STRESS RESPONSE IN HOARDING DISORDER

STRESS RESPONSE IN INDIVIDUALS DIAGNOSED WITH HOARDING DISORDER

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Abstract

Hoarding disorder (HD) is characterized by (a) the acquisition of and inability to discard a large number of possessions; (b) clutter that interferes with the use of appliances and general living areas in the home; and (c) clinically significant distress or impairment in functioning. Although previous studies have reported that individuals with HD exhibit emotional dysregulation when discarding personal items, this investigation is the first to examine the biological indices of distress. The current study aimed to examine whether individuals with HD differed from healthy controls in their psychological and biological responses to a general psychosocial stressor and to investigate whether individual differences in stress response relate to differences in symptom severity and impairment. Twenty-one individuals with HD and 22 healthy controls (CTLs) completed the Trier Social Stress Task and self-reported affect and salivary cortisol responses to the stressor were assessed. Individuals with HD did not significantly differ compared to CTLs in their salivary cortisol levels in relation to the stressor. However, individuals with HD significantly differed compared to CTLs in their subjective levels of distress in relation to the stressor. Contrary to our hypotheses, responses to stress were not significantly correlated with measures of symptom severity and impairment due to hoarding. The current findings indicate that individuals with HD exhibit a greater self-reported emotional response to a general stressor. The implications of these findings are discussed.

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List of all Abbreviations and Symbols

ACTH: adrenocorticotropic hormone
ACC: Anterior Cingulate Cortex
ADHD: Attention Deficit/Hyperactivity Disorder
ADL-H: Activities of Daily Living in Hoarding
ANOVA: Analysis of Variance
APA: American Psychiatric Association AS: Anxiety Sensitivity
AUC_G: Area under the curve with respect to ground
CBT: Cognitive Behavioural Therapy
CIR: Clutter Image Rating
CRH: Corticotrophin-releasing hormone
CTL: Control
DASS: Depression Anxiety Sensitivity Scale
DERS: Difficulties in Emotion Regulation Scale
DSM: Diagnostic and Statistical Manual of Mental Disorders
DT: Distress Tolerance
GAD: Generalized Anxiety Disorder
HD: Hoarding Disorder
HPA: Hypothalamic-pituitary adrenal
HRS-I: Hoarding Rating Scale-Interview
IIRS: Illness Intrusiveness Rating Scale
M: Mean
MDD: Major Depressive Disorder
NA: Negative Affect
OCD: Obsessive-Compulsive Disorder
OCI-R: Obsessive-Compulsive Inventory- Revised
OCPD: Obsessive-Compulsive Personality Disorder
PANAS: Positive and Negative Affect Scale
PD: Panic Disorder
PTSD: Post-traumatic Stress Disorder
RM-ANOVA: Repeated Measure-Analysis of Variance
SAD: Social Anxiety Disorder
SCID: Structured Clinical Interview for DSM-IV Axis I Disorders
SD: Standard deviation
SE: Standard error
SIHD: Structured Interview for Hoarding Disorder
SI-R: Savings Inventory-Revised
TSST: Trier Social Stress Test
Δ: Change

Declaration of Academic Achievement

I hereby certify that the material presented in this thesis towards completion of a Masters (M.Sc.) degree in the McMaster Integrative Neuroscience Discovery and Study program, at McMaster University, Hamilton, Ontario is exclusively my own work and has not been submitted to any academic assessment other than partial-fulfillment of the degree named above.

Introduction

Overview of Hoarding Disorder

Hoarding disorder (HD) is a newly established disorder in the *American Psychiatric Association's (APA) Diagnostic and Statistical Manual of Mental Disorders* (DSM) (APA, 2013); it is included under an equally new Obsessive-Compulsive and Related Disorders section. Along with HD, this section includes body dysmorphic disorder, trichotillomania (hair pulling disorder), and excoriation (skin picking disorder). HD was primarily included in this section due to similarities between HD and other obsessive-compulsive and related disorders. However, HD also shares features with disorders such as attention deficit and hyperactivity disorder (Tolin & Villavicencio, 2011), which are located in the Neurodevelopmental Disorders section of the DSM-5. As research on this debilitating disorder increases over time, it will help further refine the most appropriate section that it should be contained in.

In previous editions of the DSM, specifically the fourth edition of the DSM (APA, 2000), the "inability to discard worn-out or worthless objects even when they have no sentimental value" was one of eight diagnostic criteria for obsessive-compulsive personality disorder (OCPD). The differential diagnosis section of OCPD further stated: "A diagnosis of obsessive-compulsive disorder (OCD) should be considered especially when hoarding is extreme" (p. 728). Therefore, although hoarding was not explicitly mentioned in the OCD section, when hoarding was considered severe it was a symptom of OCD. However, extensive research over the past decade conducted on hoarding cases has exemplified that the majority of individuals with hoarding symptoms do not meet diagnostic criteria for either OCD or OCPD (Frost, Steketee, & Tolin, 2011; Frost, Steketee, Williams, & Warren, 2000; Hall, Tolin, Frost & Steketee, 2013). In fact, recent research also suggests that HD is neurobiologically different from OCD (Saxena, 2008; Saxena et al., 2004).

Diagnostic Criteria

In the current edition of the DSM (DSM-5; APA, 2013), HD has six criteria that must be met for a diagnosis. This includes two exclusion criteria, which are used to rule out other potential causes for hoarding behavior.

Criterion A. This criterion focuses on the primary feature of hoarding, the inability to part with possessions regardless of their actual value. Individuals struggle with any attempt at parting with items, which includes donating, recycling, or selling (Frost, Steketee, & Tolin, 2012). It is important to note that difficulty must be persistent in order to differentiate from temporary life circumstances (i.e., inheriting a large number of items). Items that are most commonly collected include: newspapers, magazines, bags, books, clothing, and paperwork (Pertusa et al., 2008). Although it may seem that accumulated possessions are worthless or worn-out, in fact, collected items are usually a mix of valuable as well as worthless items (Frost, Steketee, & Tolin, 2012). It is for this reason that the criterion specifically states, "regardless of actual value." Rarely, items such as animals, bodily products or rotten food can be hoarded. The primary reasons that individuals with HD are unable to discard possessions fall into three broad categories: (1) the item is useful or valuable, (2) the item has intrinsic value, due to its aesthetic qualities, or (3) there is emotional attachment to the item because it is related to a significant person, time, event, or place (Frost, Hartl, Christian, & Williams, 1995). However, some individuals also report saving due a sense of responsibility for items (Steketee, Frost, & Kyrios, 2003). For example, an individual with HD may not want to waste an item that can still be used or may experience significant guilt when discarding. Another reason that individuals with HD struggle with discarding is due to a fear of losing information; individuals believe that discarding items would result in losing the memories associated with that item (Hartl et al., 2004).

Criterion B. This criterion helps differentiate hoarding behavior from other forms of

psychopathology, passive collecting, or accumulating. Individuals with HD intentionally accumulate possessions and experience extreme distress when discarding. This behavior is very different from normative collecting, and simple messiness or laziness. Hoarding behavior is also distinct from other forms of psychopathology that result in passive accumulation of items (see Criterion E).

Criterion C. This criterion pertains to clutter in active living spaces, due to difficulty discarding, that inhibit their intended use. If living spaces are uncluttered, it is due to the efforts of third parties. It is important to note that clutter must prevent the use of active living areas. This aids in differentiating clutter in basements and garages (i.e., inactive living areas) that might be cluttered in the majority of individuals not meeting diagnostic criteria, versus clutter in the kitchen or bedroom (i.e., active living areas). Clutter is defined as a large group of unrelated or marginally related items piled together in a disordered fashion, which inhibits the use of the living space (Steketee & Frost, 2003). Clutter must substantially inhibit the use of living areas. For example, the individual might not be able to take a shower, use the kitchen to cook, or sleep on their bed. In circumstances where living areas have been cleared due to the interference of family members, partners, or even the local authorities; individuals can still meet this diagnostic criteria because their living spaces are likely to become cluttered again.

Criterion D. This criterion pertains to the distress or impairment caused by hoarding symptoms (i.e., clutter/difficulty discarding). This criterion specifies that hoarding symptoms must cause clinically significant distress or impairment in a number of important areas of functioning. It is important to note that individuals with low insight will not report distress or impairment due to hoarding symptoms. The inability to discard and resulting clutter will severely interfere with normal activities such as cooking, cleaning, and personal hygiene (Grisham, Brown, Savage, Steketee, & Barlow, 2007; Kim, Steketee, & Frost, 2001). Hoarding

significantly affects an individual's quality of life (Saxena et al., 2011), and family relationships (Tolin, Frost, Steketee, Gray, & Fitch, 2008).

Criterion E. This criterion allows the clinician to rule out other potential causes of hoarding. In order to meet diagnostic criteria, hoarding behavior cannot be a direct consequence of another medical condition, such as a brain tumor, cerebrovascular disease, brain injury, or a rare genetic condition (i.e., Prader-Willis syndrome). Individuals who acquire a brain injury to the anterior ventromedial prefrontal and cingulate cortices, will begin to accumulate items after the injury (Mataix-Cols, Petusa, & Snowdon, 2011).

Criterion F. This criterion is the second exclusion criteria, which allows clinicians to rule out other potential causes of hoarding behavior, such as another form of psychopathology. HD should not be diagnosed if it is a consequence of a neurodegenerative disorder (i.e., Alzheimer's disease). In these individuals, hoarding behavior follows the onset of the neurocognitive disorder. Similarly, HD should not be diagnosed if the behavior is a consequence of a neurodevelopmental disorder (i.e., autism spectrum disorder), due to symptoms or delusions in schizophrenia, loss of energy to clean up in major depression, or symptoms of OCD (i.e., fear of harm, or feelings of incompleteness) (Mataix-Cols et al., 2010; Pertusa, Frost, & Mataix-Cols, 2010).

Specifiers. DSM-5 criteria includes two specifiers: Excessive Acquisition and Insight. The Excessive Acquisition specifier refers to excessive buying, collecting, or stealing of items that the individual does not need, have available space for, or cannot afford. Acquisition must be in excess, and directly impair functioning. This behavior is welcomed by the individuals, who find gratification and comfort in acquiring. Approximately 75% of individuals engage in excessive or compulsive buying, and over half acquire free things in excess (Frost, Tolin, Steketee, Fitch, & Selbo-Bruns, 2009). A number of studies have reported significant correlations between acquisition and symptoms of psychopathology. In a recent study by Reid and colleagues

(2011), high acquisition scores on the Savings Inventory- Revised (SI-R; Frost, Steketee, & Grisham, 2004) were significantly correlated with measures of social phobia, OCD, depression and worry in a non-clinical sample. In a clinical sample, high acquisition scores on the SI-R were associated with OCD symptoms, positive and negative affect (Frost, Steketee, & Grisham, 2004), as well as anxiety, stress, and depression (Frost, Rosenfield, Steketee, & Tolin, 2013). Therefore, it is important to measure excessive acquisition in HD as it may influence responses to stress (e.g., negative affect) and be associated with symptoms of other anxiety disorders. The second specifier is Insight, which has clinical implications for seeking treatment, as well as adherence to treatment programs (Tolin, Fitch, Frost, & Steketee, 2010). It is important to note that individuals who seek treatment and volunteer for research studies have reasonably good insight. The Insight specifier includes three categories to correctly capture the level of insight. It focuses on an individual's awareness of hoarding symptoms and resulting impairment. More than half of family members of people who hoard described their hoarding family member as having poor insight or lacking insight/delusional. Low levels of insight may also contribute to the poor treatment compliance commonly observed in patients with HD (Frost, Tolin, & Maltby, 2010). Low insight in HD remains a challenging feature for clinicians and family members.

Diagnosis and Assessment of Hoarding Disorder

The diagnosis and assessment of HD requires a comprehensive and multimethod approach due to its complex and multifaceted nature. In the past, clinicians and researchers have relied heavily on the hoarding subscales in existing measures of OCD (e.g., Obsessive Compulsive Inventory; Foa, Kozak, Salkovskis, Coles, Amir, 1998). However, after a decade of research on HD, several measures have been developed to aid in diagnosis and assessment of symptom severity. The Savings Inventory-Revised (SI-R; Frost, Steketee, & Grisham, 2004) is one of the most widely used measures for HD. The SI-R is a self-report questionnaire with three

subscales: clutter, difficulty discarding, and acquisition. As presented in Table 2, cut-off scores and clinical means have been established for total and subscale scores (see Tolin, Frost, & Steketee, 2010). The SI-R is able to reliably distinguish between individuals with hoarding problems and both non-hoarding OCD and controls (Frost, Steketee, & Grisham, 2004). Furthermore, the SI-R has been translated into 6 different languages, which reflect the applicability of the measure. In an effort to circumvent low insight in individuals with HD, Frost and colleagues (2008) developed the Clutter Image Rating (CIR; Frost, Steketee, Tolin, & Renaud, 2008). The CIR consists of nine standardized photographs that show various stages of clutter in different active living areas (i.e., bedroom, living room, and kitchen), respondents are asked to select the image that most closely resembles their homes. As many individuals with HD fail to recognize their behavior as problematic, selecting a picture instead allows for a less biased reporting. The CIR has good psychometric properties and is sensitive to treatment effects (Frost, Pekareva-Kochergina, & Maxner, 2011; Tolin, Frost, & Steketee, 2007). In addition to self-report measures, it is important to include interview-based assessments of hoarding symptoms. One commonly used semi-structured interview is the Hoarding Rating Scale-Interview (HRS-I; Tolin, Frost, & Steketee, 2010), which is comprised of five items to assess clutter, difficulty discarding, excessive acquisition, and the degree of impairment and distress due to hoarding. This measure has demonstrated good discrimination between hoarding and OCD patients. In addition to the HRS-I, another well-validated semi-structured interview is the Structured Interview for Hoarding Disorder (SIHD; Nordsletten et al., 2013). This measure is based on the provisional DSM-5 criteria for HD. This measure contains questions pertaining to clutter, difficulty discarding, acquisition, and distress/interference. The SIHD also contains questions to help rule out alternative diagnoses (i.e., OCD and Autism-Spectrum Disorder), as well as general medical conditions that would account for hoarding symptoms. To assess for HD specifiers, the SIHD

also includes questions to assess excessive acquisition and low insight.

As hoarding often occurs comorbid with other Axis I and Axis II diagnoses or symptoms, measures assessing commonly occurring anxiety and mood disorders should be included for clinical treatment and research purposes. Frost and colleagues (2011) reported that in a large community sample of 217 individuals, the most prevalent comorbid condition was major depressive disorder (MDD) with over half of the sample receiving this diagnosis. Whereas, generalized anxiety (GAD) and social anxiety disorder (SAD) occurred less frequently in this sample, with only one quarter of individuals receiving this comorbid diagnosis. Consistent with cognitive-behavioral models of hoarding (Frost & Hartl, 1996), which cite information processing deficits, nearly 30% of individuals had a comorbid attention deficit disorder. Furthermore, half of individuals in this sample reported experiencing a traumatic life event. Overall, nearly 75% of individuals in this sample had a comorbid mood and/or anxiety disorder. Due to limited research, it is not yet known the extent to which comorbid diagnoses affect the course and outcome of this disorder. Perfectionism has also been suggested to play an important role in hoarding behavior. Compared to community controls, individuals with HD score higher on measures of perfectionism (Frost & Gross, 1993). Perfectionism is also highly correlated with hoarding symptom severity and hoarding-related beliefs (Steketee, Frost, & Kyrios, 2003). Therefore, due to high rates of comorbidity in HD, it is important to include measures to assess anxiety and mood disorders.

Despite being relatively understudied, HD is widely prevalent. The occurrence of clinically significant hoarding ranges from 2.3% to 6% in the general adult population (Bulli et al., 2014; Iervolino et al., 2009; Mueller, Mitchell, Crosby, Glaesmer, & de Zwaan., 2009; Timpano, Keough, Traeger, & Schmidt, 2011). Initial symptom onset is typically in childhood or early adolescence (Tolin, Meunier, Frost, & Steketee, 2010), with symptom severity increasing

with age (Steketee & Frost, 2003). While not conclusive, it appears that the prevalence of this disorder does not vary by gender, despite clinical studies of hoarding citing mainly female participants (Frost, Steketee, & Tolin, 2011; Pertusa et al., 2008; Saxena et al., 2002). This finding can in part be explained by more women volunteering for research studies or seeking treatment more readily than men. Growing evidence suggests that individuals with HD are less likely to be married (Frost & Gross, 1993) and are more likely to live alone (Nordsletten, de la Cruz, Billotti, & Mataix-Cols, 2013). Due to the profoundly negative effect that symptoms can have on family (Tolin, Frost, Steketee, Gray & Fitch, 2008), this is understandable.

Excessive acquisition combined with a failure to discard and the resulting clutter, have significant consequences not only for the individual but family members and society at large. Hoarding can have a significant impact on an individual's health, often associated with obesity, poor nutrition, headaches, and breathing difficulties (Tolin, Frost, Steketee, Gray, & Fitch, 2008). The most commonly reported medical conditions associated with HD are hypertension, chronic stomach/gallbladder trouble, arthritis, lupus/thyroid disorder, autoimmune disease, chronic fatigue syndrome, diabetes/high blood sugar, and fibromyalgia. Children and family members living in the same home will also be at risk for the same medical problems (Steketee, Frost, & Kim, 2001; Steketee, Youngren, & Mallya, 1999). Moreover, hoarding behavior is associated with an increased risk of harm or death in a house fire, unsanitary conditions in the home, limited ability to use furniture or move through the home, and increase risk of illness due to poor sanitation (Frost, Steketee, & Williams, 2000; Kim, Steketee, & Frost, 2001). About half of individuals suffering from HD are unable to use their refrigerators, stovetops, sinks or tubs, and one in ten are not able to use the toilet in their home due to the debilitating clutter (Frost, Steketee, & Williams, 2000). This clutter can extend to the exterior of an individual's home, which can be why community and public health departments often receive numerous complaints

and incur significant cost addressing the problem. For example, the city of Ottawa, Ontario spent nearly $133,328.00 in 2005 on 94 hoarding cases (Dinning, 2006) and the San Francisco Task Force on Compulsive Hoarding (2009) estimated that over $6 million is spent each year on hoarding cases.

Economic burden further extends to work impairment due to hoarding. In a large sample of individuals who met full criteria for HD, an average of seven psychiatric work impairment days per month were reported (Tolin, Frost, Steketee, Gray, & Fitch, 2008), which is significantly greater than individuals with depressive, anxiety and substance use disorders (Kessler et al., 1994). Even those individuals who did not meet full criteria for HD reported more psychiatric work impairment than individuals diagnosed with social phobia, alcohol abuse, alcohol dependence, drug abuse and drug dependence (Tolin, Frost, Steketee, Gray, & Fitch, 2008). The high costs associated with this debilitating disorder may be broken down into loss of work productivity, mental health service utilization, medical costs associated with symptoms and the involvement of community agencies. Therefore, HD is a multifaceted problem that poses a challenge to individuals, their loved ones, public health workers and communities. Due to its serious and potentially life-threatening pathology it is pertinent to understand the psychological and biological mechanisms underlying this disorder.

Cognitive Behavioral Model of Hoarding

In 1996, Frost and Hartl proposed a cognitive behavioral model (CBT) of hoarding. This model proposed that hoarding behavior stemmed from four problems:

A. Strong emotional attachments to objects

B. Erroneous beliefs about possessions

C. Deficits in information processing

D. Behavioral avoidance.

Individuals with HD have very strong emotional attachments and erroneous beliefs about their possessions. These two factors are conceptualized as the driving forces in the maintenance of this disorder. Individuals with HD often anthropomorphize possessions or feel a sense of fusion with them and find it difficult to delineate boundaries between who they are and what they own (Kellett, Greenhalgh, Beail & Ridgway, 2010). Therefore, it is not surprising that individuals with HD feel extremely distressed when asked to discard their possessions, which they feel are a part of themselves.

In regards to the information processing deficits, individuals with HD often report difficulty with concentration, absentmindedness, failure in perception and memory, and slips of the mind (Frost & Steketee, 2014). In a recent study by Frost and colleagues (2013), cognitive failures were found to be significantly correlated with compulsive buying, free acquisition, and the excessive acquisition subscale in the SI-R. These results correlate with other investigations linking cognitive difficulties with symptom severity (Hartl, Duffany, Allen, Steketee, & Frost, 2005; Grisham, Norberg, Williams, Certoma, & Kadib, 2010). Furthermore, individuals with HD are more likely to demonstrate cognitive difficulties, evidenced by inattention (Tolin, Villavicencio, Umbach, & Kurtz, 2011). This is understandable due to the high comorbidity of HD with ADHD (Frost, Steketee, & Tolin, 2011). As an effective treatment option for hoarding is CBT, which includes techniques aimed at improving information processing difficulties (Gilliam, Norberg, Villavicencio, Morrison, Hannan, & Tolin, 2011), it would be important to explore the role of cognitive difficulties in treatment outcomes in the future.

In addition to information processing deficits, the CBT model of hoarding suggests that behavioral avoidance plays a role in the maintenance of this disorder. Not only has experiential avoidance (i.e., saving behavior) been found to be strongly correlated with all three subscales of the SI-R (difficulty discarding, clutter, excessive acquisition), but it was a predictor of excessive

acquisition and clutter (Wheaton, Abramowitz, Franklin, Berman, & Fabricant, 2011). Furthermore, individuals with HD continually engage in behavioral avoidance strategies (i.e., not discarding) in an effort to avoid the distress caused by discarding (described further in the section on emotion dysregulation). It is also not uncommon, for individuals with HD to use avoidance as a means of reducing hoarding behavior. For example, hoarders often report avoiding specific stores, aisles in stores, streets, and sometimes whole cities or sections of towns in an effort to keep from acquiring (Steketee & Frost, 2010). Therefore, this pattern of behavior plays a large part in this disorder.

In summary, a central component of this model is the dysfunctional emotional processes that underlie the inability to discard possessions. The model posits that individuals with HD experience negative emotions with greater intensity and engage in deleterious strategies (e.g. avoidance of discarding) to manage those negative emotional states. Maladaptive beliefs about the importance of possessions, coupled with exaggerated emotional attachment to acquired objects, further intensifies the distress individuals with HD experience when discarding everyday items.

Emotion Dysregulation

As outlined above, a core symptom of HD is the inability to discard possessions due to an exaggerated emotional attachment and distorted beliefs about the importance of limited value objects. Objects take on a human-like status (Frost, Hartl, Christian & Williams, 1995) and individuals often report loving them in a manner similar to loving people (Frost & Gross, 1993). Being surrounded by possessions provides a sense of comfort and security (Frost & Hartl, 1996). This heightened emotional connection to possessions explains why the purging of possessions elicits intense feelings of loss, sadness, and grief that cause severe distress for the individual (Steketee & Frost, 2010). When asked to discard possessions, individuals report being unable to

part with items because it would feel like losing a piece of themselves or an essential part of their life.

These examples underscore the severity of distress caused by discarding possessions, which directly lead to patterns of behavioral avoidance observed in hoarding patients (Frost & Hartl, 1996). It has been hypothesized that acquiring, saving and being able to visually observe or be surrounded by possessions allows the individual to avoid the potentially negative emotional states that are caused by not collecting an object or making the wrong decision regarding the value of the item and discarding it (Frost et al., 1998). Thus, due to the distress caused by discarding possessions, and the inability to regulate those negative emotional states, individuals with HD engage in behavioral avoidance to avoid distress.

These anecdotal reports are supported by empirical evidence showing that individuals with HD report significantly greater subjective anxiety compared to healthy control (CTL) participants when deciding to discard items (An et al., 2009; Tolin, Kiehl, Worhunsky, Book, & Maltby, 2009). In a recent study by Tolin and colleagues (2009), 12 individuals with HD and 12 matched CTLs were asked to make decisions about whether to discard personal paper items that they had brought with them and control items that did not belong to them. Items chosen to be discarded were immediately shredded by the experimenter. During this discarding paradigm, individuals were asked to rate their subjective levels of anxiety. Individuals with HD reported significantly greater subjective anxiety compared to CTLs when deciding whether to discard personal possessions, as well as lab items. The results of this study complement anecdotal evidence; individuals with HD experience significant levels of distress when asked to discard possessions.

The same researchers extended their findings by examining the pathophysiology of hoarding behavior (Tolin et al., 2012). In this study, the neural activity of 43 patients with HD,

31 patients with OCD and 33 CTLs were compared while making real-time decisions to keep or discard both personal and lab items. When deciding to discard personal possessions, individuals with HD showed excessive functional magnetic resonance imaging signals in the anterior cingulate cortex (ACC) and insula compared to patients with OCD and CTLs. The region of ACC implicated in this study is involved with monitoring error during uncertainty. Whereas, the mid-to-anterior insula regions are associated with the perception of negative affective states, identifying the emotional significance of stimuli and emotionally-driven emotions. Taken together, these brain regions are part of a network of structures used in identifying the emotional significance of a stimulus, generating an appropriate emotional response, and regulating affective state (Taylor, Seminowicz, & Davis, 2009; Phillips, Drevets, Rauch, & Lane, 2003; Ernst & Paulus, 2005; Chaudhry, Parkinson, Hinton, Owen & Roberts, 2009; Menon & Uddin, 2010). These findings suggest that the distress experienced by individuals with HD is not limited to subjective reports of anxiety but is also evidenced in the underlying neural circuitry.

Taken together, the degree of distress experienced by individuals with HD during discarding, and the inability to regulate those emotions, is relatively well established in the literature. The saving behavior observed in hoarding may allow individuals to avoid feelings of loss and dysphoria that are triggered by discarding (Frost, Steketee, Williams, & Warren 2000). Thus, individuals with HD save possessions in an attempt to regulate both anxious and dysphoric mood states. Based on this evidence, hoarding can be conceptualized as a disorder in which individuals have a dysregulated emotional response to discarding possessions. However, it is not yet known whether individuals with HD will experience emotional dysregulation to non-hoarding related stressors. Elucidating the link between hoarding and emotional dysregulation could aid in the treatment of this debilitating disorder. For example, the incorporation of emotion regulation strategies aimed at reducing anxiety and avoidance during exposure to general

stressors could aid in reducing hoarding behavior (i.e., difficulty discarding).

Tentative evidence from analog samples provides preliminary support for more general difficulties with managing stress in individuals with hoarding behavior. In a large nonclinical sample, self-reported hoarding symptoms were associated with greater difficulty tolerating distress and greater fear of internal anxiety-related sensations (Timpano, Buckner, Richey, Murphy, & Schmidt, 2009). This study was the first to provide evidence that individuals high in hoarding behavior had low tolerance of distress. These findings complement case reports and clinical observations that have reported hoarders to be less able to cope with emotions and situations that are stress-provoking. In a more recent study, behavioral measures of distress tolerance were assessed in a nonclinical sample after a series of negative mood inductions (Timpano, Shaw, Cougle & Fitch, 2014). Interestingly, self-reported hoarding symptoms were associated with experiencing negative emotions more intensely and reporting lower tolerance of them. Hoarding behavior was also was also linked to perceiving emotions as more dangerous or threatening. The results of this study provide further evidence that a central component in this disorder is the dysfunctional emotional processes that underlie the inability to discard possessions. An individual's tolerance for and sensitivity to negative emotional states can serve as vulnerability factors for engaging in problematic coping strategies such as hoarding and can potentially predict the extent of hoarding behavior. This is particularly important in individuals with HD; an exaggerated stress response to life stressors, coupled with their inability to tolerate that distress, leads to sustained hoarding symptoms.

Previous studies have examined subjective levels of distress in individuals with HD during hoarding-specific stressors (e.g., discarding paradigms). However, to our knowledge, no study thus far has examined stress responses in a clinical sample of individuals with HD to a general stressor. Responses to a general stressor could elucidate the extent of emotional

dysregulation in individuals with HD. When assessing responses to stress it is critical to include both psychological self-reports of distress (e.g., negative affect), as well as biological measures (e.g., cortisol). It is important to include biological measures, because they: 1) overcome the limitations of self-report measures, 2) provide unbiased information, and 3) allow monitoring of long-term health implications associated with stress such as cardiovascular disease (McEwen & Seeman, 2003). Biological measures provide information about processes occurring at an autonomic level, which circumvents reporting bias and low-insight observed in HD.

Assessing Responses to Stress

A central marker of individuals' biological stress response is the hypothalamic-pituitary-adrenal (HPA) axis. The activation of the HPA axis is vital to the biological stress response in humans (Patchev & Patchev, 2006). Extensive literature has established that psychological factors can greatly influence the neuroendocrine system by activating the HPA axis (Dickerson & Kemeny, 2004). The HPA axis plays an essential role in regulating normal physiological functions and is vital in activating physiological changes that ready individuals to respond to stress. HPA axis activation is initiated when the hypothalamus releases corticotrophin-releasing-hormone (CRH), which travels through the blood vessels to stimulate the anterior pituitary gland to secrete adrenocorticotropic hormone (ACTH). ACTH is carried by the blood to the adrenal gland, which triggers the release of the glucocorticoid hormone cortisol into the blood stream. Cortisol is the primary stress hormone. It is also an important regulator in physiological systems, such as immune system functioning and cardiovascular systems. Therefore, conditions that elevate cortisol levels have the potential to affect and disrupt critical physiological processes that are regulated by HPA axis activity (for review, see Lovallo & Thomas, 2000; Sapolsky, Romero, & Munck, 2000). Under normative conditions, cortisol is released 30 to 45 minutes after waking, with a gradual decrease during the day until late afternoon, after which there is a brief spike in

secretion. However, stressful events can interrupt the normal diurnal fluctuations and produce elevated cortisol levels. Cortisol levels will peak 10 to 15 minutes following a stressor onset and return to baseline 20 to 41 minutes after stressor offset. Through negative feedback loops, cortisol levels are returned to baseline; elevated levels of cortisol are identified by glucocorticoid and mineral-corticoid receptors in the hippocampus, hypothalamus, and pituitary gland, which signal the HPA axis to decrease cortisol production. Salivary cortisol is the most reliable and commonly used indicator of stress response (Starcke & Brand, 2012).

The HPA axis plays a critical role in stress responses by facilitating essential biological responses to stress and threat; however, chronic HPA axis activation resulting in cortisol secretion is associated with a wide variety of disease states and pathogenic processes such as bone loss, hypertension, autoimmune diseases, wound healing, and psychiatric disorders (Cohen, Kessler, & Gordon, 1995; Gold & Chrousos, 1999; McEwen, 1998).

One methodology that has been used extensively in the literature for examining reactions to psychological stress is the Trier Social Stress Test (TSST; Kirschbaum et al., 1999). The TSST is the gold standard for the experimental induction of psychological stress in both healthy participants and clinical populations (Dickerson & Kemeny, 2004; Heim et al., 2000; Williams et al., 2004). Extensive literature has established that psychological stressors induced in a laboratory setting can greatly influence the HPA axis. Moreover, previous studies have documented atypical patterns of cortisol reactivity typified by dysfunctional responses to stress in patients with major depressive disorder (MDD), panic disorder (PD), and general anxiety disorder (GAD). Individuals with MDD, PD and GAD exhibit a hyperactive cortisol response to stress (respectively, Heim et al., 2000; Abelson & Curtis, 1996; Mantella et al., 2008). Not only do these individuals have exaggerated stress reactivity but studies have reported higher cortisol levels during the recovery period (Burke et al., 2005). This prolonged biological response to

stress has been found in both currently depressed individuals (e.g., Parker, Schatzberg, & Lyons, 2003) and those at risk for depression (e.g., Firk & Markus, 2009). Therefore, biological responses to stress can be indicative of mental health status.

Current Study

Importantly, although the literature suggests that individuals with HD will exhibit dysregulated emotional responses to stress, including general life stressors, this has never been experimentally tested. Thus far, studies have focused exclusively on young undergraduate nonclinical samples rather than focusing specifically on individuals with HD. This limits the generalizability of past findings to clinical populations. In addition, previous studies have exclusively included psychological and subjective measures of distress, but have not included objective, biological measures (e.g. cortisol). Finally, current literature has exhaustively examined hoarding-specific stressors (e.g. discarding); however, no study thus far has explored whether individuals with HD respond differently than CTLs to a non-hoarding stressor.

The purpose of the present study was to examine the stress response in a clinical sample of individuals diagnosed with HD compared to healthy controls (CTL). More specifically, the primary aims of this study are to determine:

A. whether individuals with HD will differ from CTLs in their psychological response to a general psychosocial stressor as assessed via self-reported affect;
B. whether individuals with HD will differ from CTLs in their biological response to a general psychosocial stressor as assessed via salivary cortisol;.
C. to investigate whether individual differences in psychological and biological stress responses relate to differences in HD symptom severity and impairment.

Based on previous studies examining subjective distress in individuals with HD during discarding paradigms (An et al., 2009; Tolin, Kiehl, Worhunsky, Book, & Maltby, 2009), we

expect that individuals with HD will experience greater psychological and biological responses to the stressor than CTLs. Thus, we expect to see greater self-reported negative affect and salivary cortisol during the stressor and recovery period for the HD group compared to the CTL group. Based on previous studies linking symptom severity to impairment (Coles, Frost, Heimberg, & Steketee, 2003; Frost, Steketee, & Grisham, 2004; Tolin, Frost, & Steketee, 2007); we also expect greater responses to stress to be associated with greater symptom severity and impairment in individuals with HD.

Methods

Participants

The sample consisted of 21 individuals who reported symptoms that met DSM-5 (APA, 2013) diagnostic criteria for HD and 22 healthy controls who did not meet criteria for a current or past Axis I disorder. Individuals were recruited from community agencies that provide treatment for HD (e.g. Anxiety Treatment and Research Center, St. Joseph's Healthcare, Hamilton) and from community postings. Diagnostic status was established using the Structured Clinical Interview for DSM-IV (SCID-IV; First, Spitzer, Gibbons, & Williams, 1996). In addition, diagnostic criteria for HD was established by administering the Hoarding Rating Scale-Interview (HRS-I; Tolin et al., 2010) and the Structured Interview for Hoarding Disorder (SIHD; Pertusa & Mataix-Cols, 2010). Participants were excluded if they reported severe head trauma, learning disabilities, psychotic symptoms, alcohol or substance abuse within the past 6 months, seizures or epilepsy, color blindness, or health conditions known to interfere with the hypothalamic-pituitary-adrenal axis (including pregnancy and endocrine disorders). Participants were also excluded if they were younger than 18 years old, older than 60 years of age, or not fluent in English.

Measures

Structured Clinical Interview for DSM-IV Axis I Disorders (SCID; First, Spitzer, Gibbons, & Williams, 1996). The SCID is a semi-structured interview used to assess the presence of DSM-IV Axis I disorders. In this study, all participants were assessed for lifetime and current Axis I disorders. The SCID was administered by a senior graduate student, who had received extensive training and supervision in conducting this interview. A subset of interviews were reviewed and discrepancies were resolved by a staff psychologist with extensive experience administering the SCID-IV. The SCID has been found to have adequate inter-rater reliability for all disorders and adequate test-retest reliability over a 1 to 3 week interval in patient samples (Zanarini & Frankenburg, 2001).

Structured Interview for Hoarding Disorder (SIHD; Nordsletten et al., 2013). The SIHD was used to evaluate the presence of HD and its two specifiers (excessive acquisition and insight). This measure was only administered to participants in the hoarding group, to confirm diagnosis and assess symptom severity. The SIHD is a highly reliable and valid tool for the assessment of HD, with the resulting diagnosis being highly replicable, relatable to current HD measures and aids in differential diagnoses (e.g. OCD) (Mataix-Cols et al., 2013; Nordsletten et al., 2013b).

Hoarding Rating Scale-Interview (HRS-I; Tolin, Frost & Steketee, 2010). The HRS-I is a brief 5-item semi-structured interview that assesses the central features of hoarding (clutter, difficulty discarding, excessive acquisition, distress and impairment). This measure was only administered to participants in the hoarding group, to confirm diagnosis and assess symptom severity. Items were rated on a 9-point scale from 0 (none) to 8 (extreme). A total score was derived by calculating the sum of all 5 items. The HRS-I has shown high internal consistency and inter-rater reliability, is strongly correlated with other measures of hoarding, and reliably discriminates hoarding from non-hoarding participants (Tolin, Frost, & Steketee,

2010). Cronbach's alpha for the sample in this study was 0.89 for all items, indicating high internal reliability.

Demographic and health questionnaire. All participants completed a standard demographics and health questionnaire in order to assess for factors that have been found to influence salivary cortisol production (Kudielka, Hellhammer, & Kirschbaum, 2007). The questionnaire included variable such as: age, race, medical history, current medical conditions, medication use, level of physical exercise, sleep patterns, past/current drug use, recent food consumption, current use of contraceptives, and intake of caffeine/alcohol.

Activities of Daily Living in Hoarding (ADL-H; Frost, Hristova, Steketee, & Tolin, 2013). The ADL-H is a 15-item questionnaire used to assess impairment in daily living (e.g., eating, sleeping, use of furniture) due to clutter or hoarding symptoms. Items are rated on a 1 ("can do it easily") to 5 ("unable to do it") scale, with higher scores indicating more impairment in functioning. A "not applicable" (NA) rating is available where specific items do not apply. This questionnaire was scored by the mean of items not including NA. The ADL-H has high test-retest, inter-rater and internal reliability (Frost, Hristova, Steketee, & Tolin, 2013). Cronbach's alpha for the sample in this study was 0.95 for all items, indicating high internal reliability.

Savings Inventory- Revised (SI-R; Frost, Steketee, & Grisham, 2004). The SI-R is a 23-item questionnaire used to assess hoarding symptoms. It consists of three subscales assessing (a) excessive acquisition, (b) excessive clutter, and (c) difficulty discarding. Items are rated using a 5-point scale ranging from 0 ("not at all") to 4 ("extremely"). In addition to a total score, a sum was calculated for each subscale, with higher scores indicating greater symptom severity. The SI-R has been found to have strong internal consistency (α=.94; Coles, Frost, Heimberg, & Steketee, 2003), good test-retest reliability, and satisfactory convergent validity (Frost, Steketee, & Grisham, 2004). Cronbach's alpha for the sample in this study was 0.98 for all items,

indicating high internal reliability.

The Depression Anxiety Stress Scale-21 (DASS; Lovibond & Lovibond, 1995). The DASS-21 is a shortened version of the 42-item DASS scale that was designed to assess symptoms of depression, anxiety and stress. Each subscale has seven items, with four responses options from 0 ("did not apply to me at all") to 3 ("applied to me very much, or most of the time"). In order to yield equivalent scores to the full DASS 42, the total score of each scale was multiplied by two (Lovibond & Lovibond, 1995). Higher scores are indicative of greater levels of distress. The DASS-21 has demonstrated high internal consistency and strong psychometric properties in clinical populations (Antony, Bieling, Cox, Enns, & Swinson, 1998). Cronbach's alpha for the sample in this study for each subscale indicates high internal reliability (depression $\alpha = 0.96$, anxiety $\alpha = 0.856$, and stress $\alpha = 0.921$).

Obsessive-Compulsive Inventory-Revised (OCI-R; Foa et al., 2002). The OCI-R is an 18-item questionnaire used to assess the severity of OCD symptoms. Items are rated on a 5-point Likert scale, from 0 ("not at all") to 4 ("extremely"). Subscale and total scores are calculated by adding items, with higher scores indicative of a likely presence of OCD. This scale measures obsessive-compulsive symptoms and has strong psychometric properties (Hajcak, Huppert, Simons, & Foa, 2004). Cronbach's alpha for the sample in this study was 0.91 for all items, indicating high internal reliability.

Illness Intrusiveness Rating Scale (IIRS; Devins, 1994). The IIRS is a 13-item questionnaire used to assess the extent of impairment caused by symptoms of chronic problem in 12 different life domains including: health, diet, work, active recreation (e.g., playing sports), passive recreation (e.g., listening to music), finances, relationship with partner, sex life, family relations, other social relations, self-expression/improvement, religious expression, and community/civic involvement. In the present study, the IIRS was used to assess impairment due

to symptoms of anxiety. For clarity, the instructions at the beginning of the questionnaire (i.e., How much does your illness and/or its treatment interfere…) were altered; the word "anxiety" was substituted for "illness". Each item was rated on a scale from 1 to 7, with higher scores indicating more intrusiveness. This measure has strong psychometric properties (Cina & Clase, 1999). Cronbach's alpha for the sample in this study was 0.95 for all items, indicating high internal reliability.

Psychosocial Stressor

Trier Social Stress Test (TSST; Kirschbaum et al., 1999). We used a modified version of the TSST to induce mild psychosocial stress. The TSST is the gold standard for the experimental induction of psychological stress in healthy subjects as well as clinical populations (Dickerson & Kemeny, 2004; Heim et al., 2000; Williams et al., 2004). As described in more detail below (see Procedure), the TSST is a performance task consisting of a brief preparation period (5 minutes) followed by a test period in which the participant has to deliver a free speech (5 minutes) and perform mental arithmetic (5 minutes) in front of an audience. This stress paradigm combines uncontrollable and socio-evaluative elements in a highly standardized manner, and has therefore been found to induce significant increases in salivary cortisol levels, a major stress hormone (Dickerson & Kemeny, 2004).

Salivary cortisol. Salivary cortisol was used as to measure biological responses to stress. Cortisol was extracted from saliva collected using salivette swabs (Sarstedt, Numbrecht, Germany). Samples were stored at -20 °C until taken to a laboratory for cortisol assay. Samples were centrifuged for 15 minutes at 3000 rpm to produce a clear supernatant of low viscosity. Salivary cortisol was then quantified using a competitive Enzyme Immunoassay (EIA) kit (Salimetrics, LLC State College, PA, USA). The intra-assay coefficient of variation was 3.50%, the inter-assay coefficient of variation was 5.08%, and the sensitivity was 0.08 nmoles/L.

Positive and Negative Affect Scale (PANAS; Watson et al., 1988). Self-reported affect was assessed using the PANAS at five time points (see Procedure). The PANAS is a self-reported measure of mood state. It is comprised of two mood scales, one of which measures negative affect (i.e., distressed, upset, guilty, scared, hostile, irritable, ashamed, nervous, jittery, and afraid). The instrument has proven a reliable and valid measure of the constructs of positive and negative affect for different time frames (Krohne et al., 1996; Crawford & Henry, 2004).

Procedure

Participants were instructed to abstain from eating and drinking two hours prior to their session. All experimental sessions took place between the hours of 11:00 am and 5:00 pm in order to control for diurnal variations of cortisol secretion (Pruessner et al., 1997).

After providing informed consent, participants were asked to fill in a battery of questionnaires (30 minutes). At the end of the questionnaire period, participants began the TSST (Kirschbaum et al., 1999), and the first negative affect and cortisol samples were collected (see Measures of stress response; Figure 1). This saliva sample and negative affect rating served as the initial assessment prior to the baseline, and will be thus referred to as the *pre-baseline* sample.

Next, participants watched a calming nature video (20 minutes) and then completed the second set of negative affect and cortisol samples. This saliva and affect rating was collected prior to the preparation period (-15 minutes relative to TSST), and will be thus referred to as the *baseline* measure. Participants were then instructed to prepare a speech for a job of their choice, to introduce themselves to the selection committee and tell them why they are the ideal candidate for the job in a free speech. Participants were given a blank piece of paper to outline their speech (5 minutes); however, they were not allowed to use their notes for their speech. After the preparation period, participants were guided to another room and had to stand in front of the committee, who were sitting down, and a conspicuous video-camera. After completing the

speech task, participants were asked to serially subtract the number 13 from 2083 as quickly and accurately as possible (5 minutes). If the participants made an error, a committee member would respond with "Error 2083" to signal the participant to start again from the original number. Following the completion of these two tasks, the third affect and cortisol samples (i.e., *stress*) were collected. Subsequently, participants were guided back to the original room and asked to rest quietly (30 minutes). The fourth and fifth negative affect and cortisol samples (i.e., *recovery 1* and *recovery 2*) were collected were collected at 15-minute intervals during this rest period.

As in the original TSST, the two members of the evaluation committee (one man and one woman who wore white laboratory coats) were trained to withhold verbal and non-verbal feedback and were presented as experts in the evaluation of non-verbal behavior. Moreover, to avoid bias, members of the evaluation committee were blind as to group of the participant (HD or CTL). To minimize confounding variables, the members of the committee consisted of the same six volunteers throughout the study.

Results

Participant Characteristics

Demographic and clinical characteristics of participants in the two groups are presented in Table 1. The two groups did not differ significantly in their sex composition $\chi^2(1, N = 43) = 0.17$, $p = .89$, race, $\chi^2(3, N = 43) = 6.70$, $p = .08$, or age, $t(41) = 1.27$, $p = .21$. In regards to medication use, 10 individuals (48%) in the hoarding group were on psychotropic medication at the time of the study, compared to zero psychotropic medication use in the CTL group.

Hoarding-Specific Characteristics

As expected, the HD group endorsed high levels of symptom severity, assessed via two semi-structured interviews (i.e., HRS-I and SIHD). The average symptom severity, as measured by HRS-I was 30.29 ($SD = 3.07$). The established clinical mean for this measure is 24.22 (5.67)

(Tolin, Frost, & Steketee, 2010). The mean length of illness, as assessed by SIHD was 25.3 years (*SD* = 20.2). The majority of HD participants endorsed excessive acquisition, 21 individuals (95%). With regard to comorbidity features, 14 (67%) of the hoarding participants were diagnosed with at least one additional lifetime Axis-I psychological disorder. The two most common comorbid Axis I disorders were Social Anxiety Disorder (38%) and Major Depressive Disorder (29%; see Table 1). Moreover, a total of 7 individuals (16.28%) had received treatment for an Axis-I diagnosis.

Clinical Characteristics

The study measures are presented in Table 2. All participants completed the SI-R as a measure of hoarding symptoms and severity. There was a significant difference between CTL (*M* = 13.68, *SD* = 9.65) and HD (*M* = 61, *SD* = 10.98) participants on total SI-R scores, $t(41) = 15.02$, $p < .001$. Individuals with HD scored higher in the SI-R than the optimal cutoff scores, and scores were comparable to those cited in previous studies (Frost, Steketee, & Grisham, 2004; Tolin, Frost, & Steketee, 2010; Steketee, Frost, Tolin, Rasmussen, & Brown, 2010). Participants also differed on the individual subscales of the SI-R, with the HD group reporting significantly greater hoarding symptoms on all three scales: clutter, $t(41) = 14.23$, $p < .001$; acquisition, $t(41) = 9.40$, $p < .001$; and difficulty discarding, $t(41) = 11.03$, $p < .001$. The HD group also reported significantly greater illness intrusiveness due to symptoms of anxiety (as measured by the IIRS): for CTLs *M* = 29.59 and *SD* = 18.09 and for HD *M* = 53.07 and *SD* = 18.86, $t(41) = 4.17$, $p < .001$. There was a significant difference between CTL (*M* = 16.91, *SD* = 12.87) and HD (*M* = 50.24, *SD* = 30.24) participants on total scores in the DASS, $t(41) = 15.02$, $p < .001$. Participants also differed on the individual subscales of the DASS, with the HD group reporting significantly more symptoms of depression, $t(41) = 4.17$, $p < .001$, anxiety, $t(41) = 4.74$, $p < .001$, and stress, $t(41) = 4.33$, $p < .001$. As expected, there was a significant difference between groups on

impairment in daily functioning due to hoarding as measured by the ADHL; the HD group (M = 1.25, SD = 0.54) reported significant greater impairment than the CTL group (M = 2.21, SD = 0.64), $t(41) = 5.34$, $p < .001$. Lastly, there was a significant difference in total scores assessing symptoms of obsessive-compulsive disorder (OCI) in CTL (M = 10.50, SD = 0.54) and HD (M = 2.21, SD = 0.64), $t(41) = 4.89$, $p < .001$. When examining the OCI subscales, the HD group reported greater symptoms of Hoarding (CTL, M = 2.09, SD = 2.09; HD, M = 8.52, SD = 2.27), Checking (CTL, M = 1.82, SD = 2.74; HD, M = 2.95, SD = 3.12), Ordering (CTL, M = 3.82, SD = 3.38; HD, M = 4.90, SD = 3.42), Mental Neutralizing (CTL, M = 0.77, SD = 1.31; HD, M = 2.43, SD = 3.30), Washing (CTL, M = 0.82, SD = 1.01; HD, M = 2.19, SD = 3.03), and Obsessing (CTL, M = 1.19, SD = 1.92; HD, M = 5.57, SD = 3.33).

Negative Affect

To examine the change in negative affect between the two groups over the five time points (i.e., baseline, anticipation, stress, recovery 1, recovery 2) a repeated-measures analysis of variance (ANOVA) was conducted with group (HD, CTL) as the between-subject factor and time (baseline, anticipation, stress, recovery 1, recovery 2) as the within-subject factor on negative affect. There was a significant main effect of group, $F(1, 41) = 16.39$, $p < .001$, $\eta_p^2 = .29$, indicating higher negative affect scores in the HD versus CTL group. There was also a significant main effect of time, $F(4, 164) = 39.44$, $p < .001$, $\eta_p^2 = .49$. To follow up with this significant finding, paired samples t-tests were conducted to examine affective reactivity to the stressor and affective recovery from the stressor. Overall, participants demonstrated the anticipated affective response to the TSST. Negative affect ratings are depicted in Figure 1. As expected, negative affect significantly decreased from baseline to anticipation, $t(42) = 4.41$, $p < .001$. Also as expected, negative affect significantly increased from anticipation to stress, $t(42) = 9.26$, $p < .001$. Moreover, negative affect significantly decreased from stress to recovery 1, $t(42)$

= 6.33, $p < .001$, and from recovery 1 to recovery 2, $t(42) = 3.78$, $p < .001$.

There also was a significant group by time interaction at the cubic order, $F(4, 164) = 13.46$, $p = .001$, $\eta_p^2 = .247$. To determine the source of the significant interaction, we examined whether negative affect ratings differed between the HD and CTL groups at each time point. The HD group reported higher negative affect ratings then did the CTL group at each time point $t(41)$, $p < .01$.

In addition, we calculated change scores (Δ) to examine whether reactivity and recovery from stress differed by groups. That is, negative affect at baseline (sample #2) was subtracted from negative affect at the anticipation period (sample #1), with greater values indicating an increase in negative affect during the nature video. In this manner, change scores were calculated for all time-points: Δ from baseline to anticipation, Δ from anticipation to stress, Δ from stress to recovery 1, and Δ from recovery 1 to recovery 2. As Δ reflects change in the ratings of negative affect from one time point to another, an increase in negative affect is denoted by a positive value and a decrease in negative affect is denoted by a negative value. Change scores for negative affect are presented in Table 3. To examine differences in change scores, independent samples *t*-tests were run with group (HD, CTL) as the between-subject factor on change scores. The Δ from baseline to anticipation, signified a significant decrease in change scores, $t(41) = 3.78$, $p = .003$. The Δ from anticipation to stress, signified a significant increase in change scores, $t(41) = 2.10$, $p = .042$. This is an important change value, as it signifies that all participants reacted to the TSST through an increase in negative affect ratings. The Δ from stress to recovery 1, signified a non-significant decrease in change scores, $t(41) = 0.64$, $p = 0.95$. The Δ from recovery 1 to recovery 2, signified a significant decrease in change scores, $t(41) = 3.42$, $p = .001$.

Negative affect response to stress was also examined by calculating area under the curve with respect to ground (AUC_G) as recommended by Pruessner, Kirschbaum, Meinlschmid, and

Hellhammer (2003). AUC_G data is presented in Table 4. To examine group differences in AUC_G, an independent samples t-test was run with group (HD, CTL) as the between-subject factor on AUC_G. AUC_G values were significantly less for the CTL group (M = 111.35, SD = 20.01) than the HD group (M = 164.88, SD = 56.40), $t(41) = -4.187$, $p < .001$.

Salivary Cortisol

Given that previous research has demonstrated that gender influences salivary cortisol response to psychosocial stress tasks (see Kudielka, Hellhammer, & Wust, 2009 for review), we initially included sex as another between-subjects factor. Additionally, given that 48% of participants in the HD group were taking psychotropic medication, all analyses were initially conducted including medication status as a between-subjects factor. Results including sex and medication status were not significant, and the pattern of results with or without sex or medication status as a factor did not differ from each other. Therefore, all analyses were reported without gender and medication status as a factor.

Raw cortisol data was positively skewed, with values ranging from 1.60 to 3.14 (Standard Error [SE] = 0.36), with kurtosis ranging from 2.99 to 13.74. We log-transformed cortisol values, which resulted in normalizing the skewness and kurtosis of the data. Log-transformed cortisol skew values ranged from 0.22 to 0.65 (SE = 0.361), with kurtosis ranging from 0.33 to 1.12 (SE = 0.71). For salivary cortisol change over time, see Figure 3. To examine the change in salivary cortisol between the two groups over the five time points (i.e., baseline, anticipation, stress, recovery 1, recovery 2) a repeated-measures analysis of variance (ANOVA) was conducted with group (HD, CTL) as the between-subject factor and time (baseline, anticipation, stress, recovery 1, recovery 2) as the within-subject factor on salivary cortisol. The main effect of group was not significant, $F(1, 41) = 0.70$, $p = 0.79$, $\eta_p^2 = .002$, neither was the group by time interaction, $F(4, 164) = 0.22$, $p = 0.93$, $\eta_p^2 = .005$. There was, however, a significant main effect of time, $F(4,164)$

= 5.42, $p < .001$, $\eta_p^2 = .12$. To follow up with this significant finding, paired samples *t*-tests were conducted to examine cortisol reactivity to the stressor and cortisol recovery from the stressor. Given that cortisol levels typically peak 10-15 minutes after stressor onset (Dickerson & Kemeny, 2004), we expected cortisol levels to peak at recovery 1. We therefore anticipated that reactivity to stress would be reflected by an increase in cortisol from baseline through recovery 1, and recovery from stress would be reflected by a decrease in cortisol from recovery 1 to recovery 2. From baseline to anticipation, salivary cortisol significantly decreased, $t(42) = 4.42$, $p < .001$. From anticipation to stress, salivary cortisol did not significantly change, $t(42) = 1.74$, $p = .089$. However, as expected, salivary cortisol significantly increased from stress to recovery 1, $t(42) = 3.42$, $p = .001$. Moreover, as expected salivary cortisol significantly decreased from recovery 1 to recovery 2, $t(42) = 5.17$, $p < .001$.

Cortisol response to stress was also examined by calculating area under the curve with respect to ground (AUC_G). AUC_G data is presented in Table 4. To examine group differences in AUC_G, an independent samples t-test was run with group (HD, CTL) as the between-subject factor on AUC_G. The CTL group ($M = 120.22$, $SD = 44.73$) and HD group ($M = 123.12$, $SD = 28.99$) did not significantly differ, $t(41) = -0.25$, $p = .80$.

Relation between Response to Stress and Symptom Severity

In order to examine whether affective response to stress correlated with hoarding symptom severity (SI-R, HRS-I) and impairment (ADL-H) in the HD group, we examined responses to stress via AUC_G. See Table 5 for Pearson-product data. Overall, affective responses to stress did not significantly correlate with any measures of hording symptom severity or impairment.

Discussions

Hoarding disorder is a newly established disorder in the DSM-5 (APA, 2013). It is a

chronic and debilitating disorder, which has been largely understudied despite its serious and potentially life-threatening pathology. It is characterized by significant difficulty discarding personal possessions, which results in clutter that hinders an individuals' safety, health, occupation and emotional well-being. Although previous studies have noted psychological distress caused by discarding personal items (An et al., 2009), this investigation was the first to examine both the biological and psychological indices of distress to a psychosocial stressor unrelated to hoarding. The primary purpose of this study was to examine for the first time, whether individuals with HD have different psychological and biological responses to a stressor compared to healthy controls. The secondary aim of this study was to investigate whether individual differences in stress response related to differences in HD symptom severity and impairment. Self-reported negative affect and salivary cortisol were assessed before, during, and after the stressor. We hypothesized that individuals with HD would experience greater distress than healthy controls during the stressor, indicated by both psychological and biological markers. Moreover, compared to healthy controls, we expected that individuals with HD would exhibit difficulty recovering from that stress, evidenced by prolonged negative affect and salivary cortisol. We also expected that stress reactivity and recovery would correlate with greater HD symptom severity and impairment.

Results from the current study suggest that individuals with HD reported significantly greater subjective distress than CTLs in anticipation of the stressor, during peak stress and recovery period. Cortisol levels, however, did not differ between the HD and CTL groups. Moreover, although individuals with HD reported significantly greater affective reactivity to the stressor than CTLs, their cortisol reactivity to stress did not differ from CTLs. Previous studies have linked HD with emotion dysregulation during hoarding-specific discarding paradigms; however, the results of this study extend these findings by providing preliminary evidence that

individuals with HD may struggle with self-reported emotion regulation to general stress as well.

In this study, individuals with HD reported significantly greater subjective reactivity to the stressor, and higher levels of negative affect during the recovery period. These results suggest that the HD group struggled to regulate their negative emotional states. Our results are consistent with a recent study by Fernandez de la Cruz and colleagues (2013), who examined a self-report measure of emotional regulation in a clinical sample of 24 individuals with HD. Compared to CTLs, individuals with HD obtained higher scores on the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004). Interestingly, higher scores on the DERS did not correlate with symptom severity, assessed via SI-R. Their results suggest that individuals with HD struggle with emotion regulation, regardless of symptom severity. The findings are similar to those obtained in this study, which suggest that regardless of symptom severity all HD participants struggled with regulating their subjective levels of distress after a general psycho-social stressor.

Emotional dysregulation is not limited to hoarding disorder, rather it is cited as a common feature in numerous forms of psychopathology. For example, a central characteristic of depression is difficulty regulating negative emotional states (Beauregard, Paquette, & Levesque, 2006). Dysfunctional emotional regulation strategies also successfully predict the level of depression two years after initial assessments (Kraaij, Pruymboom & Garnefski, 2002). Emotion regulation difficulties also play a role in a number of anxiety disorders. For example, individuals with self-reported GAD report greater difficulty understanding emotions, greater negative reactivity and fear of negative consequences associated with experiences (Mennin, Heimberg, Turk, & Fresco, 2005). Moreover, emotional dysregulation may serve as a vulnerability factor in the development and maintenance of post-traumatic stress disorder (Cisler & Olatunji, 2012). Emotional regulation plays a very important role in a variety of emotional disorders; however, it remains unclear whether difficulties are a risk factor or a consequence of the disorder. Future

studies should aim to elucidate this mechanism in hoarding.

Another risk factor linked to the maintenance of anxiety disorders is distress tolerance (DT). DT represents an individual's ability to tolerate and experience negative emotional states (Simons & Gaher, 2005). Individuals with low DT often perceive negative emotional states as unbearable, unacceptable, and uncontrollable. Therefore, individuals who are low in DT will engage in maladaptive behaviors in order to avoid negative emotional states. There is growing evidence that low levels of DT serve as a risk factor for a range of anxiety disorders (Leyro, Zvolensky, & Berstein, 2012). Recent studies examining the role of DT in HD, provide evidence that individuals with HD experience negative emotions with greater intensity (Timpano, Shaw, Cougle & Fitch, 2014). DT has very important implications for clinical practice, as well as research. As lower tolerance for negative emotional states can directly influence hoarding behavior; due to an inability to tolerate negative emotions, individuals engage in behavioral avoidance (i.e., not discarding) to avoid negative emotional states. Due to this, emotional tolerance plays an important role in the maintenance of hoarding behaviors and thus may directly affect treatment outcomes. Moreover, an individual's ability to tolerate distress directly impacts their reactivity and recovery when faced with a stressor. In the current study the heightened response to the stressor may be influenced by lower DT in the hoarding group.

Similar to an individual's tolerance of negative emotional states, anxiety sensitivity can also serve as a vulnerability factor. High levels of anxiety sensitivity (AS) are associated with beliefs that stress-related physical sensations are dangerous, harmful and associated with negative consequences (Reiss, Peterson, Gursky, &McNally, 1986). This intensified fear of anxiety or stress-related emotions can lead to avoidance of those specific stress-inducing experiences (Reiss, 1991; Taylor, Koch & McNally, 1992). There is substantial evidence that AS plays a role in the development and maintenance of anxiety-related symptoms in many anxiety

disorders (Naragon-Gainey, 2010). With regard to hoarding, there is evidence that excessive acquisition significantly correlates with anxiety sensitivity (Timpano, Buckner, Richey, Murphy, and Schmidt, 2009); however, no studies thus far have examined this relationship in a clinical hoarding sample. Therefore, the underpinnings of emotional tolerance, characterized by AS and DT, play an important role in hoarding. It is important to explore the extent to which emotional tolerance affects hoarding behavior (i.e., difficulty discarding as a result of low emotional tolerance). In the current study, we did not account for emotional tolerance; however, future studies are encouraged to elucidate the role of AS and DT, as they may affect responses to stress.

It is interesting to note that despite significant differences in negative affect between the groups, the HD group did not exhibit significantly greater cortisol stress reactivity. These results are largely consistent with the mixed findings on the lack of coherence between subjective and cortisol responses to stress (e.g., Brooks & Robles, 2009; Yoon & Joormann, 2012). The divergence between self-reported indices of distress and physiological measures underscore the importance of obtaining multiple measures in studies examining responses to stress. It should be noted that differences in biological versus psychological responses to stress could also be due to salivary cortisol being confounded by the high rate of comorbidity. In the HD group, 14 individuals (66.67%) had a comorbid Axis-I diagnosis: 8 (38.10%) individuals with social phobia, 6 (28.57%) with major depressive disorder, 3 (14.29%) with obsessive-compulsive disorder, 3 (14.29%) with generalized anxiety disorder, 1 (4.76%) with post-traumatic stress disorder, 1 (4.76%) with panic disorder with agoraphobia, and 1 (4.76%) with substance abuse. The high rate of comorbidity could potentially confound the levels of salivary cortisol produced in response to the stressor. The literature examining responses to stress in individuals with mood or anxiety disorders is mixed and lacks consistency. Depression has been associated with a blunted physiological response to stress (see Burke et al., 2005, for review), although this has

largely been mixed, with some studies reporting hyperactive cortisol response to stress in depression (Rao, Hammen, Ortiz, Chen, & Poland, 2008). Furthermore, individuals who are currently experiencing a Major Depressive episode experience slower recovery in both salivary cortisol and negative affect after the TSST (Dienes, Hazel, & Hammen, 2013). In contrast, individuals with social phobia (Kramer et al., 2012) and post-traumatic stress disorder (Simeon et al., 2007) do not respond differently to the TSST compared to a healthy control group. Further adding to the inconsistent literature, individuals with panic disorder tend to exhibit a blunted response to the TSST (Petrowski, Wintermann, Schaarschmidt, Bornstein, & Kirschbaum, 2013).

The majority of participants in the HD group met criteria for a comorbid depressive or anxiety disorder, as is frequently the case in other studies of HD (Frost, Steketee & Tolin, 2012). Future studies, should extend our findings in a pure clinical hoarding sample in order to better understand the role that comorbidity might play in influencing cortisol response to stress in HD.

The observed divergence between salivary cortisol and negative affect in response to the stressor, could also be attributed to the variability of cortisol regulation and production. Numerous factors can impact cortisol responses to stress (Kudielka, Hellhammer, & Wust, 2009). Factors such as nicotine, coffee, alcohol and dietary energy supplements all greatly impact cortisol. For example, the consumption of glucose an hour prior to TSST exposure results in higher levels of absolute salivary cortisol and net increases (Gonzalez-Bono, Rohleder, Hellhammer, Salvador, & Kirschbaum, 2002). Therefore, it is important to control for blood glucose levels when examining responses to stress. The use of psychotropic medication can also significantly alter HPA axis responses. In this sample, 10 individuals (47. 62%) were taking psychotropic medication. In the current study, we recruited individuals current using medication and with comorbidity in order to examine responses to stress in a sample that closely reflected the general population with HD. Another important variable that impacts HPA axis responses is

childhood trauma or familial adversity (Kudielka, Hellhammer, & Wust, 2009). This is particularly important for hoarding, as nearly half of individuals meeting diagnostic criteria for HD report at least one traumatic event occurring in their life (Frost, Steketee, & Tolin, 2011). Moreover, in a disorder such as hoarding, little is currently known about how other exposure to chronic stress might affect responses to stress. Individuals may be suffering from chronic stress due to impairment, social repercussions and family strain caused by symptoms. Studies examining responses to stress in individuals with chronic stress cite blunted as well as heightened free cortisol responses (for review see Kudielka, Bellingrath, & Hellhammer, 2004). Therefore, due to the numerous factors that can affect cortisol responses to stress, we recommend the use of multiple biological measures to assess distress. Potential measures of biological stress include, but are not limited to: adrenocorticopic hormone (ACTH), blood pressure, heart rate, and salivary alpha-amylase. Future studies might consider incorporating multiple biological measures to assess responses to stress. For example, ACTH is released earlier than cortisol by the HPA axis, and should therefore predict cortisol responses. However a meta-analysis conducted by Dickerson and Kemeny (2004), show that although some studies found similar ACTH and cortisol responses others have found increases in ACTH but not in cortisol in response to acute psychological stressors.

In this study, we hypothesized that hoarding symptom severity and impairment would strongly correlate with responses to stress in the hoarding group; however, this was not supported. Instead, our findings suggest that the severity of hoarding symptoms and associated impairment, do not affect how individuals will respond to a general psycho-social stressor. Future studies could re-examine this relationship using a hoarding-specific paradigm. Hoarding-specific paradigms have been used effectively in the past (see An et al., 2009) to study responses to stress.

Several limitations should be mentioned. Participants in this study were primarily self-selecting, this suggests that all HD participants had good insight into their symptoms and the impairment that hoarding causes in their lives; therefore, this sample might not be representative of individuals with HD who lack this degree of insight (Frost, Tolin & Maltby, 2010). Furthermore, this study relied solely on participant self-report for measures of symptom severity and impairment. However, given the discrepancy in reporting hoarding symptoms and severity by individuals (Tolin, Fitch, Frost & Steketee, 2010), self-reported measures should be supplemented by information from family members. Another potential confounding variable was the rate of co-morbid Axis I diagnosis in the hoarding group, 14 individuals (66.67%). Although all participants in the study had a current primary diagnosis of HD, 7 individuals (16.28%) in the HD group had received treatment for an Axis-I diagnosis. This could potentially confound their response to the stressor; however, it is important to note that despite their treatment history all participants met DSM-5 criteria for HD. Nonetheless, future studies are encouraged to examine differences in stress response in treatment-naïve individuals. Although a treatment-naïve sample would need to be recruited with the help of community support agencies, such as fire departments, police, city departments and mental health agencies. This sample would be difficult to recruit as they would be less likely to seek treatment, and as a result of low insight, be less likely to self-identify as a hoarder.

Despite the limitations, this study provides preliminary evidence that individuals with HD exhibit different emotional responses to a general psycho-social stressor compared to a healthy control group. These findings emphasize that emotion dysregulation is not limited to hoarding-specific stressors, such as discarding. Rather, individuals with HD struggle with regulating negative emotional states when faced with general stressors as well. The findings of this study can contribute to clinical practice by elucidating the role of emotion regulation in the

maintenance of this debilitating disorder. By including emotional regulation strategies as part of a treatment program, individuals with HD may improve their ability to manage responses to stress (i.e., discarding), which hinders treatment progress. Moreover, due to the difference between psychological and biological reactivity to the stressor, it is important to examine the role of self-reported distress tolerance and negative affect. Individuals with HD may over-report negative mood states and underestimate their ability to cope with stressors. Thus, treatment programs that incorporate these findings could improve treatment outcomes.

Research efforts to understand distress in hoarding have thus far relied on self-report and behavioral indicators of distress (i.e., refusal to discard). Our study provides preliminary evidence that individuals with HD experience significantly greater levels of subjective distress in response to a general stressor. However, additional research is still needed to understand to role that comorbidity, treatment and emotional tolerance may play in responses to stress. Future research might compare responses to a general stressor, as well as a hoarding-specific stressor (i.e., discarding paradigm; see An et al., 2008). It would also be important for future research to incorporate multiple biological indices of stress, including salivary cortisol, ACTH, heart rate, or blood pressure. Furthermore, to overcome the limitations of self-report and limitations associated with low-insight, we recommend in-home assessments and interviews with friends and/or family members.

In conclusion, the current study is the first to examine whether individuals with HD differed from CTLs in their psychological and biological responses to a general psychosocial stressor. Results from the current study suggest that individuals with HD reported significantly greater subjective distress than did CTLs in anticipation of the stressor, during peak stress and during the recovery period. Cortisol levels, however, did not significantly differ between the HD and CTL groups. Moreover, although individuals with HD reported significantly greater affective

reactivity to the stressor, their cortisol reactivity to stress did not differ from CTLs. The findings of this study extend previous studies linking HD with difficulties in self-reported emotion regulation.

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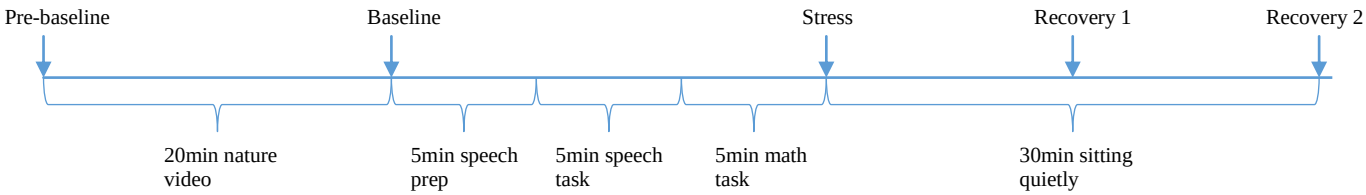

Figure 1. Trier Social Stress Test and Measures of Stress Response

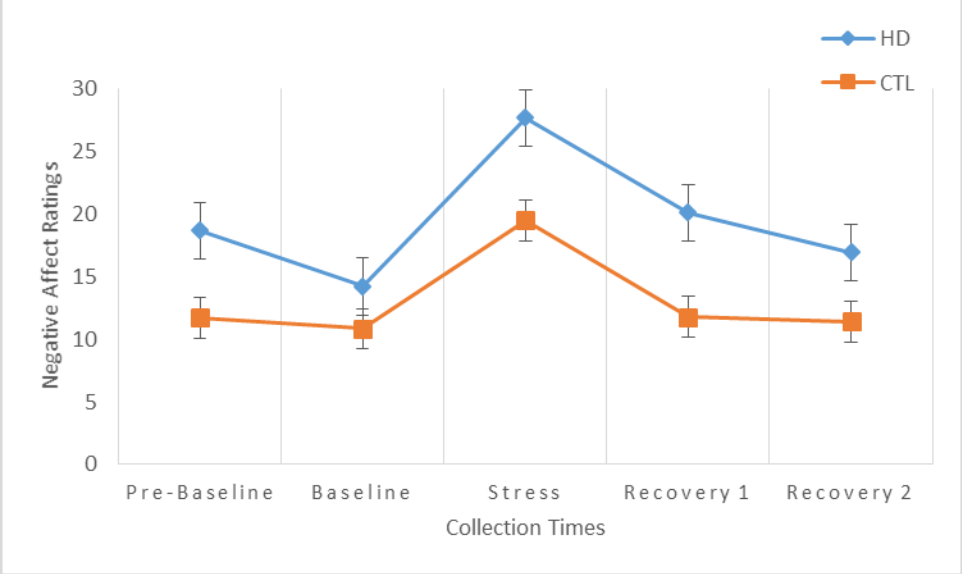

Figure 2. Negative affect ratings over time.

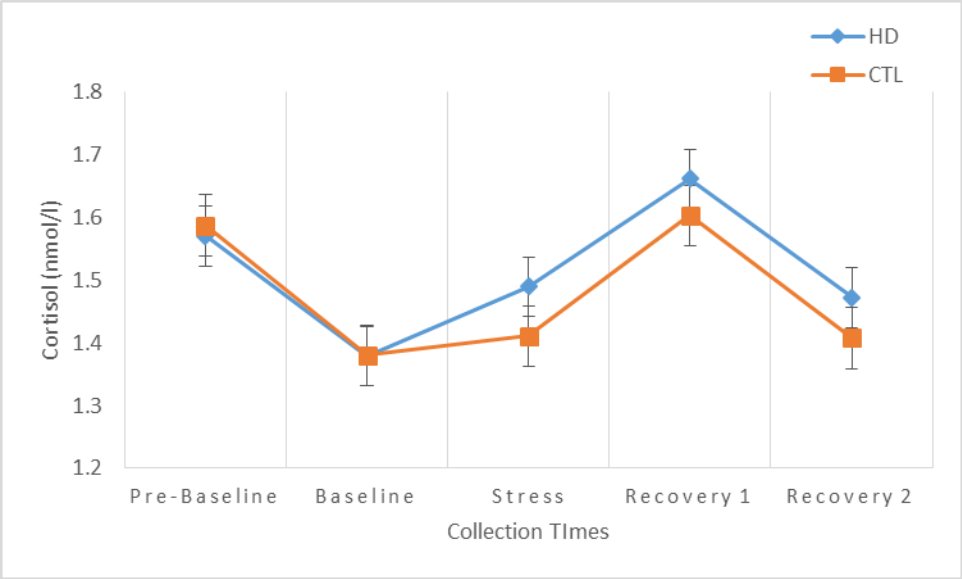

Figure 3. Changes in salivary cortisol over time.

Table 1.

Demographic and symptom information.

Variable	HD	CTL
N	21	22
Age, mean (S.D.)	43 (13.74)	38 (11.22)
Gender, *n* (%)		
Female	12 (57.14)	13 (59.09)
Male	9 (42.86)	9 (40.91)
Race, *n* (%)		
Caucasian	12 (57.14)	19 (86.36)
Asian	4 (19.05)	3 (13.64)
Other	5 (23.81)	0
Psychotropic medication, *n* (%)	10 (47.62)	0
HRS-I	30.29 (3.07)	-
SIHD		
Excessive acquisition, *n* (%)	21 (95.45)	-
Length of illness, total years	25.33 (20.25)	-
Co-morbid Axis I diagnosis, *n* (%)	14 (66.67)	-
Social Phobia	8 (38.10)	-

Obsessive-Compulsive Disorder	3 (14.29)	-
Generalized Anxiety Disorder	3 (14.29)	-
Major Depressive Disorder	6 (28.57)	-
Post-Traumatic Stress Disorder	1 (4.76)	-
Panic Disorder (with Agoraphobia)	1 (4.76)	-
Substance Abuse	1 (4.76)	-

Note. HD = Hoarding Disorder group; CTLs = Control group; HRS-I, hoarding rating scale-interview; SIHD, structured interview for hoarding disorder. Values are given in means (standard deviations) unless otherwise specified.

Table 2.

Means and Standard Deviations for Clinical Measures.

Variable	HD	CTL
SIR, total	61.00 (10.98)	13.68 (9.65)
Clutter	24.24 (5.64)	3.32 (3.88)
Acquisition	17.29 (4.04)	5.41 (4.24)
Difficulty discarding	19.48 (3.87)	4.95 (4.71)
IIRS	53.07 (18.86)	29.59 (18.09)
DASS, total	50.24 (30.24)	16.91 (12.87)
Depression	16.95 (11.99)	5.27 (4.84)
Anxiety	13.10 (9.75)	3.64 (4.08)
Stress	20.19 (11.04)	9.09 (6.19)
ADHL	2.17 (0.67)	1.25 (0.54)
OCI, total	26.57 (12.38)	10.50 (9.00)
Hoarding	8.52 (2.27)	2.09 (2.09)
Checking	2.95 (3.12)	1.82 (2.74)
Ordering	4.90 (3.42)	3.82 (3.38)
Mental neutralizing	2.43 (3.30)	0.77 (1.31)
Washing	2.19 (3.03)	0.82 (1.01)
Obsessing	5.57 (3.30)	1.19 (1.92)

Note. HD, hoarding disorder; CTL, control; SIR, savings inventory-revised; IIRS, illness intrusiveness scale; DASS, depression anxiety Stress Scale; OCI, obsessive-compulsive inventory. Values are given in means (standard deviations) unless otherwise specified.

Table 3.

Change Scores (Δ), Negative Affect

Time points	Mean (SD)
Control Group	
baseline-anticipation	- 0.89 (1.88)
anticipation- stress	8.66 (6.64)
stress- recovery 1	- 7.73 (5.90)
recovery 1- recovery 2	- 0.36 (1.18)
Hoarding Group	
baseline-anticipation	- 4.45 (4.96)
anticipation- stress	13.45 (8.30)
stress- recovery 1	- 7.57 (9.76)
recovery 1- recovery 2	- 3.14 (3.62)

Table 4.

Area Under the Curve (AUC_G)

Variable	Mean, (SD)
Negative Affect	
Control	111.35 (20.01)
Hoarding	164.88 (56.40)
Salivary Cortisol	
Control	120.22 (44.73)
Hoarding	123.12 (28.99)

Table 5.

Pearson-Product Correlation (two-tailed), for AUC_G

Variable	Negative Affect	Salivary Cortisol
SI-R, total	.118	.249
Clutter	-.104	.221
Acquisition	.162	.255
Difficulty discarding	.367	.119
HRS-I	.300	.109
ADL-H	.004	.305

Note. * $p < 0.05$; SIR, savings inventory-revised; HRS-I, Hoarding Rating Scale-Interview; SIHD, Structured Interview for Hoarding Disorder; ADL-H, Activities in Daily Living-Hoarding.