excellent internal consistency and validity (Henry & Crawford, 2005). In the current sample, only the DASS anxiety and depression scales were used as a representation of general mood and anxiety symptoms. In the present sample, the DASS demonstrated excellent internal consistency (α=.91).

Demographics Questionnaire. The Demographics Questionnaire collected general demographic information, such as the participant's age, gender, and ethnicity. It also inquired about the participant's personal and family psychiatric history.

Saving Inventory-Revised *(SIR; Frost et al., 2004).* The SIR is a 23-item self-report inventory of the main facets of hoarding, including subscales of clutter, difficulty discarding, and acquiring. Participants rate their behaviors and tendencies on a five-point scale, with higher scores reflecting greater levels of hoarding symptoms. The SIR has shown good internal consistency and divergent validity in both nonclinical and clinical samples (Frost et al., 2004). The SIR demonstrated excellent internal consistency in the present sample (α=.90).

Cued Distractibility Task (CDT)

Procedure and Design. The task consisted of 360 trials in total (60 trials x 3 stimuli types x 2 auditory cue types), divided into 3 blocks of 120 trials each. Prior to these blocks, a set of practice trials were conducted to ensure participants' understanding of the task, with a requirement of at least 75% accuracy to continue. As shown in Figure 1, a blank screen preceded each trial, which was displayed for a variable duration (ranging from 500 to 1200 ms for each trial). An auditory task cue then instructed the participant to perform one of two tasks: either a) identify whether the presented number is odd – signified by one beep or b) identify whether the presented number is greater than 12 – signified by two beeps. Participants were asked to respond to each of the tasks by pressing one of two buttons on the response box, which will be labeled as either "YES" or "NO". Stimuli were presented until either a response was provided or 3 seconds had elapsed, whichever occurred first. For half of the trials, the stimulus was presented 800 ms after the auditory cue, while for the other half, the onset of the stimulus occurred 200 ms after the cue[1]. Trials were presented in a fixed randomized order for all participants, though the order of each specific stimulus was variable. This study design has been used in extant studies (e.g., Malooly, Genet, & Siemer, 2013).

Stimuli. Images presented were color photographs depicting either inanimate hoarding-related items or non-hoarding-related items (i.e., images of inanimate objects found in nature). Blank screens were also included as a comparison stimuli type without a distracting image. Images relevant to hoarding depicted household items that are commonly hoarded, selected from the "hoarding subset" of the Maudsley Obsessive-Compulsive Stimuli Set (MOCSS; Mataix-Cols, Lawrence, Wooderson, Speckens, & Phillips, 2009), a standardized database of images with subsets for the main dimensions of OCD, including hoarding. Nature images showed items commonly found in nature, collected from the Internet. The luminosity of the Hoarding (M = 108.91, SD = 19.25) versus Nature images (M = 100.06, SD = 19.73) did not significantly differ from one another; $t(98) = 2.27$, p = *n.s*. Hoarding and Nature images were also approximately matched for content by pairing each stimulus with an opposite-category image of a similar complexity (e.g., number of items in each picture).

Dependent Indices Derived from the CDT*.* Behavioral and eye-tracking outcomes were collected on the CDT. The primary behavioral attention indicator

[1] This element of the task is not central to the aims and hypotheses outlined for the present investigation, but is based on findings that a shorter duration between cue and stimulus onset results in performance costs, given a lag in deploying attentional resources to the relevant stimuli (Longman, Lavric, & Monsell, 2012). The 200 ms trials will first be compared to the 800 ms trials to determine whether differences in attention indicators emerge. If no significant differences are observed between the two conditions, the attention indicators will be collapsed across all trials for the planned data analyses.

of interest is mean *reaction time (RT)* of keyboard presses across trials, and the primary eye-tracking attention indicator is percentage of *initial orientations (IO)* in the distracting regions, as opposed to in target regions. The target region consists of the rectangular area containing the number, as the stimuli that the participant is instructed to look at in order to respond to the cue. The distracting region is comprised of the background area displaying the image (whether blank, hoarding-, or non-hoarding-related). Secondary behavioral and eye-tracking indicators are mean *accuracy (ACC)* across trials, and total *viewing time (VT)* on distracting regions, respectively.

Object Sorting Task (OST)

Procedure and Design. Procedures for this task were adapted from a categorization task conducted by Woody et al. (personal correspondence), which was based upon prior versions conducted to assess hoarding symptoms (Luchian, McNally, & Hooley, 2007; Wincze et al., 2007). Participants were asked to sort three sets of 20 objects each: (1) trivial items, (2) typically hoarded items, and (3) personal items. Upon enrolling in the experiment, participants were asked to bring 20 personal objects from home corresponding to each of the items on this list: nail clippers or a nail file, a pen or a pencil, a mug, a key, a bag, a sock, a t-shirt, a belt, a comb or brush, a book, a magazine or newspaper, a photo, a shampoo bottle or soap or conditioner, an umbrella, a watch or alarm clock or clock, a toothpaste tube/container or toothbrush, a pillow case, a take-out menu or instructional manual, a pair of sunglasses, and a spoon or fork.

The set of trivial items included objects of little or no value, such as: a magazine, a fortune from a cookie, a rubber ball, a pencil, a black & white film, hand wipes, a sticker, a candy bar wrapper, stamps, a birthday candle, a button, a pen, a stretch toy, a wrapped cookie, a bar of soap, a die, candy, post-it notes, a cocktail umbrella, and a metal puzzle game.

The set of typically hoarded items included objects such as the following: a hat, shaving cream, a journal article, a magazine, an elastic band, a t-shirt, a pencil, a tie, a paper bag, deodorant, toothpaste, a paper clip, an empty coffee can, a newspaper, a book, a candy wrapper, a sock, a soap bar, transparent tape, and an empty paper towel roll.

The order of the item sets was counterbalanced across participants, as to avoid potential order effects. All three sets of items were presented to participants in a standardized way, with an example provided in Figure 1. Participants were asked to “separate the items into different groups in any way that makes sense” to them; an example script for the instructions for this task is included in Appendix A.

After sorting each set of objects, participants were asked a series of questions. For the non-personal sets of objects (trivial items and typically hoarded items), participants were asked the following questions: a) “Out of the 20 objects, how many items do you wish to acquire if you could do so?” and b) “How strong is your general urge to acquire, on a scale of 0-10?”. For the personal set of objects brought from home, participants were asked: a) “Out of the 20 objects, if you were asked to donate or discard as many items as possible, how many items would you toss or give away?" and b) "How strong is your general urge to save them, on a scale of 0-10?" In addition, at the beginning and end of the task, as well as prior to the CDT, participants were asked to rate their momentary mood ratings for happiness, boredom, and distress, on a subjective scale of 1-5.

Dependent Indices Derived from the OST. The primary outcomes of interest from this behavioral task are the Time to Sort and the Number of Categories created. Secondary indicators included: Number of Items Wished to Acquire, Urge to Acquire, Number of Items Willing to Discard, and Urge to Save.

Chapter 3: Data Preparation

Power Analyses

A projected sample size of 60 participants was identified as a suitable N, based on *a priori* power analyses for the planned statistical methods described below (GPower; Faul & Erdfelder, 1992). In previous investigations the relationship between hoarding and self-reported inattention symptoms was characterized by a large effect size (Grisham et al., 2007; Hartl et al., 2005). Similarly, past studies relying on neuropsychological assessments of attention, such as the CPT and selected WAIS subtests, have also demonstrated moderate to large effects of attentional differences between hoarding and comparison groups (Ayers et al., 2013; Grisham et al., 2007; Tolin et al., 2011). Thus, the current investigation was powered for a medium effect size, and the proposed sample size was deemed appropriate to test the primary study hypotheses (Aim 1) with a Type 1 error (α) < .05, at a power greater than 80%.

Data Screening

Pilot testing was first conducted on 13 participants, after which minor changes were made to the CDT to ensure that eye-tracking recordings yielded operationalized data in the proposed format for analysis. Subsequently, a total of 81 participants participated in the study; all data were screened prior to conducting the proposed analyses, including checking for errors in data entry and the suitability of the eye-tracking data. Missing data for questionnaires were minimal, as responses were collected via an online data survey system, and all 81 participants completed the behavioral sorting task. With respect to the eye-tracking data, 12 participants who generated a sample rate percentage of <70% were excluded from analyses, in line with standard procedures of data-cleaning for eye-tracking. The sample rate percentage is a rough estimate of the number of valid eye-gaze points for each participant and represents an approximate measure of recording quality. Excluding these participants resulted in 69 individuals with analyzable eye-tracking data. Despite the fact that not all of the proposed analyses included eye-tracking data, we selected to only examine the individuals with sufficient eye-tracking data for a cleaner look at the association between ADHD and hoarding symptoms. We chose this more conservative approach in part because of the possibility that those without sufficient sample rate percentage may have been so distractible that they may have not been engaged in the study. In support of this distinction, an independent samples t-test showed that those with an insufficient sample percentage reported significantly greater ADHD-Inattention scores (M = 7.56), compared to those who generated adequate eye-tracking data and who were retained for the final sample (M = 5.29). It should also be noted that the final selected sample (N = 69) was in line with the originally proposed sample size of 60 participants.

As no evidence for significant skewness or kurtosis was found for any of the variables examined, data were not transformed for analysis. Participants were also screened for whether they were taking any stimulant medications (e.g., Adderall, Concerta) to treat ADHD, as that could influence the level of distractibility as assessed by the CDT. No participants reported taking any stimulant medications that would exclude them from analyses.

Chapter 4: Results

Descriptives

Self-Report Questionnaires. Means, standard deviations, and score ranges for the self-report measures are included in Table 2. Internal reliability of the self-report questionnaires was examined by calculating Cronbach's alpha for each measure; levels were found to be in the acceptable range. Score ranges are reflective of a normal student sample; DASS-Anxiety and Depression mean scores were both lower than the respective means of 4.70 (*SD* = 4.91) and 6.34 (*SD* = 6.97) reported for general community samples (Henry & Crawford, 2005).

The mean of the SIR Total score for the present sample was 18.39 (*SD* = 11.27). Though it was similar to the prescreening mean (*M* = 17.56, *SD* = 11.45), this mean score in the current sample was lower than that of typical non-clinical samples (*M* = 23.7, *SD* = 13.2) (Frost et al., 2004). This reflects the fact that our over-selection sampling method, which was intended to result in a higher than typical SIR mean, was not effective. Although we used methods in line with previously successful over-sampling techniques, we experienced great difficulties with recruiting the individuals high in hoarding symptoms.

Object Sorting Task. Table 3 shows the means and standard deviations for the outcomes on the OST. On average, participants took less than a minute to sort each group (i.e., Personal *M* = 59.00 seconds, Trivial *M* = 52.13 seconds, Commonly Hoarded *M* = 41.32 seconds) of items (overall *M* = 51.83 seconds), with a mean number of 5.77 categories created for each group. The mean number of categories is in line with previously published reports using an analogue sample and a slightly modified version of the OST (Luchian et al., 2007), though the current sample took less time to sort on average. For example, Luchian et al. (2007) reported the mean number of categories to be 5.62 for self-identified nonclinical "packrats" while the mean time to sort was 169 seconds; control participants created 4.65 piles on average and took 88 seconds to sort.

As expected given the non-clinical sample, participants as a whole did not wish to acquire a great deal of novel items (mean number of items = 2.52 out of 20; urge to acquire = 2.81 out of 10). In other words, participants only wanted to take home approximately 12% of the items that we presented to them in the laboratory. However, when it came to personal items, participants wanted to keep approximately 57% of their own items to take back home with them, which reflects that saving behaviors are not uncommon in even a non-clinical sample (mean number of items willing to discard = 11.44 out of 20; urge to save = 4.10 out of 10).

Correlations between the OST outcomes and SIR-Total and SIR-Discarding scores are also displayed in Table 3. SIR-Total significantly correlated with Time to Sort Personal Items, indicating that those with higher hoarding symptoms spent a longer time categorizing their own items brought from home, as expected. SIR-Total was not significantly associated with the number of categories created for any of the item groups; nor was it associated with Number of Items Acquired/Discarded. However, SIR-Total was significantly associated with Urge to Acquire both Trivial and Commonly Hoarded items.

Cued Distractibility Task. The means and standard deviations for each of the eye-tracking indicators on the CDT are displayed in Table 4. Of note, the mean accuracy rate was 93.94%, indicating that participants for the most part did not encounter significant difficulty with answering correctly throughout the task. Table 4 also shows the correlations between the CDT attention indicators (RT, IO, ACC, or VT) and both SIR-Total and SIR-Discarding scores. Although none of the CDT variables were correlated with SIR-Total, VT was significantly associated with SIR-Discarding ($r = .24$, $p < .05$).

As the CDT was intended to reflect levels of distractibility, we also examined the associations between the various indicators and self-reported ADHD symptoms, which can be seen in Table 5. In fact, none of the primary nor secondary indicators of the task were significantly associated with ADHD-CL scores – whether Inattentive, Hyperactive, or Total.

Aim 1: Associations Between Attention Indicators and Self-Reported Hoarding Symptoms.

Hypothesis 1.1 Our first aim was to examine the relationship between self-reported ADHD and hoarding symptoms. First, zero-order correlations between ADHD-CL scores and SIR scores were examined. ADHD-Inattentive ($r = .51$, $p < .01$), ADHD-Hyperactive ($r = .54$, $p < .01$), and ADHD-Total ($r = .58$, $p < .01$) scores were all significantly associated with SIR-Total scores.

ADHD Inattentive and Hyperactive scores were then simultaneously entered into a regression equation with SIR-Total scores as the outcome. As Model 1 in Table 6 shows, Inattention and Hyperactive scores were each independent predictors of SIR-Total scores, in support of our initial hypothesis. Then, an additional regression analysis was constructed – again with SIR-Total scores as the outcome variable – to examine whether each ADHD subscale remained an independent predictor while controlling for DASS-Anxiety and DASS-Depression subscales. As can be seen in Model 2 in Table 6, after including anxiety and depression symptoms as covariates, neither ADHD-Inattentive nor ADHD-Hyperactive scores remained significant independent predictors of SIR-Total scores.

Additional analyses were performed to examine whether ADHD symptoms similarly predicted the different subscales of the SIR (Clutter, Discarding, and Acquiring). Across the analyses, a generally similar pattern of results as was noted for the total SIR score was observed. The ADHD-Total scores were significantly correlated with all three of the SIR subscales (Clutter $r = .48$, $p < .01$; Discarding $r = .48$, $p < .01$; Acquiring $r = .56$, $p < .01$), and the same was true for both the ADHD-Inattentive (Clutter $r = .46$, $p < .01$; Discarding $r = .43$, $p < .01$; Acquiring $r = .41$, $p < .01$) and ADHD-Hyperactive (Clutter $r = .39$, $p < .01$; Discarding $r = .43$, $p < .01$; Acquiring $r = .59$, $p < .01$) subscale scores.

Table 6 also shows the respective regression analyses for the three SIR subscales. ADHD-Inattentive scores was initially an independent predictor of SIR-Clutter; however, once mood and anxiety symptoms were included as covariates, the relationship became non-significant. Inattentive ($p = .05$) and Hyperactive ($p = .05$) symptoms were marginal independent predictors of SIR-Discarding, though again, these associations became non-significant after controlling for mood and anxiety. Hyperactive but not Inattentive symptoms independently predicted SIR-Acquiring scores; this relationship was the only one to remain significant after controlling for general mood and anxiety.

Hypothesis 1.2 examined the behavioral indicators of the distractibility task (RT and ACC) in relation to the self-reported hoarding symptoms. The primary outcome of RT was not found to be significantly correlated with SIR-Total (r = .13, p = .30) thus, follow-up regression analyses were not conducted. On the subscale level, RT was marginally associated with SIR-Acquiring (r = .22, p = .07), but not with SIR-Discarding (r = .15, p = .21) or SIR-Clutter (r = -.03, p = .84). We next examined the robustness of the trending relationship between RT and SIR-Acquiring by controlling for depression and anxiety in a regression equation. Results demonstrated that the relationship between RT and Acquiring was no longer trending once covariates were included in the model (β = .09, t(65) = .79, p = .43, R^2 = .29). A similar pattern of results was found when considering the secondary behavioral indicator on the CDT. Specifically, ACC was not found to be significantly correlated with either the total (r = -.10, p = .40) or subscale (Acquiring r = -.17, p = .18; Discarding r = -.10, p = .42; Clutter r = -.01, p = .91) scores on the SIR.

Hypothesis 1.3 investigated the association between the eye-tracking indicators of the CDT (primary variables: IO and VT) and self-reported hoarding symptoms. The primary indicator (IO) was not found to be significantly associated with SIR-Total (r = .20, p = .11); thus, no additional regression analyses were conducted with IO as a predictor. Though IO was also not associated with the Clutter (*r* = .04, *p* = .72) subscale on the SIR, it was marginally associated with the Discarding (*r* = .23, *p* = .05) and Acquiring (*r* = .24, *p* = .05) subscales. Regression analyses controlling for DASS-Anxiety and DASS-Depression demonstrated that IO was a marginal predictor of both Discarding (β = .20, *t*(65) = 1.90, *p* = .06, R^2 = .28) and Acquiring (β = .18, *t*(65) = 1.75, *p* = .09, R^2 = .32).

The secondary CDT eye-tracking indicator VT was marginally associated with SIR-Total (*r* = .22, *p* = .08), but was not found to significantly predict SIR-Total after controlling for depression and anxiety (β = 13, *t*(65) = 1.26, *p* = .21, R^2 = .35). Looking more closely at the SIR subscales, VT was significantly associated with both SIR-Discarding (*r* = .24, $p < .05$) and SIR-Acquiring (*r* = .25, $p < .05$), but not with SIR-Clutter (*r* = .08, *p* = .54) – similar to the pattern of results found with IO. After controlling for anxiety and depression, VT was found to marginally predict SIR-Discarding (β = .19, *t*(65) = 1.71, *p* = .09, R^2 = .27), but was not found to significantly predict SIR-Acquiring (β = .16, *t*(65) = 1.48, *p* = .14, R^2 = .31).

Aim 2: Associations Between Attention and Behavioral Hoarding Indicators.

Aim 2 examined the relationships between the indicators from the sorting and distractibility tasks. For Hypotheses 2.1-2.4, a series of bivariate correlations (see Table 7) were conducted between the primary and secondary attention indicators from the task (RT, IO, ACC, VT) and the outcomes from the behavioral OST (Sort Time, Number of Categories, Number of Items Acquired, Number of

Items Discarded, Urge to Acquire, and Urge to Save). The OST variables were examined first as an aggregate mean across the three types of objects, and then within each object type (personal, trivial, and commonly hoarded).

Hypothesis 2.1 investigated the association between Sort Time and the attention indicators. The correlation between RT and Average Sort Time approached significance, (r = .23, p = .06). Specifically, RT was significantly associated with the Sort Time for Commonly Hoarded objects (r = .30, p < .05), but not with Personal (r = .19, p = .11) or Trivial (r = .10, p = .43) items. As can be seen in Table 7, Sort Time was not significantly associated with any of the other distractibility task indicators.

Hypothesis 2.2 focused on the Number of Categories created by participants, in relation to the CDT attention indicators. RT was not associated with Average Number of Categories, nor with the specific Number of Categories for Personal, Trivial, or Commonly Hoarded item types (see Table 7). The correlation between ACC and the Personal Number of Categories created was a trend (r = .20, p = .09), though ACC was not associated with Trivial or Commonly Hoarded Number of Categories. IO was significantly associated with the Number of Categories for Commonly Hoarded items, though in the opposite direction than expected (r = -.26, p < .05); IO did not correlate with any other item type's Number of Categories. Finally, VT was not significantly associated with Number of Categories for any item type.

Hypothesis 2.3 examined the relationship between Number of Items Acquired and CDT indicators. In contrast to what was proposed in this hypothesis, no indicator from the distractibility task was significantly associated with the Number of Items Acquired, whether they were Trivial or Commonly Hoarded items.

In Hypothesis 2.4 – looking at the association between attention indicators and Number of Items Willing to Discard – RT, IO, and VT were not associated with the Number of (Personal) Items Willing to Discard. In contrast, ACC was significantly associated with the Number of Items Willing to Discard ($r = -.26$, $p < .05$), indicating that the more accurate a participant was on the distractibility task, the fewer personal items they were willing to discard on the sorting task, which was in the opposite direction of the initial hypothesis.

Urge to Acquire and Urge to Save were examined as secondary outcomes on the OST. The association between RT and the Average Urge to Acquire items approached significance, $r = .21$, $p = .08$ Specifically, RT was significantly associated with Urge to Acquire Trivial items ($r = .29$, $p < .05$) and not Commonly Hoarded ones ($r = .09$, $p = .48$). RT was not associated with the Urge to Save Personal items ($r = .04$, $p = .73$). Neither IO nor ACC were associated with either Urge to Acquire or Urge to Save. VT was marginally associated with the Urge to Save ($r = -.23$, $p = .06$), but was not associated with Urge to Acquire items ($r = .07$, $p = .55$).

Aim 3: Inattention as a Function of Image Type and Hoarding Symptoms.

Aim 3 investigated whether potential differences in the attention indicators from the distractibility task (CDT: RT, IO, ACC, VT) would emerge depending on the type of image (Blank, Nature, and Hoarding images) and/or the level of hoarding symptoms (low vs. high hoarding). Based on whether their SIR-Total score fell below or above the mean of the overall sample (*M* = 18.39, *SD* = 11.27), participants were categorized into a Low (*n = 34,* SIR-Total *M* = 9.52*, SD* = 5.14) or High (*n = 35,* SIR-Total *M = 26.53, SD = 8.96*) Hoarding group.

For each of the four CDT indicators (i.e., primary: RT, IO; secondary: ACC, VT), a 3 (Image Type: Blank, Nature, Hoarding) x 2 (Hoarding Group: Low, High) analysis of variance (ANOVA) analysis was conducted. Hypothesis 3.1 predicted a main effect of Image Type, while Hypothesis 3.2 predicted a main effect of Hoarding Group. Hypothesis 3.3 predicted an interaction between the two variables of Image Type x Hoarding Group, such that those High on Hoarding symptoms would reveal greater inattention for Hoarding images compared to those Low on Hoarding symptoms.

For RT, the primary behavioral indicator, the main effect of Image Type yielded an F ratio of $F(1, 24834) = 120.31$, $p < .01$, indicating that the mean RT significantly differed between images, in support of Hypothesis 3.1. Findings are displayed in Figure 3. Bonferroni post-hoc tests showed that RT was highest for Hoarding images (*M* = 1169.46, *SD* = 527.69), followed by Nature images (*M* = 1118.65, *SD* = 502.11) and then Blank images (*M* = 1047.71, *SD* = 494.25), with significant differences between each pair of Image Types. Regarding Hypothesis 3.2, the main effect of Hoarding Group was not significant, $F(1, 24834) = .86$, $p = .35$, indicating that the mean RT did not differ between the high hoarding Group compared to those in the low hoarding group. In contrast to what was predicted in Hypothesis 3.3, the Image Type x Hoarding Group interaction effect was also non-significant, $F(1, 24834) = 1.40$, $p = .25$.

In terms of IO, the primary eye-tracking indicator, the main effect of Image Type was also significant, $F(1, 24511) = 3.89$, $p < .05$, indicating that the mean IO significantly differed between images. This was in support of Hypothesis 3.1. Specifically, post-hoc tests indicated that the mean IO for Blank images ($M = .19$, $SD = .39$) was significantly higher than that for Nature images ($M = .18$, $SD = .38$), while Hoarding images ($M = .19$, $SD = .39$) were marginally higher than Nature images, though Hoarding and Blank images did not significantly differ from one another. These findings are shown in Figure 4. The main effect of Hoarding Group was not significant, $F(1, 24511) = .52$, $p = .47$, indicating that the mean IO did not significantly differ between the high and low hoarding groups, in contrast to Hypothesis 3.2. The Image Type x Hoarding Group interaction effect was non-significant as well, $F(1, 24511) = .59$, $p = .55$, which did not support Hypothesis 3.3.

With respect to the secondary indicators, a generally similar pattern emerged. For the secondary behavioral indicator of ACC, the main effect of Image Type yielded an F ratio of $F(1, 24834) = 2.63$, $p = .07$, indicating that the mean ACC marginally differed between images, in partial support of Hypothesis 3.1. However, a closer look did not reveal significant differences between ACC for Blank images ($M = .94$, $SD = .23$), compared to that of Hoarding images ($M = .93$, $SD = .25$) or Nature images ($M = .94$, $SD = .23$). In regards to Hypothesis 3.2, the main effect of Hoarding Group was not significant, $F(1, 24834) = .006$, p

= .94, indicating that the mean ACC did not significantly differ between those in the high hoarding group compared to those in the low hoarding group. The Image Type x Hoarding Group interaction effect was non-significant as well for Hypothesis 3.3, $F(1, 24834) = 1.62$, $p = .20$. Results for the ANOVA analysis for ACC are shown in Figure 5.

Finally, regarding the secondary eye-tracking indicator of VT, the main effect of Image Type was not significant, $F(1, 24503) = .79$, $p = .45$, indicating that the mean VT did not significantly differ across Blank, Nature, and Hoarding images. This was not in support of Hypothesis 3.1. For Hypothesis 3.2, the main effect of Hoarding Group was significant, $F(1, 24503) = 10.75$, $p < .01$, indicating that the mean VT was significantly higher for individuals in the high hoarding group compared to those in the low hoarding group. The Image Type x Hoarding Group interaction effect was significant as well, in support of Hypothesis 3.3. $F(1, 24503) = 6.20$, $p < .01$, indicating that the effect of Image Type was different between the group that was high on hoarding and the one low on hoarding, as can be seen in Figure 6. Specifically, the difference in VT between the low and high hoarding groups was not significant for Blank images ($p = .36$), but there was a significant difference in mean VT between the groups for Nature ($p < .01$) and Hoarding ($p < .01$) images. Moreover, the high hoarding group's VT did not significantly differ across image types; paired samples t-tests showed that the Blank images did not differ from Nature ($p = .26$) or Hoarding ($p = .52$) images; nor did the Nature and Hoarding images differ from one another ($p = .75$) within the high hoarding group. Within the low hoarding group, VT for Hoarding images did not significantly differ from either Nature (p = .46) or Blank (p = .23) images; however, the difference between Blank and Nature images was a trend (p = .09).

Post-Hoc Supplemental Analyses

As the indicators of the distractibility task did not appear to be as strongly associated with the OST outcomes as initially predicted, additional analyses were conducted to investigate potential explanations.

Post hoc power analyses. As noted across analyses, actual effect sizes were smaller than originally estimated. As a result, we conducted post-hoc power analyses, which indicated that the primary analyses were only powered at 67.28%, rather than the planned 80%.

Practice Effects. Considering that participants performed relatively well on the distractibility task (i.e., M = 94% accuracy), we examined the possibility that their outcomes improved with increased practice throughout the task. The task consisted of three blocks of 120 trials each. Though accuracy rate did not differ between the blocks, reaction time significantly improved across the three blocks (M = 1144.85, 1103.40, and 1085.81 ms, respectively, $p < .001$ for each paired sample t-test). As RT decreased significantly while achieving the same level of accuracy, it is likely that practice effects could be playing a role as participants progressed through the task. Faster RT throughout the task may also indicate that participants could have rushed through the latter blocks due to boredom and the repetitive nature of the trials. In order to reduce the potential influence of either a “boredom” or “practice” effect, primary analyses were performed on Block 1 of 3 trials only (i.e., the first 120 of 360 total trials).

The pattern of findings for Aims 1-3 remained largely unchanged from those of the initial results. In attempt to reduce the redundancy of the Results section, findings will be presented for the Aim 3 ANOVA analyses for the primary variables of interest (RT and IO). Results of two-way ANOVA analyses on Block 1 of 3 only did not change the pattern of results as described above for the primary attention indicator of RT. In other words, the main effect of Image Type remained significant in support of Hypothesis 3.1, $F(1, 8274) = 18.07$, $p < .01$. RT for Hoarding images ($M = 1183.76$, $SD = 513.59$) was significantly greater than RT for Nature images ($M = 1150.91$, $SD = 506.88$), $p < .05$, and both were significantly higher than that for Blank images ($M = 1100.94$, $SD = 506.79$), $p < .01$. Results for Hypothesis 3.2-3.3 remained the same in that neither the main effect of Hoarding Group ($F(1, 8274) = 2.38$, $p = .12$) nor the Image Type x Hoarding Group interaction effect ($F(1, 8274) = 1.83$, $p = .16$) reached significance.

The same pattern of results also held in terms of the primary eye-tracking indicator of IO. For Hypothesis 3.1, the main effect of Image Type remained significant, $F(1, 8231) = 6.90$, $p < .01$, indicating that the mean IO significantly differed between images. This was in support of Hypothesis 3.1. Specifically, mean IO for Blank images ($M = .19$, $SD = .39$) was significantly higher than that for Nature images ($M = .15$, $SD = .36$; $p < .01$) and Hoarding images ($M = .16$, $SD = .36$; $p < .05$), though Hoarding and Nature images did not significantly differ from one another. Again, for Hypothesis 3.2, the main effect of Hoarding Group was not significant ($F(1, 8231) = .12$, $p = .73$), indicating that the mean IO did not significantly differ between the high and low hoarding groups. For Hypothesis 3.3, the Image Type x Hoarding Group interaction effect remained non-significant as well, ($F(1, 8231) = .89$, $p = .41$).

Cue Length. As trials varied between cue lengths of either 200 vs. 800 ms, these two different trial types were examined separately. A potential explanation was that based on whether the cue length was shorter vs. longer, this duration could affect the difficulty of the task. For instance, on trials with an 800 ms cue, participants may have had a harder time sustaining attention to retain the auditory cue instructions, prior to the onset of the stimulus. Separate post-hoc analyses were conducted, each time including trials of each cue length (e.g. only examining RT across all trials with a 200 ms cue length, independent from examining RT across all trials with an 800 ms cue length).

Again, the pattern of findings for Aims 1-3 remained unaltered for the most part from that of the initial results. To reduce redundancy, results will be presented for the Aim 3 ANOVA analyses for RT and IO as the primary variables of interest. With regards to RT, when specifically examining the trials with a 200 ms cue, the pattern of results did not change compared to when including all trials. In other words, the main effect of Image Type remained significant in support of Hypothesis 3.1, $F(1, 12621) = 66.63$, $p < .01$. RT for Hoarding images ($M = 1196.70$, $SD = 544.22$) was significantly greater than RT for Nature images ($M = 1135.30$, $SD = 511.11$), $p < .01$, and both were significantly higher than that for Blank images ($M = 1067.19$, $SD = 495.40$), $p < .01$. Results for Hypothesis 3.2-3.3 also remained the same, in that neither the main effect of Hoarding

Group (*F*(1, 12621) = .55, *p* = .46) nor the Image Type x Hoarding Group interaction effect (*F*(1, 12621) = .61, *p* = .55) reached significance.

When including only the trials with a 800 ms cue, the pattern of results was similar to that above. Again, the main effect of Image Type remained significant, *F(*1, 12207) = 55.41, *p* < .01. RT for Hoarding images (*M* = 1142.23, *SD* = 509.71) was significantly greater than that for Nature images (*M* = 1101.13, *SD* = 491.92), *p* < .01, and both were significantly higher than that for Blank images (*M* = 1027.27, *SD* = 492.27), *p* < .01. Regarding Hypothesis 3.2, the main effect of Hoarding Group remained non-significant, *F*(1, 12207) = .31, *p* = .58. For Hypothesis 3.3, the Image Type x Hoarding Group interaction effect became a trend when examining the 800 ms cue length trials, *F*(1, 12207) = 2.72, *p* = .07)

The same pattern of results also held in terms of the primary eye-tracking indicator of IO. When only including trials with a 200 ms cue, the main effect of Image Type remained significant, *F(*1, 12435) = 5.44, *p* < .01, indicating that the mean IO significantly differed between images. This was in support of Hypothesis 3.1. Specifically, mean IO for Blank images (*M* = .22, *SD* = .41) was significantly higher than that for Nature images (*M* = .19, *SD* = .39; *p* < .01). Otherwise, Hoarding images (*M* = .21, *SD* = .41) did not significantly differ from either Blank (*p* = .98) or Nature (p = .08). For Hypothesis 3.2, the main effect of Hoarding Group remained not significant, *F*(1, 12435) = .31, *p* = .58, indicating that the mean IO did not significantly differ between the high and low hoarding groups. For Hypothesis 3.3, the Image Type x Hoarding Group interaction effect remained non-significant as well, *F*(1, 12435) = .08, *p* = .92.

Finally looking at the 800 ms cue trials, the only difference was that the main effect of Image Type was no longer significant, $F(1, 12070) = .72$, $p = .49$. The main effect of Hoarding Group remained non-significant ($F(1, 12070) = .20$, $p = .66$), as did the interaction effect as well ($F(1, 12070) = .86$, $p = .42$).

Chapter 5: Discussion

Inattention is a key information-processing deficit that has been associated with hoarding disorder in previous studies. As attention impairments may underlie the comprehensive range of hoarding symptoms including sorting, saving, and acquiring, it is imperative to better understand the nuances of the attention indicators that may be differentially related to both self-reported and behavioral symptoms of hoarding. The present investigation extended the field of research by examining inattention via a novel eye-tracking task designed to measure distractibility (CDT), in conjunction with an improved behavioral object sorting task (OST). Overall, we partially replicated past findings in regards to self-report measures. However, when we examined our eye-tracking indicators of attention and the behavioral hoarding measures, the association between hoarding and inattention became less clear.

Previous comorbidity studies (e.g., Grisham et al., 2007; Hartl et al., 2005) have indicated that there is a robust association between ADHD and hoarding symptoms. Our study replicated these findings, as SIR-Total scores – as well as all three SIR subscales – were significantly associated with ADHD-Total, Inattentive, and Hyperactive symptoms. More specifically, the extant literature has suggested that there is a strong link between hoarding symptoms and Inattentive symptoms, more so than with Hyperactive symptoms (Tolin & Villavicencio, 2011b). Our findings provided only partial support of this notion. Inattention did significantly predict SIR-Total scores in line with the previous reports; however, the relationship between SIR-Total and Hyperactive symptoms was significant as well. Moreover, after accounting for general mood and anxiety symptoms, neither association with the ADHD subscales remained significant, in contrast to the findings of Tolin and Villavicencio (2011b). Considering the main subfacets of hoarding, we also found a different pattern of results than that noted by Tolin and Villavicencio (2011b). While that report indicated that Inattention symptoms predicted all three SIR subscales, our results showed that Inattention only significantly predicted Clutter and that Hyperactivity only predicted Acquiring, while neither subscale was significantly linked with Difficulty Discarding. If these findings are replicated in future studies, an interesting hypothesis to test would be whether ADHD symptom types may differentially give rise to the three core subfacets of hoarding.

Characteristics of the present sample may have contributed to the fact that our findings demonstrated a slightly different pattern of results than did previous studies. Even though hoarding symptoms are dimensionally distributed (Timpano et al., 2011), a lack of variability on the SIR in our current sample may have influenced findings. As previously noted, the group mean on the SIR was lower than expected from a typical non-clinical sample, and our over-sampling methods were not effective in procuring a high-hoarding analogue sample. Though our initial examination of comparing groups low versus high on hoarding did not generally reveal great differences on the behavioral assessment of inattention, we nevertheless cannot rule out whether greater variability across the dimension of hoarding symptoms may provide more accurate insight into the association with attention indicators,. Replication of the study in a clinical population could help clarify the pattern of results.

Another potential factor differentiating our sample was age: we recruited undergraduates at a university resulting in a mean age of 19.39, while Tolin and Villavicencio (2011b) recruited a self-identified hoarding sample from the community, resulting in a hoarding group with a mean age of 49.59. Both self-reported ADHD and hoarding symptoms could have cumulative effects over the lifespan (Grisham, Frost, Steketee, Kim, & Hood, 2006; Spencer et al., 2007; Tolin et al., 2010). Moreover, while hyperactive symptoms tend to diminish with age, inattentive symptoms have been noted to be pervasive as individuals grow into adulthood (Asherson, 2012). In fact, there is some evidence that even when performance on neuropsychological attention tasks does not worsen over time, self-perceived, subjective inattention in particular tends to deteriorate with increasing age (Bramham et al., 2012). It is possible that in a younger student population, effect sizes for these purported attention deficits may be weaker, especially when using a self-report inventory (Woody, Kellman-McFarlane, & Welsted, 2014). An additional feature that may have contributed to the distinct pattern of results was the role of anxiety in our sample. ADHD and anxiety disorders are often comorbid (Schatz & Rostain, 2006), and high levels of anxiety can influence attentional processes, making individuals more vulnerable to distractions (Eysenck & Byrne, 1992; Eysenck, Derakshan, Santos, & Calvo, 2007). In our sample, the high hoarding group was found to endorse significantly higher DASS-Anxiety scores than did the low hoarding group, which speaks to the role of high anxiety. Self-reported anxiety accounted for a great deal of the variance when examining the association between ADHD and hoarding. It is possible that for those participants high in hoarding, effects were driven by this general level of anxiety, obscuring the potential link with inattention.

Turning to the eye-tracking measure of distractibility, our results were less compelling regarding the association between hoarding and inattention. For the most part, eye-tracking indicators did not predict either self-report or behavioral hoarding symptoms, as was expected. One notable exception was the interaction finding regarding the distinct effects of Image Type for VT between the low vs. high Hoarding group. Specifically, when there was a distractor image rather than a blank background (whether the image was Nature or Hoarding related), those high in Hoarding spent significantly longer looking at them. Perhaps there is low specificity for distracting content in relation to hoarding; if there is something in the environment that attracts attention in general, those with high hoarding symptoms may be more easily sidetracked by it regardless of its specific content.

Several factors may have influenced the unexpected lack of association between eye-tracking and hoarding indicators, as a whole. Our CDT task was initially developed to operationalize attention with a different approach than previous laboratory tasks. However, the CDT indicators were not found to be significantly associated with ADHD-CL scores, making it difficult to discern whether the task effectively targeted distractibility as intended. It is possible that the methodology of our task did not tap into the same construct of inattention as did the self-report ADHD questionnaire. The CDT highlighted aspects of selective, visual, and auditory attention, which may be independent from the type of distractibility that the questionnaire targets. For instance, items from the Inattentive subscale include rating the extent to which one “lose[s] things necessary for tasks or activities” or “fail[s] to give close attention to details or make[s] careless mistakes in [their] work”, which may instead reflect a more overarching lack of focus in one’s daily routine, rather than during a confined 20 minute task with concrete instructions. It is possible that our task was actually successful in tapping into distractibility, but that this momentary distractibility is not the same concept as self-perceived general inattention that is captured by self-report (and related to hoarding in previous studies). To further elaborate, there is often a distinction made between concepts in the “state” – involving the more enduring tendency to react in a consistent way – versus “trait” form – which takes into account specific situational factors (Endler & Kocovski, 2001). It may be the case that the ADHD-CL targets a more pervasive sense of inattention across many different types of experiences (“state” assessment), while the CDT only provided a narrow glimpse at a specific response to a rigid task (“trait” performance). Another potential complication was the relative ease and/or tediousness of the CDT, as evidenced by both the 94% accuracy rate and the decreased RT across blocks as participants likely “checked out”. Consequently, data may not have yielded sufficient variability in the attention indicators to adequately reflect a range in individual differences with respect to RT/ACC/IO/VT. A more challenging eye-tracking assessment might better map on to self-reported ADHD and also hoarding symptoms.

There are also construct considerations to keep in mind. On a broader theoretical level, it may be the case that inattention and distractibility each represent slightly different aspects of underlying attention problems. Perhaps the CDT successfully targeted distractibility, but the inattentive component may be more salient in the context of hoarding. Incorporating a second measure specifically targeting distractibility rather than overall ADHD symptoms could help confirm the construct validity of the CDT. Alternatively, the CDT may have been ineffective at capturing distractibility as a construct. To this end, the merit of IO as a viable eye-tracking indicator has recently been questioned. In a study of attentional biases to threat in social anxiety, Waechter, Nelson, Wright, Hyatt, and Oakman (2014) found that attentional orientation indices "do not appear to be a reliable index of individual differences" (p.326). Regarding VT, the authors also found that eye-tracking indices assessed over at least 5,000 ms demonstrated very good reliability; the maximum VT in the current study was merely 3,000 ms, which may not be a sufficient duration to consistently capture "inattention" across participants. Replicating findings with a task incorporating longer duration trials of 5,000 ms may clarify the pattern of results for VT and enhance support for visual inattention as a core deficit underlying hoarding.

Taking a closer look at the link between the CDT and the behavioral measure of hoarding also raises additional considerations. RT was found to be associated with Sort Time for Commonly Hoarded objects, as well as Urge to Acquire Trivial items. However, as a whole, the CDT indicators were not as strongly associated with the OST outcomes as expected. No significant associations were found with outcomes for Personal items, in contrast to expectations, considering that self-reported hoarding symptoms were linked with taking longer to sort Personal objects. It is possible that since participants were asked to select and bring their Personal items from home from a list, they had already sorted/organized them in a mental and/or tactile capacity, which thus "buffered" the effect of attention difficulties once asked to do so again during the lab session.

Similar to our consideration of whether the CDT is a valid measure of inattention, is the question of whether the OST was the best behavioral measure to select to assess hoarding. In support of the OST, specific indicators did map onto self-reported hoarding symptoms, as anticipated. In particular, Sort Time for Personal items was significantly associated with SIR-Discarding, SIR-Acquiring, and SIR-Total; one would expect that having difficulty discarding or making decisions about belongings would result in taking a longer time to organize them into piles. This is in line with previous findings using slightly modified sorting tasks; Wincze et al. (2007) found that those individuals with hoarding took longer to sort personal items than did healthy controls, despite using index cards as proxies for actual personal objects. In their study, hoarding was also associated with greater Number of Categories for Personal items. However, Wincze et al. (2007) recruited a hoarding group with clinically significant symptoms, while difficulties with sorting may not be as evident with a non-clinical sample. We did find that SIR-Clutter was significantly associated with the Number of Categories for Personal items. This is in line with Luchian et al. (2007)'s finding that nonclinical individuals who self-identified as “packrats” did also create more categories for Trivial items than those who did not. In a practical sense, the tendency to classify items into numerous different groups may make it difficult to organize a large number of belongings.

Interestingly, SIR-Clutter, SIR-Discarding, and SIR-Total scores were significantly associated with Urge to Acquire both Trivial and Commonly Hoarded objects, but not with the actual Number of Items Acquired. One potential explanation could be that increased hoarding symptoms manifest more strongly as an initial urge to acquire novel objects that can be down-regulated in a non-clinical population, instead of translating into actual number of items obtained (as may be the case in a more severe population). Another possibility is that the OST is a “snapshot” assessment of in-the-moment hoarding, while the SIR reflects a more long-term, cumulative pattern of behaviors where accumulated possessions are “churned” through over time. The specificity of the momentary OST could be part of the reason why certain indicators (such as Number of Items Wished to Acquire/Discard) were not overwhelmingly associated with self-reported hoarding or ADHD symptoms. Moreover, the SIR does not directly tap into categorization; perhaps a more targeted questionnaire regarding category under-inclusiveness or self-perceived difficulty with sorting would better corroborate with behavioral outcomes on a sorting task. Alternatively, behavioral tasks of acquiring and discarding may also better map onto the three primary subfacets of hoarding as assessed by the SIR.

In general, the low concurrence between the OST and CDT in relation to the self-report questionnaires could also speak to a broader issue of poor overlap between behavioral assessments and self-report inventories of neuropsychological constructs, which has been shown in the past literature. For instance, individuals with hoarding tend to report great difficulties with decision-making and planning, as reflected by self-report questionnaires (Frost & Gross, 1993; Frost, Tolin, Steketee, & Oh, 2011; Tolin & Villavicencio, 2011a). However, studies using neuropsychological tasks aiming to study these particular executive functioning deficits have largely been unsuccessful in consistently corroborating this association (e.g., Blom et al., 2011; Grisham et al., 2007; Tolin & Villavicencio, 2011a). Furthermore, this problem is pervasive across diagnostic categories and is not limited to hoarding measures. In general, a multitude of factors such as test environment, emotional and behavioral problems, and compensatory strategies can influence the degree to which a neurological task is ecologically valid (Chaytor & Schmitter-Edgecombe, 2003). It is possible that our selected CDT and/or OST tasks are in line with these various neuropsychological assessments that do not quite capture the same aspect of information processing deficits that are reflected in self-reports.

An interesting direction for future investigations would be to consider the difference between actual and perceived deficits in information processing. Those with hoarding tend to report low confidence in remembering things, though their actual memory may be intact (Hartl et al., 2004). Within the field of research in our own lab, there is also evidence in the realm of decision-making that it may be the cognitive fear of making decisions that plays a role in hoarding, rather than actual performance on neuropsychological assessments. Both Tolin et al. (2011) and Grisham et al. (2010) have suggested that decision-making difficulties may be specific to situations where individuals with hoarding experience emotional reactions to possessions, rather than a pervasive deficit that can manifest in performance differences on laboratory tasks. A similar phenomenon may be occurring with attention as well, such that explicit inattention may not be captured by objective tasks, but may be influenced by either a self-perceived tendency to be distractible or an affect-relevant context that potentially “triggers” inattentive behavior. For instance, “emotionally taxing situations” such as having to sort and discard personal items in a cluttered space may exacerbate or highlight distractibility (Fitch & Cougle, 2013, p.197). Moreover, symptom severity may also be a factor in the disparity between actual vs. perceived deficits. In support of this, Fitch and Cougle (2013) conducted a battery of neuropsychological tests with an undergraduate sample – though participants *reported* more ADHD symptoms and greater levels of impulsiveness, indecisiveness, and memory concerns, no *actual* performance deficits were noted on the actual tasks. Specifically, on a continuous performance test that is often used to assess ADHD, the non-clinical hoarding group did not differ from the control group on errors of omission or hit reaction time, which are outcomes indicating sustained attention (Fitch & Cougle, 2013). It may be the case that non-clinical participants may report self-perceived difficulties with ADHD symptoms in line with clinical samples, but do not exhibit actual deficits to the extent that individuals with more severe hoarding symptoms do.

This study contributed to the body of literature of attention and hoarding by implementing an original eye-tracking task and improved behavioral sorting task. Though there was some concordance between several outcomes on the OST and the SIR, for the most part, many of these objective indicators were not associated with the self-report measures of ADHD and hoarding as was originally expected. Additional studies may further explore the possibility that distractibility and inattention may be two related but distinct aspects of this executive function domain. Future investigations may help clarify the specific components of attention that are impaired in hoarding, and whether there are potential differences between non-clinical samples and those who experience hoarding symptoms in the clinical range. Continuing in the vein of multi-modal assessments is important to help detect notable deficits and discrepancies across the range of information processing deficits. Finally, better understanding of whether actual or perceived deficits may be of more importance can inform conceptualization of and treatments for hoarding, potentially including components to help target improved attention.

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Figures

Figure 1

Course of One Trial on the Modified Attention Task

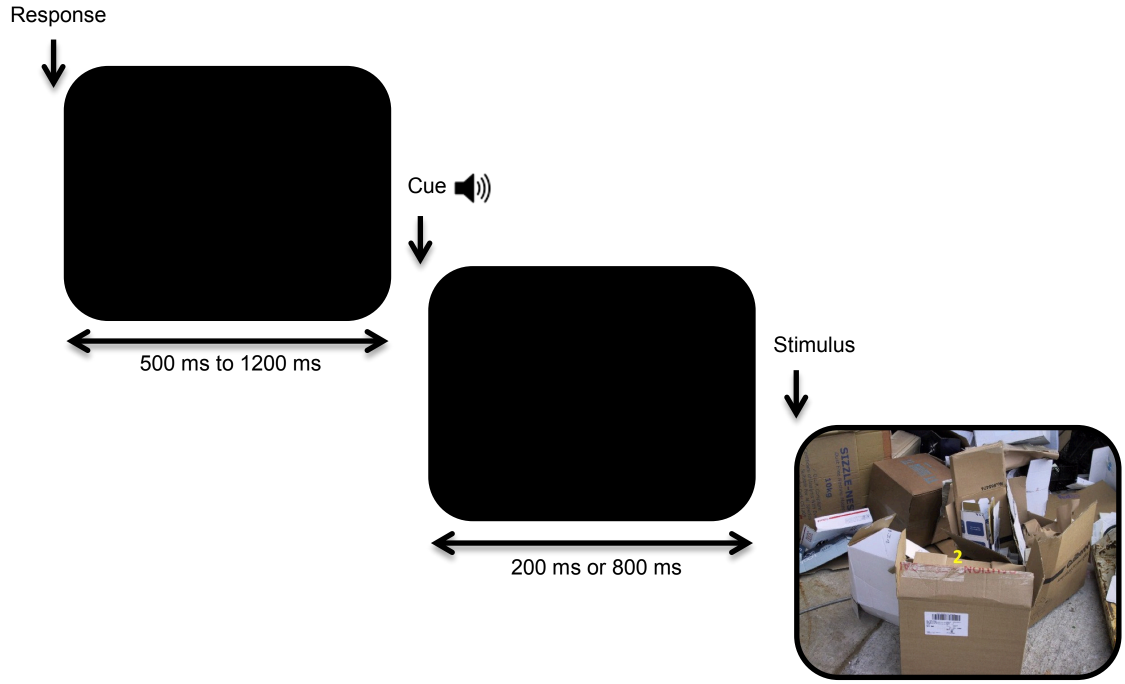


Figure 2

Example of Standardized Set-up for Object Sorting Task - Personal Items.

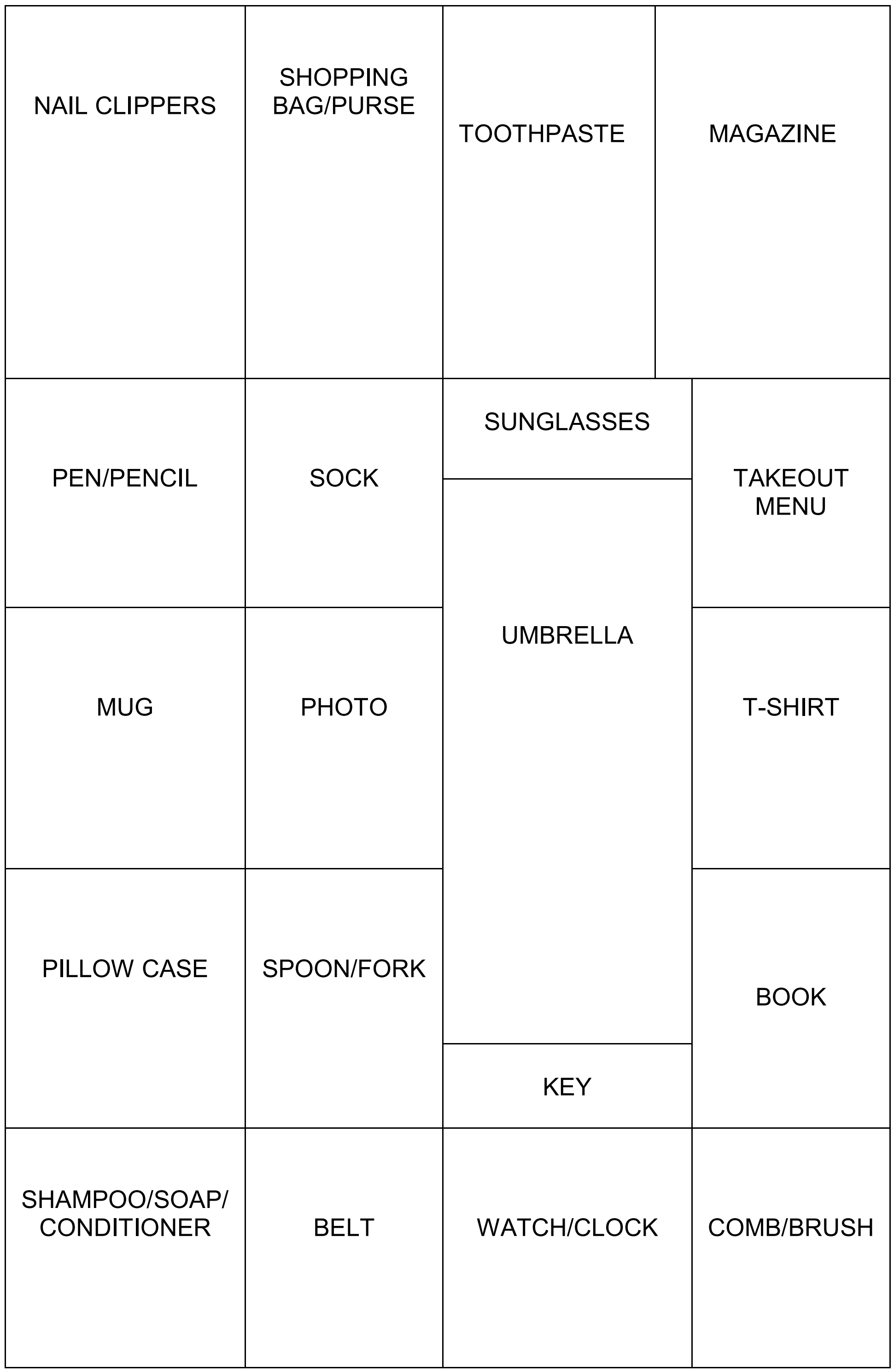
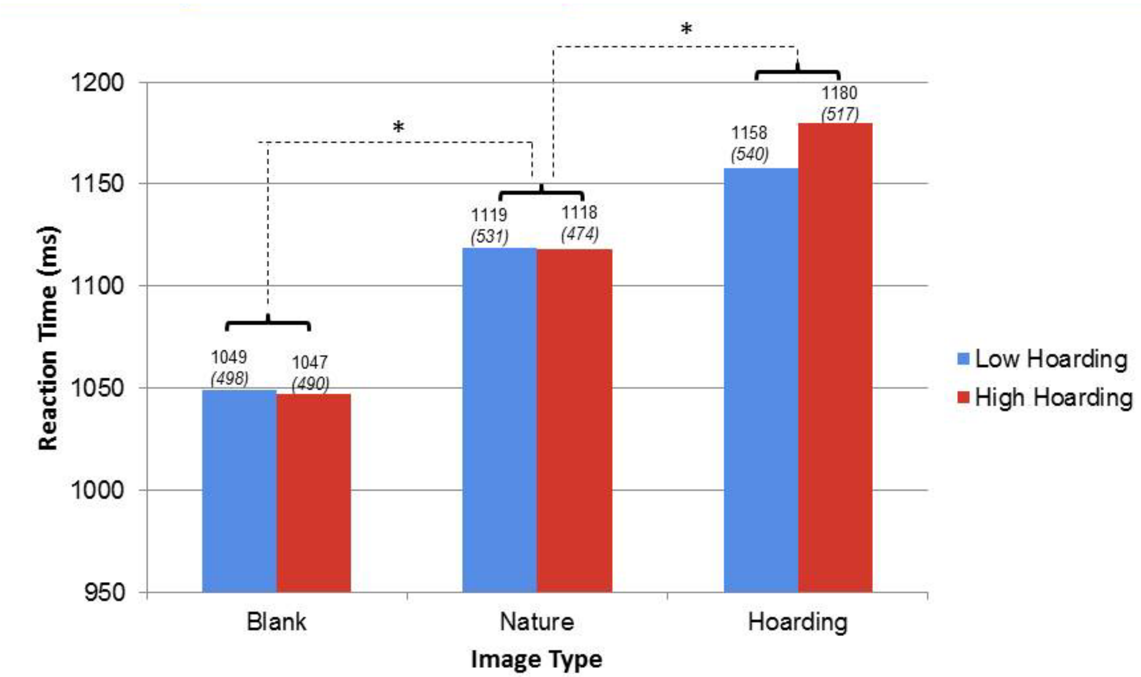


Figure 3

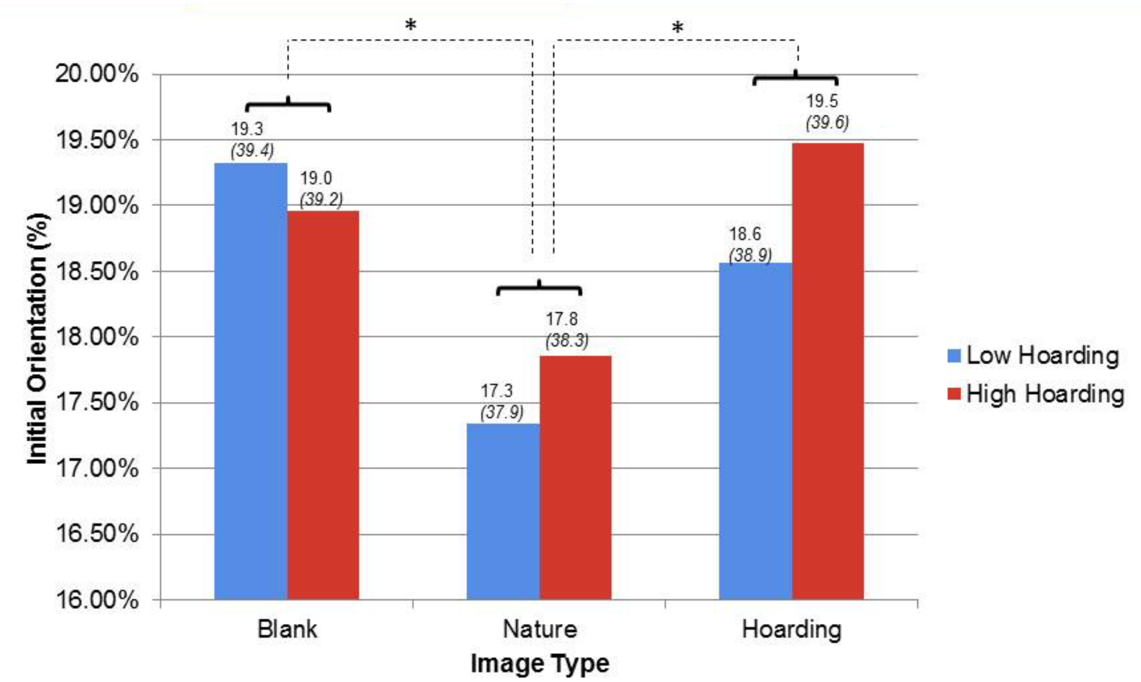
Mean Reaction Time by Image Type and Hoarding Group



Note. * $p < .05$.

Figure 4

Mean Initial Orientation by Image Type and Hoarding Group



Note. * $p < .05$.

Figure 5

Mean Accuracy Rate by Image Type and Hoarding Group

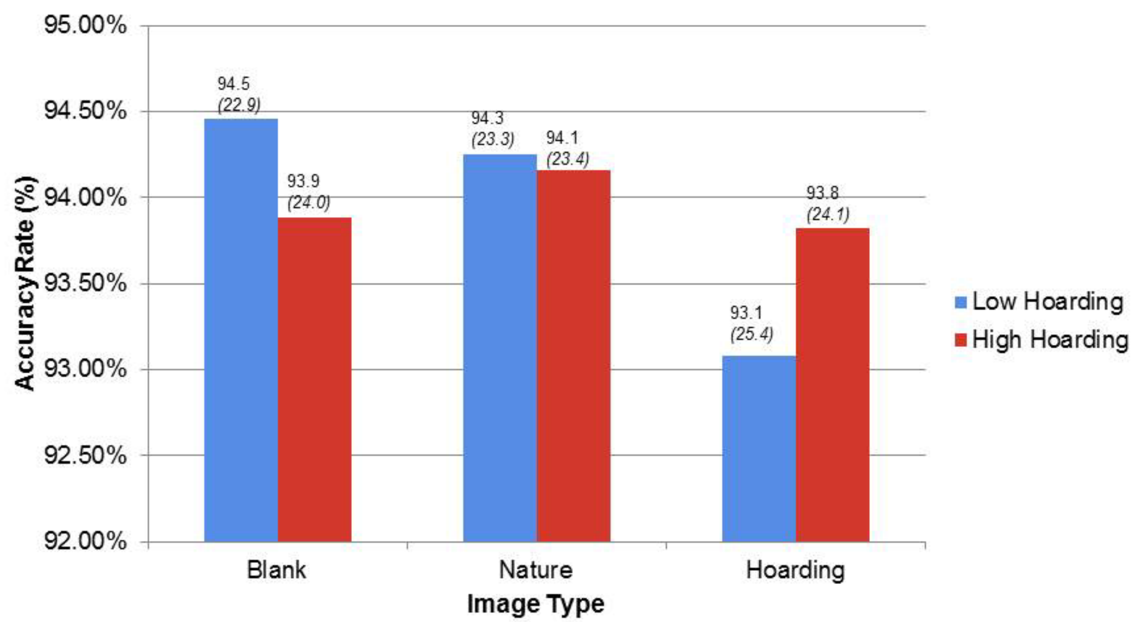
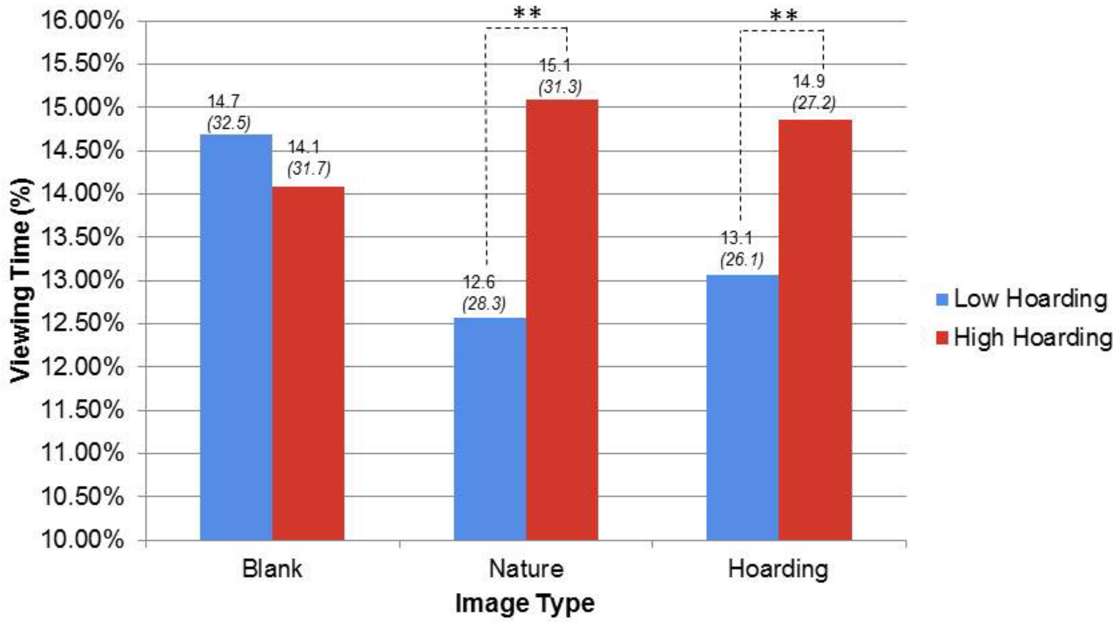


Figure 6

Mean Viewing Time by Image Type and Hoarding Group



Note. ** $p < .01$.

Tables

Table 1

Summary of Key Laboratory Studies on Hoarding and Attention.

Task Administered	Study	Proband vs. *Comparison Group*	Key Findings
Wisconsin Card Sorting Task	1. Lawrence et al., 2006	1. OCD+Hsx vs. *OCD-Hsx & HC*	1. No group differences
	2. Tolin et al., 2011	2. HD vs. *CC (OCD) & HC*	2. No group differences
	3. McMillan et al., 2012	3. HD vs. *HD+OCD*	3. No group differences
	4. Ayers et al., 2013	4. Older HD vs. *Older HC*	4. HD < HC on total errors
Continuous Performance Test	1. Grisham et al., 2007 (Conners' CPT)	1. HD/OCD vs. *CC (mood or anxiety) & HC*	1. HD < [CC & HC] on sustained & spatial attention
	2. Tolin et al., 2011 (UPenn CPT)	2. HD vs. *CC (OCD) & HC*	2. HC > [HD & CC] on levels of attentional capacity
Stroop Color Word Test	1. Tolin et al., 2011	1. HD vs. *CC (OCD) & HC*	1. OCD+Hsx > OCD-Hsx on attenuated attention
	2. Mackin et al., 2011	2. HD+LLD vs. *LLD*	2. No group differences
Intra-Extra Dimensional Set Shift	1. Grisham et al., 2010	1. HD vs. *CC (mood or anxiety) & HC*	1. No group differences
Affective Go/No-Go	1. Grisham et al., 2010	1. HD vs. *CC (mood or anxiety) & HC*	1. No group differences
Wechsler Subtests:			
Letter Number Sequencing	1. Mackin et al., 2011	1. HD+LLD vs. *LLD*	1. No group differences
	2. Ayers et al., 2013	2. Older HD vs. *Older HC*	2. HD < HC on attentional span/set shifting
Digit Span	1. Mackin et al., 2011	1. HD+LLD vs. *LLD*	1. No group differences
	2. McMillan et al, 2012	2. HD vs. *HD+OCD*	2. No group differences
	3. Ayers et al., 2013	3. Older HD vs. *Older HC*	3. HD < HC on focused attention
Spatial Span	1. McMillan et al, 2012	1. HD vs. *HD+OCD*	1. No group differences
Visual Memory Span	1. Grisham et al., 2007	1. HD/OCD vs. *CC (mood or anxiety) & HC*	1. HD < CC on response inhibition

Note. HD = Hoarding disorder; Hsx = Hoarding symptoms; OCD = Obsessive compulsive disorder; HC = Healthy controls; HD/OCD = Hoarding in the context of OCD; LLD = Late life depression; CC = Clinical controls; CPT = Continuous Performance Test; UPenn = University of Pennsylvania.

Table 2

Means and Standard Deviations for Key Self-Report Variables

Self-Report Measure	**Mean**	***SD***	**Range**
SIR Total	18.39	11.27	0-63
SIR Clutter	5.39	4.61	0-20
SIR Discarding	6.49	4.64	0-21
SIR Acquiring	6.51	3.89	0-22
DASS Total	17.01	16.20	0-68
DASS Depression	4.12	5.82	0-34
DASS Anxiety	4.20	5.16	0-24
ADHD Total	11.52	6.90	0-35
ADHD Inattentive	5.29	3.98	0-16
ADHD Hyperactive	6.23	3.73	0-19

Note. SIR = Saving Inventory-Revised; DASS = Depression, Anxiety and Stress Scale; ADHD = Attention Deficit Hyperactivity Disorder Symptom Checklist.

Table 3

Means and Standard Deviations for Key Indicators of Object Sorting Task

	Mean	*SD*	Range	Correlation with SIR-Total	Correlation with SIR-Discarding
Average Sort Time	50.82	12.29	21.33-80.33	.26*	.27*
Personal Items	59.00	16.30	26-108	.32*	.32**
Trivial Items	52.13	17.03	15-99	.17	.17
Commonly Hoarded Items	41.32	12.02	17-77	.11	.17
Average Number of Categories	5.74	1.08	3-9	.09	-.05
Personal Items	6.19	1.83	2-12	.19	.11
Trivial Items	5.99	1.45	3-9	.02	-.17
Commonly Hoarded Items	5.04	.79	3-7	-.11	-.15
Average Number of Items Acquired	2.47	2.25	0-10.50	.16	.17
Trivial Items	3.03	2.57	0-14	.14	.15
Commonly Hoarded Items	1.91	2.29	0-9	.14	.17
Average Urge to Acquire	2.65	1.90	0-8	.37**	.32**
Trivial Items	3.33	2.11	0-8	.32**	.30*
Commonly Hoarded Items	1.94	2.12	0-8	.34**	.27*
Number of Items Willing to Discard (Personal Items)	11.61	4.77	2-20	-.11	-.16
Urge to Save (Personal Items)	4.01	2.49	0-10	-.12	-.04

Note. SIR = Saving Inventory-Revised.
**p* < .05, ***p* < .01.

Table 4

Means and Standard Deviations for Key Indicators of Distractibility Task

	Mean	***SD***	**Range**	**Correlation with SIR-Total**	**Correlation with SIR-Discarding**
Reaction Time	1111.35	210.74	658.60 - 1759.53	.13	.15
Accuracy Rate	93.94%	4.56%	73.89 - 99.44%	-.10	-.10
Initial Orientation	18.55%	15.95%	.56 - 66.30%	.20	.23
Viewing Time	14.15%	15.05%	.63 - 73.14%	.22	.24*

Note. SIR = Saving Inventory-Revised.
*$p < .05$.

Table 5

Correlations Between Key Indicators of Cued Distractibility Task and ADHD-CL Scores

	Correlation with ADHD Total	**Correlation with ADHD-Inattentive**	**Correlation with ADHD-Hyperactive**
Reaction Time	.07	.05	.08
Accuracy Rate	-.14	-.15	-.11
Initial Orientation	.13	.12	.11
Viewing Time	.11	.07	.12

Note. ADHD = Attention Deficit Hyperactivity Disorder Symptom Checklist.

Table 6

ADHD Subscales Predicting SIR Scores (Model 1) and with DASS Subscales as Covariates (Model 2)

DV	**Model**	**R^2**	**Predictors**	**B**	**SE**	***β***	***t***
SIR-Total	1	.34	ADHD-Inattentive	.82	.35	.29	2.32*
			ADHD-Hyperactive	1.10	.38	.36	2.92**
	2	.41	DASS-Anxiety	.74	.30	.34	2.47*
			DASS-Depression	.02	.22	.01	.10
			ADHD-Inattentive	.54	.37	.19	1.47
			ADHD-Hyperactive	.65	.41	.22	1.60
SIR-Clutter	1	.23	ADHD-Inattentive	.42	.16	.36	2.70**
			ADHD-Hyperactive	.21	.17	.17	1.25
	2	.30	DASS-Anxiety	.31	.13	.35	2.35*
			DASS-Depression	-.02	.10	-.03	-.24
			ADHD-Inattentive	.32	.16	.28	1.97
			ADHD-Hyperactive	.02	.18	.01	.08
SIR-Discarding	1	.23	ADHD-Inattentive	.31	.16	.27	1.97
			ADHD-Hyperactive	.33	.17	.27	1.99
	2	.29	DASS-Anxiety	.21	.14	.23	1.54
			DASS-Depression	.10	.10	.12	.98
			ADHD-Inattentive	.18	.17	.15	1.08
			ADHD-Hyperactive	.21	.19	.17	1.16
SIR-Acquiring	1	.35	ADHD-Inattentive	.09	.12	.09	.73
			ADHD-Hyperactive	.56	.13	.54	4.33**
	2	.39	DASS-Anxiety	.22	.10	.29	2.08*
			DASS-Depression	-.05	.08	-.08	-.67
			ADHD-Inattentive	.04	.13	.04	.30
			ADHD-Hyperactive	.42	.14	.41	2.95**

Note: DASS = Depression, Anxiety and Stress Scale; ADHD = Attention Deficit Hyperactivity Disorder Symptom Checklist; DV = dependent variable; B = unstandardized coefficient; SE = standard error; *β* = standardized coefficient.
$^*p < .05$, $^{**}p < .01$.

Table 7

Correlations Between Key Indicators of Object Sorting Task and Cued Distractibility Task

	Correlation with RT	Correlation with IO	Correlation with ACC	Correlation with VT
Average Sort Time	.23	.07	.06	.03
Personal Items	.19	.12	-.01	.09
Trivial Items	.10	.07	.11	.01
Commonly Hoarded Items	.30*	-.05	.04	-.06
Average Number of Categories	.08	-.20	.13	-.05
Personal Items	-.91	-.15	.20	-.03
Trivial Items	.10	-.11	-.05	-.00
Commonly Hoarded Items	.17	-.26*	.14	-.16
Average Number of Items Wish to Acquire	.05	-.06	.15	-.05
Trivial Items	.06	-.08	.14	-.09
Commonly Hoarded Items	.02	-.03	.13	.01
Average Urge to Acquire	.21	.03	.06	.07
Trivial Items	.29*	.05	.04	.06
Commonly Hoarded Items	.09	.01	.05	.07
Number of Items Willing to Discard (Personal Items)	.08	-.10	-.26*	-.04
Urge to Save (Personal Items)	.04	-.20	-.12	-.23

Note. RT = Reaction Time; IO = Initial Orientation; ACC = Accuracy Rate; VT = Viewing Time.
$^*p < .05$.

Appendix A

Object Sorting Task Script

Phase 1

"I am going to be asking you to give me ratings of how distressed you are. On this scale, 0 is the most relaxed you can imagine being (perhaps on a beach somewhere without a care in the world), and 100 is literally panicking – or the most upset you can imagine being. On that scale, how would you say you're feeling right now?"

"Ok. I am now going to give you the first of three tasks. For this study, we are studying how people divide objects into categories or subcategories. I am going to place 20 items on this table, and I would like you to separate these items into different groups in a way that makes sense to you. Each group can have as few or many objects that you want to place in it; there are no right or wrong ways to complete this task. I would like to see how long it takes you to do this, so I'll be using my stopwatch, but you should take as much time as you'd like. Tell me when you are finished. Any questions? Ok, you may begin sorting the objects."

"Remember that 0-100 scale of distress, where 0 is as relaxed as possible and 100 is extremely upset? What was the highest level of distress you felt during this sorting task?"

[If set of objects is not personal] "Out of the 20 objects, how many items do you wish to acquire if you could do so? How strong is your general urge to acquire, on a scale of 0-10?"

[If set of objects is personal] "Out of the 20 objects, if you were asked to donate or discard as many items as possible, how many items would you toss or give away? How strong is your general urge to save them, on a scale of 0-10?"

Phase 2

"Ok. I am now going to have you participate in the second grouping task. This task is exactly the same as the previous one – only the objects themselves are different. Again, I will place 20 items on this table, and I would like you to separate these items into different groups in a way that makes sense to you. Each group can have as few or many objects that you want to place in it; there are no right or wrong ways to complete this task. I'll be timing you but remember to take as much time as you'd like. Tell me when you are finished. Ok, you may begin sorting the objects."

"What was the highest level of distress (on the 0-100 scale) you felt during this sorting task?"

[If set of objects is not personal] "Out of the 20 objects, how many items do you wish to acquire if you could do so? How strong is your general urge to acquire, on a scale of 0-10?"

[If set of objects is personal] "Out of the 20 objects, if you were asked to donate or discard as many items as possible, how many items would you toss or give away? How strong is your general urge to save them, on a scale of 0-10?"

Phase 3

"Ok. I am now going to set up the last grouping task, which goes exactly like the others except I have a different set of 20 items that I'm going to place on the table. I would like you to separate these items into different groups in a way that makes sense to you. Each group can have as few or many objects that you want to place in it; there are no right or wrong ways to complete this task. Once again, I'll be timing you but remember to take as much time as you'd like. Tell me when you are finished. Ok, you may begin sorting the objects."

"What was the highest level of distress (on the 0-100 scale) you felt during this sorting task?"

[If set of objects is not personal] "Out of the 20 objects, how many items do you wish to acquire if you could do so? How strong is your general urge to acquire, on a scale of 0-10?"

[If set of objects is personal] "Out of the 20 objects, if you were asked to donate or discard as many items as possible, how many items would you toss or give away? How strong is your general urge to save them, on a scale of 0-10?"