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# The Role of Negative and Positive Emotional Reactions in Hoarding Symptomatology

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UNIVERSITY OF MIAMI

THE ROLE OF NEGATIVE AND POSITIVE EMOTIONAL REACTIONS IN  
HOARDING SYMPTOMATOLOGY

By

Ashley Marie Shaw

A DISSERTATION

Submitted to the Faculty  
of the University of Miami  
in partial fulfillment of the requirements for  
the degree of Doctor of Philosophy

Coral Gables, Florida

August 2017

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THE ROLE OF NEGATIVE AND POSITIVE EMOTIONAL REACTIONS IN  
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Hoarding disorder (HD) is marked by difficulty discarding, acquisition of items, and clutter. Cognitive-behavioral theories emphasize the role of intense negative and positive emotions in maintaining hoarding behaviors. Difficulties with emotional reactivity and regulation may play a critical role in HD's etiology and may also represent important treatment targets. Despite the strong theoretical rationale, past research on emotional reactivity and regulation in relation to hoarding has been marked by methodological limitations, including sampling design, and only two studies have examined positive emotions in HD. We conducted a multi-method examination of emotional regulation and reactivity in persons with HD, collectors, and healthy controls. We predicted that in response to a negative emotion induction, hoarding severity would be associated with (1) greater emotional reactivity to emotion inductions; (2) more suppression, distraction, and rumination and less reappraisal. In response to a positive emotion induction, we predicted more savoring and less dampening of positive emotions. Finally, we further predicted that greater saving and acquiring tendencies would be associated with more emotional reactivity during behavioral hoarding tasks. We found that hoarding symptoms were linked to negative

emotional reactivity and more use of rumination, distraction, and suppression during the negative emotion induction. Heightened positive emotional reactivity was associated with acquiring more items. Depression emerged as an important covariate. Longitudinal investigations are needed to further clarify whether emotional reactivity and regulation increase risk and/or maintain hoarding symptoms.

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## TABLE OF CONTENTS

LIST OF FIGURES.....	viii
LIST OF TABLES.....	ix
Chapter	
1 INTRODUCTION.....	1
Overview of Hoarding.....	1
Cognitive-Behavioral Model of Hoarding .....	2
The Study of Emotional Reactivity and Emotion Regulation.....	4
Connection between Emotional Processes and Hoarding.....	11
Current Study.....	16
Aims and Hypotheses.....	18
Aim 1.....	19
Aim 2.....	19
Aim 3.....	19
Aim 4.....	19
2 METHOD.....	21
Participants.....	21
Procedure.....	23
Recruitment Procedures.....	23
Overview of the Screening Procedures.....	23



Overview of the Laboratory Session.....	24
3 MEASURES.....	25
Interviews.....	25
Structured Clinical Interview for DSM-IV-TR, Research Version.....	25
The Structured Interview for Hoarding Disorder.....	25
Hoarding Rating Scale Interview.....	26
Collector Eligibility Assessment.....	26
Questionnaires.....	26
Saving Inventory Revised.....	26
Depression Anxiety Stress Scale-21.....	27
Medical History Questionnaire.....	27
Emotional Reactivity.....	28
The Affect Balance Scale.....	28
Heart Rate.....	28
Emotion Inductions.....	29
Emotion Regulation.....	30
Behavioral Hoarding Measures.....	31
Behavioral Discarding Task.....	31
Behavioral Acquiring Task.....	33
4 STATISTICAL ANALYSES.....	34
Power Analyses.....	34
Preliminary Analyses.....	34
Major Data Analyses.....	35

Hypothesis 1: Hoarding Symptoms and General Emotional Reactivity..	36
Hypothesis 2: Hoarding Symptoms and Regulation of Negative Emotions.....	36
Hypothesis 3: Hoarding Symptoms and Regulation of Positive Emotions.....	36
Hypothesis 4: Hoarding-Related Emotional Reactivity and Saving and Acquiring Tendencies.....	37
5 RESULTS.....	38
Preliminary Analyses.....	38
Baseline Differences among Groups.....	41
Manipulation Check: Emotion Inductions.....	43
Behavioral Task Validation.....	44
Testing Aim 1: Hoarding Symptoms and General Emotional Reactivity	44
Negative Emotion Induction.....	44
Positive Emotion Induction.....	46
Testing Aim 2: Hoarding Symptoms and Regulation of Negative Emotions.....	46
Testing Aim 3: Hoarding Symptoms and Regulation of Positive Emotions.....	49
Testing Aim 4: Hoarding-Related Emotional Reactivity and Saving and Acquiring Tendencies.....	50
Saving Tendencies.....	50
Acquiring Tendencies.....	51
6 DISCUSSION.....	53
Hoarding Symptoms and General Emotional Reactivity.....	54
Hoarding Symptoms and Regulation of Negative Emotions.....	59

Hoarding Symptoms and Regulation of Positive Emotions.....	61
Hoarding-Related Emotional Reactivity and Saving and Acquiring Tendencies.....	62
Limitations and Future Directions.....	65
Implications.....	68
Conclusion.....	69
FIGURES.....	70
TABLES.....	79
REFERENCES.....	85

## LIST OF FIGURES

FIGURE 1: The Cognitive-Behavioral Model of Hoarding.....	70
FIGURE 2: Scatterplot of SI-R Discarding Subscale.....	71
FIGURE 3: Scatterplot of the SI-R Acquisition Subscale.....	72
FIGURE 4: Study Schemata.....	73
FIGURE 5: Mean Increase in ABS Negative Affect during the Negative Emotion Induction across Groups.....	74
FIGURE 6: Mean Use of Rumination during the Negative Emotion Induction across Groups.....	75
FIGURE 7: Mean Use of Distraction during the Negative Emotion Induction across Groups.....	76
FIGURE 8: Mean Use of Suppression during the Negative Emotion Induction across Groups.....	77
FIGURE 9: Mean Increase in ABS Negative Affect during the BDT across Groups.....	78

## LIST OF TABLES

TABLE 1: Demographics and Baseline Characteristics by Group.....	79
TABLE 2: Means, Standard Deviations, and Range for ABS, Emotion Regulation Use, and Behavioral Hoarding Tasks.....	80
TABLE 3: Means, Standard Deviations, and Range for Heart Rate Variables.....	81
TABLE 4: Inter-correlations between DASS Depression Scores and DVs...	82
TABLE 5: Inter-correlations between SI-R scores and Emotion Regulation Use during the Negative Emotion Induction.....	83
TABLE 6: Inter-correlations between SI-R scores and Emotion Regulation Use during the Positive Emotion Induction.....	84

## Chapter 1 Introduction

### *Overview of Hoarding*

Hoarding Disorder (HD), now identified in DSM-5 (American Psychiatric Association, 2013), is a severe clinical syndrome that affects 3-6% of the population (Timpano et al., 2011). Core features are extreme difficulties with discarding items and severely cluttered living spaces (American Psychiatric Association, 2013). Another common symptom of HD includes excessive acquisition, which most often involves compulsive shopping or collecting free items (Frost, Tolin, Steketee, Fitch, & Selbo-Bruns, 2009; Timpano et al., 2011). Hoarding symptoms have been found to be dimensionally distributed (Timpano et al., 2013), and two of the core symptoms of HD—saving and acquiring tendencies—are typically considered normative behaviors in the general population. However, on the clinical end of the spectrum, these tendencies can be expressed in extreme ways, resulting in substantial distress and impairment.

HD represents a significant public health burden. HD is associated with elevated rates of comorbid psychiatric and health conditions, including affective disorders, obesity, and fibromyalgia, and it results in substantial costs to the community through the involvement of social services and high rates of health care utilization (Frost, Steketee, & Tolin, 2011; Frost, Steketee, & Williams, 2000; Tolin, Frost, Steketee, Gray, & Fitch, 2008). Furthermore, HD can lead to serious health and safety risks (e.g., fire hazards and damage to the home) for the individual, their family and the community (Frost et al., 2000). HD is generally considered difficult to treat (Tolin, Frost, Steketee, & Muroff, 2015). Although new

interventions are currently being developed for HD, treatment response continues to be relatively low and the interventions are quite labor intensive, involving an average of 22 sessions and visits to the home (Tolin et al., 2015). Given that most patients with HD report a chronic, unremitting course, the low rates of response to these treatments are particularly problematic (Tolin, Meunier, Frost, & Steketee, 2010).

In sum, the extant literature on HD demonstrates that it is a severe, impairing disorder, which negatively affects the individual, their family, and the community. Thus, it is imperative to isolate modifiable factors that increase risk of developing and maintaining these symptoms, to determine novel intervention targets.

#### *Cognitive-Behavioral Model of Hoarding*

The cognitive-behavioral (CBT) model of hoarding (Figure 1) posits that several factors, including erroneous beliefs about possessions, information-processing problems, and emotional reinforcement patterns, come together to invoke the primary symptoms of hoarding (Frost & Hartl, 1996; Tolin, 2011). Persons who hoard commonly report certain beliefs about saving possessions, such as feeling emotionally attached to or excessively responsible for belongings (Steketee, Frost, & Kyrios, 2003). Patients with HD also report a strong desire to maintain control over their belongings and poor confidence in their ability to remember important information (Frost & Hartl, 1996; Steketee et al., 2003). These cognitions are theorized to contribute to initial hoarding inclinations, but are also recognized as important maintenance factors.

In addition to saving beliefs, persons with HD appear to have cognitive deficits that make sorting and discarding particularly distressing, and can directly impact the core symptoms of hoarding (e.g., clutter). For example, some studies indicate that HD patients recall less information on memory tasks than healthy controls (HCs; Blom et al., 2011; Hartl et al., 2004) and also use less efficient methods to organize memories (Hartl et al., 2004), although findings have been largely inconsistent with respect to actual memory problems (Tolin, Villavicencio, Umbach, & Kurtz, 2011). Compared to other patient groups, persons with HD report higher rates of ADHD symptoms (Frost et al., 2011) and also exhibit impaired response inhibition (Grisham, Brown, Savage, Steketee, & Barlow, 2007). Another executive functioning problem, categorization deficits, can amplify problems with organizing possessions and clutter (Frost & Hartl, 1996). Decision-making difficulties have been linked with greater hoarding symptoms on self-report questionnaires (Frost & Gross, 1993; Preston, Muroff, & Wengrovitz, 2009) and on some behavioral measures (Lawrence et al., 2006). Although there are some inconsistent findings across this literature (e.g., Grisham et al., 2007; Grisham, Norberg, Williams, Certoma, & Kadib, 2010; Wincze, Steketee, & Frost, 2007), the general understanding is that, in addition to directly contributing to hoarding symptoms (e.g., clutter), these information processing deficits may also interact with saving beliefs to contribute to the distress experienced by patients.

A central tenet of the CBT model of hoarding is that intense negative and positive emotional reactions influence subsequent negative and positive



reinforcement cycles, which can trigger both avoidant (i.e., difficulties with discarding) and approach (i.e., acquiring) hoarding behaviors (Figure 1; Frost & Hartl, 1996; Steketee et al., 2003). For example, a variety of negative emotions (e.g., sadness, anger, guilt, and distress) can occur at the threat of losing a belonging, and thus can negatively reinforce chronic saving tendencies (Frost & Hartl, 1996). In addition, positive emotions (e.g., pleasure, safety, and comfort) may occur when acquiring new possessions, and subsequently reinforce collecting behaviors (Grisham & Barlow, 2005).

While theoretical work has suggested that intense emotional reactions play a critical role in HD's etiology and maintenance (Frost & Hartl, 1996), few empirical studies have investigated these relationships in persons with clinical levels of HD. Doing so is imperative, given that emotional reactivity may represent an important treatment target that could render existing therapies more effective. Below I will first provide a discussion of general issues relevant to studying emotional reactivity and regulation, followed by a review of the extant literature on the relationship between emotional processes and hoarding.

#### *The Study of Emotional Reactivity and Emotion Regulation*

The study of how emotional processes relate to psychological symptoms has become a popular topic of study (Gross, Sheppes, & Urry, 2011). A wide variety of theoretical models have converged to implicate two key constructs, emotional reactivity and emotion regulation, in the development and maintenance of psychological symptoms (Davidson, 2003; Gross, 2002; Johnson-Laird, Mancini, & Gangemi, 2006; Douglas S. Mennin, 2004; D. S. Mennin, Heimberg,

Turk, & Fresco, 2005; Porges, Doussard-Roosevelt, & Maiti, 1994). Considered together, these two facets of processing emotions are thought to influence how any particular emotion is experienced, along with subsequent cognitive and behavioral reactions. Emotional reactivity is defined by how sensitive people are to emotional stimuli, how intensely they feel emotions, and how long their emotions persist before returning to baseline (Nock, Wedig, Holmberg, & Hooley, 2008). Emotion regulation is a broader construct that encompasses the strategies a person employs to modulate their emotions and how they express these emotions (Gross, 1998). In sum, emotional reactivity is defined as the initial emotional intensity elicited by a stimulus whereas emotion regulation includes the processes that modulate these emotional reactions (e.g., Cisler, Olatunji, Feldner, & Forsyth, 2010).

Researchers have only recently begun to focus specifically on how reactivity to and regulation of *positive* emotions are related to psychopathology. For example, recent advances in bipolar disorder have found that it is characterized not only by elevated positive affect, but also by increased use of emotion regulation strategies that intensify positive affect (Feldman, Joormann, & Johnson, 2008; Johnson, McKenzie, & McMurrich, 2008). While the role of negative emotions in substance abuse is well-established, recent research has suggested that heightened levels of positive affect may be associated with adaptive emotion regulation strategies that protect against relapse (Schlauch, Gwynn-Shapiro, Stasiewicz, Molnar, & Lang, 2013). These recent developments

underscore the importance of examining reactivity to and regulation of positive, as well as, negative emotions.

Emotional reactivity can be measured with a variety of methods, including subjective (i.e., self-report) and objective (e.g., heart rate [HR]) indices (Mauss & Robinson, 2009). Self-reports can provide an index of one's subjective experience, whereas physiological indices represent more objective measures that are less prone to demand characteristics (Kreibig, Wilhelm, Roth, & Gross, 2007; Schwartz, Fair, Salt, Mandel, & Klerman, 1976b). When simultaneously assessing reactivity to negative and positive emotions, HR represents an ideal physiological index of emotional reactivity, albeit also more ambiguous about which emotion is being experienced, given that most studies have found that a variety of negative and positive induced emotions lead to increased HR (for a review, see: Kreibig, 2010). In contrast, changes in other physiological indices (e.g., skin conductance level) are less consistently linked to negative and positive induced emotions (Kreibig, 2010).

In addition to assessing one's level of emotional reactivity to induced emotions, it is also interesting to consider which strategies a person uses to manage or regulate negative and positive emotions. Researchers have suggested that perpetual, inflexible use of some emotion regulation strategies may be ineffective (i.e., maladaptive), while others are effective (i.e., adaptive; Gross, 2002; Gross & John, 2003). For example, suppression involves inhibiting various aspects of an emotional response, including both expressive and behavioral components (Gross, 1998). Suppression is generally considered an

ineffective emotion regulation technique, because it is associated with experiencing less positive emotions, more negative emotions over time, and worse interpersonal functioning (Gross & John, 2003). Distraction is another emotion regulation tactic that involves diverting one's attention away from an emotion-eliciting stimulus to some other activity (Van Dillen & Koole, 2007). Theorists have suggested that distraction may be harmful in the long-term, as it prevents the emotional importance of a stimulus from fully being processed (Sheppes & Gross, 2011). Another strategy, rumination, involves repetitively and passively fixating on symptoms, causes, and consequences of distress, without actually engaging in problem-solving (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Rumination is generally considered a maladaptive emotion regulation method because it maintains negative moods without doing anything to prevent their recurrence (Nolen-Hoeksema & Morrow, 1993; Nolen-Hoeksema et al., 2008; Rusting & Nolen-Hoeksema, 1998).

In contrast to the strategies described above, reappraisal is a cognitive strategy that involves reframing emotional stimuli or situations in a way that lessens their emotional impact (Lazarus & Alfert, 1964). Reappraisal is widely considered an adaptive emotion regulation strategy, given that its use has been associated with experiencing more positive emotions, less negative emotions, and better interpersonal functioning (Gross & John, 2003). In sum, although the effectiveness of various emotion regulation strategies depend on context (Bonanno & Burton, 2013; Hofmann, 2014), suppression, distraction, and rumination are generally considered maladaptive strategies to reduce negative

emotions, whereas reappraisal is considered an adaptive method to decrease negative emotions.

Regulation of positive emotions has received far less empirical attention than regulation of negative emotions (Feldman et al., 2008). Strategies used to modulate positive moods can either up-regulate or down-regulate positive affect. For example, dampening involves responding to positive affect with cognitive strategies aimed at decreasing the intensity or duration of the positive mood (Feldman et al., 2008). A heightened tendency to dampen positive emotions has been associated with greater symptoms of depression (Feldman et al., 2008). In contrast, savoring, also known as positive rumination, is the tendency to respond to positive emotions with recurrent positive thoughts about one's qualities and life circumstances, which amplifies and sustains positive moods (Feldman et al., 2008). Both manic symptoms and vulnerability to mania have been linked to savoring (Feldman et al., 2008). In sum, dampening and savoring are two regulation strategies that modulate positive affect, and have been linked to psychological symptoms.

Emotion inductions in the laboratory are capable of reliably eliciting subjective and physiological changes in emotional reactivity (Levenson, Carstensen, Friesen, & Ekman, 1991; Park & Kim, 2011; Schwartz, Fair, Salt, Mandel, & Klerman, 1976a; Schwartz et al., 1976b; Tsai, Chentsova-Dutton, Freire-Bebeau, & Przymus, 2002), and also allow for the examination of which emotion regulation strategies are utilized by participants. Over the past decade, researchers have discussed the strengths and weaknesses of various emotion

induction procedures, including emotional films, autobiographical recall, and success and failure manipulations (Harmon-Jones, Amodio, & Zinner, 2007; J Rottenberg, Ray, & Gross, 2007). Emotional films are commonly used to induce a variety of negative and positive emotions and can be highly standardized across subjects (J Rottenberg et al., 2007). When compared to neutral film clips, emotional film clips elicit medium to large effects on expected emotions, although clips designed to elicit positive emotions, such as amusement, exhibit lower effects than clips designed to elicit negative emotions (Schaefer, Nils, Sanchez, & Philippot, 2010). However, films designed to elicit both negative (Kreibig et al., 2007) and positive emotions (Fernandez et al., 2012; J. Rottenberg, Kasch, Gross, & Gotlib, 2002) do not elicit consistent changes in physiological reactivity. Emotional films have also been criticized for low ecological validity (J Rottenberg et al., 2007).

Autobiographical recall tasks involve asking participants to think of, write, or talk about a memory that elicited a target emotion (e.g., Tsai et al., 2002). These tasks can be more personalized than films, but have high demand characteristics and are difficult to standardize across subjects (Nummenmaa & Niemi, 2004; J Rottenberg et al., 2007). Success and failure manipulations are another common method of eliciting negative and positive moods, although these manipulations require the use of deception and confederates (Harmon-Jones et al., 2007). Thus, most emotion inductions commonly used in the extant literature have key limitations to consider when employing them in experimental research.

Recently, researchers have begun to induce negative and positive emotions through self-referential audio-clips or sentences reflecting criticism and praise (e.g., Blair et al., 2008; Hooley et al., 2010). Compared to emotional films, these procedures are more personal and ecologically valid. Unlike autobiographical recall or success and failure manipulations, these procedures can be more easily standardized and do not require the use of confederates (Hooley et al., 2010). Across the extant literature, self-referential comments of criticism and praise have significantly increased expected changes in self-reported negative and positive emotions across clinical (e.g., dysthymic, Borderline Personality Disorder [BPD]) and HC participants (Blair et al., 2008; Hooley et al., 2010; Hooley, Gruber, Scott, Hiller, & Yurgelun-Todd, 2005; Hooley, Siegle, & Gruber, 2012), although the effects are small.

Research investigating the impact of criticism and praise on participants with various psychological disorders has demonstrated significant group differences in physiological responding to the audio-clips compared to controls (Blair et al., 2008; Hooley et al., 2009; Hooley et al., 2005; Hooley et al., 2012). For example, compared to HCs, patients with generalized social phobia exhibited greater activation in the amygdala in response to criticism (Blair et al., 2008). Similarly, in response to criticism, formerly depressed patients (compared to HCs) demonstrated greater amygdala activation and less dorsolateral prefrontal cortex and anterior cingulate cortex (ACC) activation (Hooley et al., 2009; Hooley et al., 2005). Overall, these findings suggest that using criticism and praise to induce negative and positive emotions can lead to expected changes across

various indices of emotional reactivity. One caveat is that no study to date has investigated the effects of criticism and praise, specifically, on HR. However, we might expect that criticism and praise would have the same effects on HR as other inductions of negative and positive emotions, such as autobiographical recall tasks (Kreibig, 2010).

### *Connection between Emotional Processes and Hoarding*

Despite the theoretical importance of a full range of emotions in HD, research thus far has focused primarily on negative emotions (Frost & Gross, 1993; Frost & Hartl, 1996). In a large sample of persons with serious hoarding symptoms, we found that heightened general, self-reported emotional reactivity and more intense negative emotional reactions (i.e., anger, disgust, fear, sadness, and not-just-right experiences) to imagined discarding were robustly associated with self-reported difficulties with discarding and acquisition, but not clutter (Shaw, Timpano, Steketee, Tolin, & Frost, 2015). A study of Mechanical Turk participants with elevated hoarding symptoms found that greater self-reported overall hoarding symptoms and acquisition, but not difficulties with discarding or clutter, were associated with greater trait negative affect (Raines, Boffa, Allan, Short, & Schmidt, 2015). Additionally, imaging studies in HD and Obsessive-Compulsive Disorder patients with hoarding symptoms have found excessive activation (during a discarding task) in brain regions (e.g., insula, right orbitofrontal cortex, and ACC) generally implicated in processing emotions (An et al., 2009; Mataix-Cols et al., 2004; Tolin, Kiehl, Worhunsky, Book, & Maltby, 2009; Tolin et al., 2012). Overall, the extant literature suggests that specific



hoarding symptoms--difficulties with discarding and acquisition--may be associated with a heightened reactivity to negative emotions.

To date, only two studies on hoarding have used experimental procedures to induce a negative mood state, but both of these investigations were conducted with undergraduates. One study found that higher intensity of and intolerance of negative emotions (i.e., sadness, anger, disgust, fear) induced by emotional film clips were associated with greater self-reported difficulties with discarding and acquisition, but not clutter (Timpano, Shaw, Cogle, & Fitch, 2014). Another study randomized students to complete either a sad or neutral emotion induction using a combined valence-memory recall and music procedure, prior to doing a behavioral discarding paradigm (Norberg, Karthikeyan, & Grisham, 2015). These researchers found that students who underwent the sad emotion induction, and also reported low distress tolerance (i.e., the perceived capacity to tolerate distress; Simons & Gaher, 2005), greater object value, and more distress exhibited the most difficulties with discarding on the discarding task (Norberg et al., 2015). These studies suggest that inducing negative emotions in the laboratory can predict both self-reported hoarding symptoms and behavioral saving tendencies, although research in samples with a wider range of hoarding symptoms is needed.

Research has also begun to elucidate how emotion regulation difficulties relate to hoarding symptoms. Persons who hoard have exhibited greater emotion regulation deficits than HCs on a measure that encompassed various facets of

emotion regulation, including difficulty engaging in goal-directed activities when upset, lack of awareness of emotions, and limited access to regulation strategies (de la Cruz et al., 2013). A study of Mechanical Turk participants with elevated hoarding symptoms found that greater self-reported overall hoarding symptoms and acquisition, but not difficulties with discarding or clutter, were associated with greater emotion regulation difficulties (Raines, Boffa, et al., 2015). In contrast, one study found no group differences on a broad measure of emotional intelligence (Grisham, Steketee, & Frost, 2008). To date, only two studies have examined how hoarding symptoms relate to the use of specific strategies to regulate negative emotions. Using two separate samples (undergraduates and community participants with elevated anxiety sensitivity), researchers found that greater trait rumination was associated with greater self-reported hoarding symptoms (Portero, Durmaz, Raines, Short, & Schmidt, 2015). Another study using a community sample found that self-reported overall hoarding symptoms and acquisition were associated with greater escape/avoidance coping strategies (Yorulmaz & Dermihan, 2015). These studies support the possibility that patients with HD engage in emotion regulation strategies (e.g., rumination and suppression) that are generally ineffective at reducing negative emotions in the long-term.

Several additional lines of evidence also suggest that hoarding symptoms may be associated with emotion regulation strategies that inadvertently maintain negative affect. Theoretical work and empirical research on the role of emotional avoidance in hoarding suggests that hoarding symptoms might be linked with

more use of avoidant emotion regulation strategies, such as suppression and distraction. Cognitive-behavioral theories emphasize how chronic saving and excessive acquisition result from perpetual avoidance of negative emotions associated with discarding and *not* acquiring possessions (Frost & Hartl, 1996; Steketee et al., 2003). Low affect tolerance, low distress tolerance, and high experiential avoidance have been linked to hoarding in empirical studies (Ayers, Castriotta, Dozier, Espejo, & Porter, 2014; Shaw, Llabre, & Timpano, 2015; Timpano, Buckner, Richey, Murphy, & Schmidt, 2009; Timpano et al., 2011; Timpano et al., 2014; Wheaton, Abramowitz, Franklin, Berman, & Fabricant, 2011; Williams, 2012). Overall, the extant literature suggests that hoarding symptoms could be associated with more use of strategies to regulate negative moods that are generally considered maladaptive (e.g., suppression, distraction, and rumination) and less frequent use of strategies generally considered adaptive (e.g., reappraisal).

In contrast to investigations on negative emotions in hoarding, very little research has been conducted to understand the role of positive emotions in hoarding. Saving and acquiring tendencies have been linked to feelings of joy, pleasure, and pride (Frost & Steketee, 2008; Grisham & Barlow, 2005; Grisham, Brown, Liverant, & Campbell-Sills, 2005; Steketee et al., 2003). Positive emotions occur in both the initial acquisition of new items, and during the repeated exposure to items via chronic saving (Frost & Steketee, 2008; Kellett & Holden, 2014). Clinical reports suggest that positive emotions may play a central role in maintaining hoarding symptomatology (Greenberg, 1987). Only two

empirical studies have examined the role of positive emotions in acquiring, although all measures were self-report and samples did not include a wide range of hoarding symptomatology. One study of outpatients at a psychology clinic examined the factor structure of the Saving Inventory-Revised (SI-R; Frost, Steketee, & Grisham, 2004), and found support for two sub-facets of acquiring: positive/urge-related and negative/distress-related acquiring (Raines, Allan, Oglesby, Short, & Schmidt, 2015), which suggests that acquiring tendencies can be motivated by both positive and negative emotions. Conversely, a study of students found that greater positive trait affect predicted *less* impulse buying, whereas greater negative trait affect predicted more impulse buying, controlling for state affect (Thompson & Prendergast, 2015). Despite these mixed findings, it is plausible that acquiring tendencies are associated with heightened reactivity to positive emotions, and further research is needed.

To date, no studies have explored how hoarding symptoms relate to strategies that intensify (i.e., savoring) or lessen (i.e., dampening) positive emotions. Since intense positive emotional reactions are also thought to precipitate hoarding symptoms (e.g., compulsive buying), it is possible that hoarding symptoms are linked with greater use of strategies that up-regulate, rather than down-regulate, positive emotions. Based on findings that manic symptoms are linked to more use of savoring (Feldman et al., 2008), patients with hoarding may exhibit more use of savoring and less use of dampening of positive emotions.

The research conducted to date on HD has yet to clarify whether emotional reactivity and regulation serve as risk or maintenance factors for HD. Clarification could have implications for treatment and prevention. The research is marked by several key limitations. A primary shortcoming is that most studies have used non-clinical student samples or clinical samples that have not accurately or fully captured HD symptoms (Mataix-Cols et al., 2010). Further, none has examined how positive emotional reactions relate to behavioral acquiring tendencies; used ecologically-valid stimuli to induce emotions; measured emotional reactivity with objective indicators; or investigated spontaneous emotion regulation use during emotion inductions. The current study addressed each of these limitations and filled an important gap in the literature.

### *Current Study*

This study involved a multi-method examination of the role of emotional reactivity and emotion regulation in hoarding using a dimensional sampling approach, by recruiting persons with HD, collectors, and HCs. The sampling approach more accurately captured HD symptoms than past research by using the most recent DSM-5 criteria, and also allowed for a dimensional approach to studying hoarding symptoms, which more accurately reflects the latent structure of hoarding (Timpano et al., 2013). The HD group allowed for the identification of persons who experience substantial hoarding symptoms, particularly difficulties with discarding, and who also endorsed associated distress and impairment. The Collectors group was intended to capture the middle of the spectrum and

represents an ideal comparison to the HD group, in that they similarly acquire objects, are attached to them, and demonstrate a reluctance to discard, yet experience fewer associated problems including less problems with organization and less impairment (Mataix-Cols, Billotti, Fernandez de la Cruz, & Nordsletten, 2013; Nordsletten, Fernandez de la Cruz, Billotti, & Mataix-Cols, 2013; Nordsletten & Mataix-Cols, 2012). In a previous study comparing collectors to HD persons, the majority of collectors reported distress associated with discarding and 40.00% of the collectors met criteria for an affective disorder (Mataix-Cols et al., 2013), which demonstrates how collectors represent the middle of the spectrum in terms of both difficulties with discarding and distress. The HC group was meant to display normative attachment to objects and no real difficulties with discarding or distress.

Including a clinical control group was considered. Yet, given that the primary aims were dimensional rather than group comparisons, these groups were designed to best capture the dimensional nature of two classes of hoarding symptoms. Thus, this sampling strategy (1) allowed us to collapse the groups to examine a continuous dimension of saving and acquiring tendencies (i.e., self-report and behavioral) and its relationship to various emotional variables of interest, but (2) also allowed for secondary analyses wherein we directly compared the three groups.

In addition to the novel sampling approach, this was the first study to examine how positive emotional reactivity and regulation relate to hoarding symptoms. Additionally, the procedures induced negative and positive emotions

with ecologically-valid, standardized audio recordings of criticism and praise, which are more personally relevant than emotional film clips utilized in previous studies (Timpano et al., 2014). The study assessed emotional reactivity with both subjective and objective indicators. Using objective measures is particularly important for HD patients, who often have low insight into their symptoms (Tolin, Fitch, Frost, & Steketee, 2010). The investigation also examined how emotion regulation use during emotion inductions related to hoarding symptoms. Furthermore, the study evaluated whether emotional reactivity predicted hoarding behaviors in hoarding-specific situations. The study thus clarifies whether hoarding symptoms are related to emotional reactivity *in general* (i.e., the emotion inductions) and/or to emotional reactivity *solely in hoarding-related contexts* (i.e., when faced with a need to discard or a chance to acquire). Overall, given that emotional reactivity and regulation difficulties are relatively modifiable (Linehan, 1993), this study raises possibilities of discovering new targets of intervention for HD.

### *Aims and Hypotheses*

The current study examined emotional reactivity and regulation continuously across persons with HD, collectors, and HCs. Because hoarding symptoms are dimensional (Timpano et al., 2013), the primary hypotheses examined the associations between hoarding symptoms and emotional variables, although follow-up analyses considered group differences. In contrast to past research, we used a multi-method approach, including subjective and objective

indices of emotional reactivity (i.e., self-report and HR) and hoarding (i.e., self-report and behaviors).

Aim 1 was to evaluate how hoarding symptoms related to emotional reactivity elicited during emotion inductions.

Hypothesis 1: Greater levels of self-reported difficulties with discarding and acquisition (SI-R) will predict greater subjective (Affect Balance Scale; ABS; Bradburn, 1969) and objective (HR) levels of emotional reactivity of the appropriate valence during the emotion inductions.

Aim 2 was to assess how hoarding symptoms related to spontaneous emotion regulation use during the negative emotion induction.

Hypothesis 2: Higher levels of self-reported difficulties with discarding and acquisition (SI-R) will predict more use of suppression, distraction, and rumination and less use of reappraisal during the negative emotion induction.

Aim 3 was to assess how hoarding symptoms related to spontaneous emotion regulation use during the positive emotion induction.

Hypothesis 3: Higher levels of self-reported difficulties with discarding and acquisition (SI-R) will predict more use of savoring (i.e., up-regulating) and less use of dampening (i.e., down-regulating) of positive emotions during the positive emotion induction.

Aim 4 was to evaluate how emotional reactivity during the discarding and acquiring tasks predicted saving and acquiring tendencies.



Hypothesis 4.1: Greater subjective (ABS negative affect) and objective (HR) emotional reactivity during the discarding task will predict higher levels of saving behavioral tendencies.

Hypothesis 4.2: Greater subjective (ABS positive affect) and objective (HR) emotional reactivity during the acquiring task will predict higher levels of acquiring behavioral tendencies.

## Chapter 2 Method

### *Participants*

Participants included 71 individuals over the age of 18 who were fluent in English and willing to provide informed consent. One participant was excluded due to low proficiency in English, and another participant was excluded for inconsistent reporting of hoarding symptomatology, which prevented us from categorizing this participant into any of the three groups.

The final sample consisted of 69 participants, including 25 persons with HD, 21 collectors, and 23 HCs. Table 1 summarizes the demographic characteristics and comorbid diagnoses (based on the Structured Clinical Interview for DSM-IV [SCID-IV]; First, Spitzer, Gibbon, & Williams, 2002) of the full sample and in each participant group. Participants ranged in age from 23 to 90. The full sample was 50.7% female and was primarily non-Hispanic (71.0%) and white (81.2%).

Data from three separate groups were collected to create a dimension of difficulties with discarding. We examined the scatterplot (Figure 2) and descriptive statistics (Table 1) of SI-R discarding to ensure that we achieved a normal distribution of difficulties with discarding using our sampling method. SI-R discarding scores ranged from 0 to 27 and were normally distributed (skew = .08; kurtosis = -1.06). This justifies our analytic plan to collapse across groups for the primary correlation and regression analyses, because it reveals that our primary construct of interest, difficulties with discarding, occurs dimensionally across the

sample. We also examined the scatterplot (Figure 3) and descriptive statistics of SI-R acquisition: these scores ranged from 0 to 27 and were also normally distributed (skew = .34, kurtosis = -.75).

Exclusion criteria across all participants included psychotic or bipolar disorders, current substance abuse/dependence, homicidality, clinically-significant current suicidality, or past head injuries that led to cognitive deficits or long-standing changes in memory or thinking. Group inclusion criteria were based on the reported clinical and non-clinical means of specific items and the total score on the Hoarding Rating Scale-Interview (HRS-I; Nordsletten, Fernandez de la Cruz, et al., 2013; Tolin, Frost, & Steketee, 2010). The HD group inclusion criteria were: a score of 14 or greater on the HRS-I, a score of four or greater on the *difficulty discarding* HRS-I item, and a score of three or greater on either the *distress* or *impairment* HRS-I items. Of note, one participant with HD was included in analyses, despite having a HRS *difficulty discarding* score of three, due to a long-standing diagnosis of HD, obtaining a total score of greater than 14 on the HRS-I, and meeting all other cut-offs on the HRS-I (i.e., clutter, distress and impairment). Psychiatric comorbidity was allowed in HD participants to ensure that it was a generalizable sample (Frost et al., 2011). The Collectors group inclusion criteria were: considering themselves a collector, having at least one collection of objects of a similar theme (e.g., stamps, antique toys), and not meeting full criteria for the HD group (Mataix-Cols et al., 2013; Nordsletten, Fernandez de la Cruz, et al., 2013; Nordsletten & Mataix-Cols, 2012). The HC group inclusion criteria were: a total score of 0-6 on the

HRS-I, a score of 0-1 on the *difficulty discarding* HRS-I item, and not meeting criteria for the Collectors group. The HC group was age and gender-matched to the HD group.

### *Procedure*

*Recruitment Procedures:* Subjects were recruited from the community via flyers, online and print advertisements (e.g., the Metrorail), a radio advertisement, events and talks in the community, and referrals from University of Miami (UM) clinics and/or research laboratories. Participants for the HD and HC groups were targeted through on-going recruitment efforts. Collectors were recruited via targeted advertising at collectible shops, collector groups (e.g., the Train Collectors Association), and an antique toy show. We also used successful and highly effective prior strategies such as our website, professional organizers, other treatment providers, and list-serves (e.g., the UM Alumni listserv).

*Overview of the Screening Procedures:* Interested persons were screened by a research assistant (RA) for relevant inclusion/exclusion criteria. Phone screens were discussed with the Principal Investigator. Interested and eligible phone screens were informed about the study. All ineligible treatment-seeking callers were offered referral information. For eligible participants, graduate students enrolled in UM's clinical psychology program or post-baccalaureate RAs obtained informed consent and confirmed eligibility during a screening evaluation. Specifically, they administered the SCID-IV, the Structured Interview

for Hoarding Disorder (SIHD; Nordsletten, Fernández de la Cruz, et al., 2013), the HRS-I (Tolin, Frost, et al., 2010), and a Collector Eligibility Assessment created for the current study.

*Overview of the Laboratory Session (Figure 4):* After the screening visit, eligible participants completed the laboratory session on a separate day, within one month of the HRS-I assessment. The total laboratory session lasted approximately 2 to 2 ½ hours. Details for each procedural section are outlined in Chapter 3. After providing written informed consent, participants first completed the negative and positive emotion inductions (counterbalanced) and then the behavioral hoarding tasks (counterbalanced). To prevent carryover effects of emotional reactions among the emotion inductions and behavioral hoarding tasks, participants completed a distractor task of counting backward slowly from 30 and then relaxing for several minutes, between each of the emotion inductions and behavioral hoarding tasks, as in previous studies (Labouvie-Vief, Lumley, Jain, & Heinze, 2003). At the end of the experiment, participants were debriefed and were asked to select one item from the Acquiring Task to take home with them. Participants received \$30 for participating in this session.

## Chapter 3 Measures

### *Interviews*

#### *Structured Clinical Interview for DSM-IV-TR, Research Version (SCID-IV).*

The SCID-IV (First et al., 2002) is a semi-structured interview that was used to determine the presence of current and past DSM-IV-TR Axis I diagnoses. For simplicity, we only reported on current Axis I disorders, and past major depressive episodes. The version of the SCID-IV utilized in the current study also included a psychotic screener. Assessors utilized the SCID-IV to evaluate whether participants met criteria for the following DSM-IV-TR psychiatric diagnoses: Major Depressive Disorder, Bipolar Disorder, Alcohol Abuse or Dependence, Substance Abuse or Dependence, Panic Disorder with and without Agoraphobia, Agoraphobia without Panic Disorder, Specific Phobia, Social Phobia, Obsessive-Compulsive Disorder, Post-Traumatic Stress Disorder, Generalized Anxiety Disorder, Body Dysmorphic Disorder, Anorexia Nervosa, Bulimia Nervosa, Binge Eating Disorder, and Eating Disorder Not Otherwise Specified.

#### *The Structured Interview for Hoarding Disorder (SIHD).*

The SIHD (Nordsletten, Fernández de la Cruz, et al., 2013) is a semi-structured interview that we used to diagnose HD according to the DSM-5 diagnostic criteria (American Psychiatric Association, 2013). The scale has demonstrated excellent inter-rater reliability, as well as convergent and discriminant validity (Nordsletten, Fernández de la Cruz, et al., 2013).

*Hoarding Rating Scale Interview (HRS-I).* The HRS-I (Tolin, Frost, et al., 2010) is a brief, semi-structured interview that assesses the core features of hoarding, including: clutter, difficulties with discarding, acquisition, distress, and impairment. Clinicians rate items on a nine-point scale, from 0 (none) to 8 (extreme). The HRS-I has demonstrated excellent internal consistency, good test-retest reliability, and strong divergent validity (Tolin, Frost, et al., 2010). The HRS-I exhibited excellent internal consistency in the current study ( $\alpha = .96$ ).

*Collector Eligibility Assessment.* The Collector Eligibility Assessment is a semi-structured interview developed for the current study to confirm collector status. First, participants were asked, “Would you consider yourself a collector?” Participants who endorsed this question were next asked follow-up questions about their collecting, including (1) what items (and how many) they collect, (2) whether they keep the items for their enjoyment or plan to sell them in the future, (3) whether they show their collection to others and what other people think of their collection, (4) whether they are actively collecting (i.e., in the past year), and (5) whether the collection was a part of their identity or lifestyle.

### *Questionnaires*

*Saving Inventory Revised (SI-R).* The SI-R (Frost et al., 2004) is a 23-item questionnaire with three subscales: *difficulty discarding*, *acquisition*, and *clutter*. Items are rated on a scale from 0 to 4, with higher scores reflecting more severe hoarding symptoms. The measure has demonstrated good internal consistency, test-retest reliability, divergent and convergent validity (Frost et al., 2004). The internal consistency of the SI-R in the current study was excellent ( $\alpha = .98$ ).

*Depression Anxiety Stress Scale-21 (DASS-21).* The DASS-21 (Henry & Crawford, 2005) is a brief version of the 42-item DASS questionnaire. Participants indicate how much each item has applied to them over the past week on a scale from 0 (did not apply to me at all) to 3 (applied to me very much). Although the DASS-21 includes three subscales, depression, anxiety, and stress, the current investigation only used the depression subscale. The DASS-21 has demonstrated excellent internal consistency and concurrent validity in clinical (Antony, Bieling, Cox, Enns, & Swinson, 1998) and nonclinical samples (Henry & Crawford, 2005). The depression subscale exhibited excellent internal consistency in the current study ( $\alpha = .92$ ).

*Medical History Questionnaire.* A medical history questionnaire was developed for the current study to assess for various factors that might affect HR. For instance, participants were asked to report any serious and/or chronic medical problems they have experienced in the past two years. They were also asked to list any medications (both for psychiatric and physical health) that they took the day of the experiment, as well as all medications they had taken in the past month. Participants were also asked whether they had a pacemaker and whether they had a low resting heart rate. They were also asked about their caffeine use habits and whether they consumed caffeine on the day of the experiment.



### *Emotional Reactivity*

*The Affect Balance Scale (ABS)*. The ABS (Bradburn, 1969) is a questionnaire that assesses state levels of negative and positive affect. Participants rate how much they feel different emotions “now/in the past few minutes” on a Likert scale from 1 (not at all) to 10 (extremely). The ABS has demonstrated adequate internal consistency (Bradburn, 1969) and good convergent and discriminant validity (Moriwaki, 1974). The ABS was modified for the current study to include emotions (e.g., “not just right” and “uncertain”) that have been specifically implicated in hoarding. The ABS served as a subjective index of emotional reactivity and was completed at eight time-points throughout the study: directly before and after each of the two emotion inductions and the two behavioral hoarding tasks (Figure 4). The ABS negative affect scale (10-items) was administered before and after the negative emotion induction and behavioral discarding task, whereas the ABS positive affect scale (10-items) was administered before and after the positive emotion induction and behavioral acquiring task. The internal consistency of the baseline ABS negative affect subscale was good ( $\alpha = .88$ ), while the internal consistency of the baseline ABS positive affect subscale was excellent ( $\alpha = .96$ ).

*Heart rate (HR)*. HR is a commonly used autonomic indicator of emotional responding, which reflects levels of emotional arousal (Mauss & Robinson, 2009). HR was recorded using a BioNex 8 Slot Chassis (Model 50-3711-08) and BioLab Acquisition Software (Version 3.0.5; MindWare Technologies Ltd., Gahanna, OH). HR data were collected using three Adult Multipurpose Silver

Electrocardiography electrodes (Model 93-0100-00; MindWare Technologies) attached to participants' right and left collar bones and lower left rib. This particular electrode placement, commonly referred to as the modified Lead II placement, is ideal in psychophysiological laboratories. Sensors are placed on body parts that are relatively free of fatty tissue and muscle, which reduces movement and other artifacts that commonly occur while collecting data (Stern, Ray, & Quigley, 2001).

Prior to initiating study procedures, HR data were collected for a five-minute period while participants were at rest to acclimate them to the placement of the electrodes. To measure baseline HR, HR was collected for a one-minute rest period prior to each study task, as done in previous studies (Labouvie-Vief et al., 2003). To assess emotional reactivity, HR was measured continuously throughout the emotion inductions and behavioral hoarding indices. HR values were averaged for each task within the baseline and reactivity periods (as in previous studies; Marci, Glick, Loh, & Dougherty, 2007).

### *Emotion Inductions*

Participants completed two emotion inductions (i.e., negative and positive), counterbalanced to prevent order effects, as done in previous studies using criticism and praise to induce emotions (Hooley et al., 2005). Specifically, participants listened to standardized auditory stimuli consisting of four critical and four praising comments that were developed by Hooley and colleagues (2010). To control for possible gender effects, all participants (regardless of gender) listened to four comments (two critical; two praising) by an older adult male and

four comments (two critical; two praising) by an older adult female. All comments lasted approximately 20 to 25 seconds and were followed by a five to ten-second silent rest period. All comments were phrased in the third person, and participants were instructed to listen to each comment as if it was being said about them specifically.

After both emotion inductions were completed (including the self-reports associated with those procedures), participants rated the valence, emotional arousal, and personal relevance of each comment; this constituted a manipulation check (Hooley et al., 2010). Specifically, participants reviewed the comments and rated (1) the valence of each comment on a scale from 1 (very positive) to 9 (very negative), (2) the emotional arousal level the comments generated for them on a scale from 1 (not at all arousing or emotionally stimulating) to 9 (very arousing and emotionally stimulating), and (3) how personally relevant they felt each comment was on a scale from 1 (did not at all feel this was about me) to 9 (totally felt this was about me).

### *Emotion Regulation*

Following the negative emotion induction, and immediately after completing the ABS, participants were asked to complete 12 items based on the Response Styles Questionnaire (Nolen-Hoeksema & Morrow, 1993) and Emotion Regulation Questionnaire (Gross & John, 2003). Items ask about how much they engaged in four types of regulation of negative emotions (suppression, distraction, rumination, and reappraisal) *while listening to the critical comments*. Although the suppression subscale was originally composed of three items,

analysis of the psychometric properties of the scale indicated that the three-item scale violated the assumptions of the reliability model, due to having a negative covariance among items. Thus, one reverse-scored item (“I had a hard time controlling my thoughts and feelings”) was removed from the subscale score, and the two-item scale demonstrated improved internal consistency ( $\alpha = .74$ ), and thus, was used in all analyses. The internal consistency values for the other subscales ranged from adequate to good (distraction,  $\alpha = .70$ ; rumination,  $\alpha = .86$ ; reappraisal,  $\alpha = .86$ ).

Following the positive emotion induction, and immediately after completing the ABS, participants were asked to complete six items based on the Responses to Positive Affect Questionnaire (Feldman et al., 2008), that measured how much they engaged in two types of regulation of positive emotions (savoring and dampening) *while listening to the compliments*. The internal consistency values for the subscales ranged from good to excellent (dampening,  $\alpha = .80$ ; savoring = .91).

### *Behavioral Hoarding Measures*

*Behavioral Discarding Task (BDT)*. The BDT is based on a previously-developed paradigm (Timpano & Schmidt, 2013; Tolin et al., 2009). Prior to the laboratory session, participants were asked to bring in 14 paper items that were representative of objects they save and would have difficulty discarding, yet which have no real monetary value and represent items that most people would discard without extreme distress (e.g., notes, copies of digital photos, cards). These procedures have been piloted in our lab and are effective in ensuring that

appropriate items are brought to the experimental session by both HD and HC participants (Timpano & Schmidt, 2013). At the beginning of the laboratory session, participants were asked to provide a description of each paper item, and to rate how attached they felt to the item and how much they valued the item on a scale from 0 (not at all) to 10 (extremely). These item ratings have been adapted for the current investigation by measures used in previous studies (Shaw & Timpano, 2016; Timpano & Schmidt, 2013; Tolin et al., 2009).

Later in the experimental session, during the actual behavioral task, participants were told that we were evaluating decision processes involved in saving and discarding items and that the goal of the task was to discard as many items as possible. For each item, the experimenter asked if the participant would like to (1) save the object, (2) wait to decide, or (3) discard it. If the participant chose to “save” the object, they would return home with it. For the “wait to decide” option, the participant was told that the decision would be revisited at the end of the task. If, however, the participant chose to “discard” the item, it was shredded by the experimenter. The participant had six seconds to decide for each item, after which time the item was placed in the “wait to decide” bin. The task lasted approximately five minutes, though the duration varied by participant. The primary outcome variable was the percentage of items saved during the task, with a greater percentage indicating greater saving tendencies or difficulties with discarding.

*Behavioral Acquiring Task (BAT)*. The BAT was developed for the current study as a more potent, ecologically valid version of other acquiring paradigms (Preston et al., 2009; Shaw & Timpano, 2016). For this task, participants were shown a basket of nine objects of minimal monetary value (e.g., key chain, lip balm). Participants were told that they could acquire as many objects as they want. At the end of the experiment, participants were debriefed, during which time they were informed that they could take home one of the items they selected during the BAT. The task lasted less than two minutes. The outcome variable was the number of objects acquired.

## Chapter 4 Statistical Analyses

### *Power Analyses*

Given that the emotion inductions and physiological index of emotional reactivity outlined in this study have not yet been investigated with respect to hoarding, I examined the study that most closely matched the sample and aims of the proposed project. In 628 self-identified persons with serious hoarding, we found a medium effect size ( $r = .31-.40$ ) for the relationship between subjective intensity of sad feelings to an imagined discarding task and hoarding symptoms (Shaw, Timpano, et al., 2015). Thus, I determined that a minimum significant effect size for the primary correlation analyses would be medium. Using a statistical power analysis program (Faul & Erdfelder, 1992), I determined that 55 participants would allow for examining the primary correlation analyses at a power greater than 80% to test a medium effect size ( $f^2 = .15$ ) with a Type 1 error ( $\alpha < .05$ ). To adequately cover the entire dimension of hoarding symptoms, I planned to recruit 20 participants per group. With the actual sample size of 69 participants (25 HD participants, 21 collectors, and 23 HCs), the main study hypothesis (Aim 1) was powered at 99.42% with a Type 1 error ( $\alpha < .05$ ).

### *Preliminary Analyses*

All data were screened prior to primary data analyses. The majority of questionnaires were completed by participants using the electronic data capture tool, Qualtrics, which prevented against missing data and data-entry errors. Descriptive statistics were also examined for potential data-entry errors for the non-Qualtrics measures. Following data screening, the data were examined for

potential outliers, influential observations, and possible violations of the assumptions of the linear model. Scatterplots were used to ensure that the assumptions of the linear model were met. If the plots demonstrated skewness or kurtosis, data transformations were considered. Internal consistency was examined by calculating Cronbach's alpha for all self-report measures.

Analysis of Variance (ANOVA) was conducted to test for any differences among groups on relevant continuous variables. Chi square tests were used to examine potential differences among groups on dichotomous variables. If baseline variables differed significantly among groups and were also correlated with the outcome variables (i.e., hoarding behaviors), they were controlled for in secondary follow-up analyses, by being added as predictors in the first step of the regression analyses or by being added as a covariate in an Analysis of Covariance (ANCOVA).

#### *Major Data Analyses*

Because hoarding symptoms are dimensional in nature (Timpano et al., 2013), the primary data analyses utilized Pearson correlations and/or regression, though I also conducted secondary group-wise analyses. For Aims 1 and 4, emotional reactivity change scores were computed separately for each valenced emotion (negative and positive)—emotion levels at baseline were subtracted from emotion levels during each task (as with previous studies; Levenson et al., 1991; Marci et al., 2007; Schwartz et al., 1976a, 1976b; Waldstein et al., 2000).



### *Hypothesis 1: Hoarding Symptoms and General Emotional Reactivity*

Higher hoarding symptoms were expected to predict greater emotional reactivity during the emotion inductions (regardless of valence). For the primary Pearson correlation analyses, we examined associations between emotional reactivity (ABS and HR) change scores and SI-R discarding and acquisition scores. For secondary between-groups analyses, ANOVA was utilized with group status as the between-subjects factor and emotional reactivity (ABS and HR) change scores as the DVs.

### *Hypothesis 2: Hoarding Symptoms and Regulation of Negative Emotions*

Higher hoarding symptoms were hypothesized to be associated with more use of suppression, distraction, and rumination and less use of reappraisal during the negative emotion induction. For the primary Pearson correlation analyses, we examined the associations between types of emotion regulation use (i.e., suppression, distraction, rumination, and reappraisal) and SI-R discarding or acquisition. For secondary between-groups analyses, ANOVA was utilized with group status as the between-subjects factor and types of emotion regulation use as the DVs.

### *Hypothesis 3: Hoarding Symptoms and Regulation of Positive Emotions*

Higher hoarding symptoms were expected to predict more use of savoring and less use of dampening of positive emotions during the positive emotion induction. For the primary Pearson correlation analyses, we examined the associations between types of emotion regulation use (i.e., savoring and

dampening) and SI-R difficulty discarding or acquisition. For secondary between-groups analyses, ANOVA was utilized with group status as the between-subjects factor and types of emotion regulation use as the DVs.

*Hypothesis 4: Hoarding-Related Emotional Reactivity and Saving and Acquiring Tendencies*

Greater emotional reactivity during the discarding and acquiring tasks was hypothesized to predict greater saving and acquiring behavioral tendencies. For the primary Pearson correlation analyses, we examined the associations between saving and acquiring behavioral tendencies and emotional reactivity change scores (i.e., ABS and HR). For secondary ANOVA analyses, group status served as the between-subjects factor and emotional reactivity (i.e., ABS and HR) change scores served as the DVs.

## Chapter 5 Results

### *Preliminary Analyses*

Data screening indicated that missing data were minimal. For HR, the  $N$  for each time-point ranged from 67 to 69, due to either experimenter error or equipment malfunction. For three missing pre-task baseline HR measurements, baseline data were imputed from the most recent previous baseline measurement. The HR recording for one participant's reactivity period during the negative emotion induction was cut short due to experimenter error; her mean HR was computed over a 77-second, rather than a 120-second, period.

For questionnaires and interviews filled out on paper, missing data were also minimal, and the  $N$  for each total score ranged from 67 to 69. Data imputation methods were not utilized in any of these cases because either the scales included ten or less items or the participant was missing too large a percentage of scale items to impute the total score for larger scales.

Outliers were discovered on several variables, and thus the accuracy of these data-points was examined. No data entry errors were found, and regression analyses indicated that the majority of these outliers were not particularly influential based on the investigation of Studentized residuals ( $< 3$ ) and Cook's distance ( $< 1$ ).

However, one participant was an extreme outlier on the HR change score for the negative emotion induction and was also found to be influential in the outcome of the analyses. Further investigation indicated that her HR increased over 40 beats per minute between baseline and the negative emotion induction

reactivity period. Her data were so influential on the HR change variable, that her score alone made the HR change variable for the negative emotion induction skewed (5.05) and kurtotic (34.83), and the score had elevated Studentized residuals ( $> 6$ ) and Cook's distance ( $> 1$ ). Furthermore, a review of the participant's psychiatric history suggested that past trauma may explain her elevated arousal to the negative emotion induction. Thus, we elected to exclude this participant from all analyses examining reactivity to the negative emotion induction. When excluded from the analyses, the HR change score for the negative emotion induction no longer exhibited skew or kurtosis. The participant was included in all other analyses relevant to the other study aims (e.g., positive emotion induction, emotion regulation, behavioral hoarding tasks), given that she was only an outlier on the HR change score for the negative emotion induction.

As part of the Medical History Questionnaire, we asked participants whether they had ever been told they had a low resting heart rate. Six participants (8.70% of the sample) endorsed having a low resting heart rate. Their mean resting HR ranged from 47.39 to 70.79 beats per minute, with one of the participants actually having a normal resting HR (i.e., above 60). None of these six participants were outliers on the HR variables, as there were other participants in the sample with low resting HR who did not endorse it on our questionnaire. We conducted all analyses involving HR change scores with and without these six participants, and found that excluding these six participants did

not change the outcome of the analyses. Thus, to retain power, because they were not outliers, and because their data was not particularly influential, we elected to retain these participants in all analyses.

Scatterplots were examined, and the majority of variables did not demonstrate skewness or kurtosis. However, one variable (the ABS positive affect change score for the BAT) bordered on violating the assumption of normality, although the skew and kurtosis statistics were in between the acceptable and unacceptable range (skew = 2.34; kurtosis = 8.43). We did not transform this variable in our primary correlation analysis since subjective emotional reactivity to the BAT (i.e., the ABS positive affect change score) was considered the predictor variable, and normality assumptions only pertain to the DV. However, for the secondary ANOVA analyses comparing groups on subjective emotional reactivity to the BAT, we examined the difference among groups on ABS positive affect following the BAT controlling for baseline ABS positive affect, rather than using the change score, due to the elevated skew and kurtosis values of the change score variable.

Means, standard deviations, and ranges for the ABS, emotion regulation subscales, and behavioral hoarding task variables are included in Table 2. Of note, we obtained a full range of scores on the BDT and BAT. On average, participants saved 50.95% of their items during the BDT and acquired approximately four items (out of a possible nine) during the BAT. Means, standard deviations, and ranges for each HR time-point and change score are included in Table 3.

### *Baseline Differences among Groups*

Differences among groups on baseline characteristics, such as hoarding symptoms, demographic variables, and comorbid diagnoses, are depicted in Table 1. As expected, groups significantly differed on SI-R and HRS-I scores. Groups did not significantly differ on baseline item ratings.

The HC group was successfully age and gender matched to the HD group ( $p > .10$ ). Although collectors did not significantly differ in age from the other two groups, collectors were significantly more likely to be male than the HD group. Groups did not differ significantly on any other general demographic variables. For example, medication use (encompassing use of both psychiatric and physical health medications on the day of the experiment) and presence of chronic medical conditions (e.g., high blood pressure, diabetes, arthritis) were similarly high across all participants. Follow-up analyses using ANOVA indicated that the outcome variables did not significantly differ based on gender (data available upon request; all  $p$ 's  $> .05$ ), and thus gender was not controlled for in subsequent analyses.

Participants in the HD group met criteria for a range of comorbid mood and anxiety disorders, and 40.00% of the HD group met criteria for a past major depressive episode. The most prevalent current comorbid diagnosis for HD participants was Social Anxiety Disorder. Collectors met criteria for a range of anxiety disorders, and Obsessive-Compulsive Disorder and Generalized Anxiety Disorder were their most prevalent current diagnoses. A portion of collectors also met criteria for a past major depressive episode. Groups significantly differed in

both DASS depression scores and past major depressive episodes. Specifically, participants with HD had significantly higher DASS depression scores and rates of past major depressive episodes than both collectors and HCs, and collectors reported significantly higher DASS depression scores and past major depressive episodes than HCs (Table 1). Although the average DASS depression scores of collectors and HCs fell within the normal range, the mean DASS depression scores of participants with HD fell within the moderate depression range (Lovibond & Lovibond, 1995).

We next examined the associations between DASS depression and our DVs. Greater DASS depression scores were significantly associated with subjective emotional reactivity to both the negative emotion induction and the BDT (as indicated by ABS negative affect change scores), and use of rumination, suppression, distraction, reappraisal, and dampening during the emotion inductions (Table 4). For analyses including these DVs, we will first present zero-order correlations without accounting for DASS depression, directly followed by regression analyses controlling for DASS depression. Thus, DASS depression was entered as a covariate in secondary regression analyses in the first step of the regression equation, when either subjective emotional reactivity to the negative emotion induction, subjective negative emotional reactivity to the BDT, rumination, suppression, distraction, reappraisal, or dampening were utilized as DVs. For the group-wise analyses involving these DVs, we will first report ANOVA without accounting for DASS depression, and will then report ANCOVA controlling for DASS depression.

### *Manipulation Check: Emotion Inductions*

To ensure that the emotion inductions elicited the expected emotional reactions, we evaluated the effect of each emotion induction on ABS ratings. A paired samples t-test was utilized to compare baseline ABS ratings to ratings following each emotion induction. As expected, for the negative emotion induction, there was a significant increase in ABS negative affect from baseline to post-task,  $t(67) = -4.46, p < .001$ . As anticipated, for the positive emotion induction, there was a significant increase in ABS positive affect from baseline to post-task,  $t(68) = -4.19, p < .001$ . The mean scores at each time-point are reported in Table 2.

We also examined the mean valence (from 1 = very positive to 9 = very negative), emotional arousal (from 1 = not at all aroused or emotionally stimulated to 9 = extremely aroused or emotionally stimulated), and personal relevance (from 1 = did not at all feel this was about me to 9 = totally felt this was about me) of each emotion induction. On average, for the critical comments, participants rated the valence as between somewhat and very negative ( $M = 7.85, SD = 1.31$ ) and moderately emotionally stimulating ( $M = 4.32, SD = 2.13$ ). For personal relevance, they rated the critical comments as a 3.49 ( $SD = 2.16$ ), indicating that they only “mildly felt” that the comments were about them. Participants rated the praise comments as very positive ( $M = 1.74, SD = .97$ ) and moderately emotionally stimulating ( $M = 4.97, SD = 1.86$ ). On average, they rated that they “somewhat felt” the praise comments were about them ( $M = 6.43, SD = 1.70$ ).



### *Behavioral Task Validation*

We next examined whether performance on the BDT and BAT was associated with self-reported hoarding symptoms and whether there were expected differences among groups on these behavioral measures.

Unexpectedly, performance on the BDT was *not* associated with SI-R discarding ( $r = .08, p = .50$ ). However, acquiring more items on the BAT was significantly associated with greater SI-R acquisition scores ( $r = .34, p < .01$ ), which provides evidence for convergent validity of the BAT. Contrary to expectations, groups did not differ significantly on percentage of items saved on the BDT,  $F(2, 65) = 1.33, p = .27$ , or on number of items acquired on the BAT,  $F(2, 66) = 2.44, p = .10$ .

### *Testing Aim 1: Hoarding Symptoms and General Emotional Reactivity*

*Negative Emotion Induction.* We examined the associations between SI-R discarding and acquisition scores and subjective emotional reactivity to the negative emotion induction (i.e., the ABS negative affect change score). Both greater levels of SI-R discarding,  $r = .31, p < .05$ , and acquisition,  $r = .32, p < .01$ , predicted greater subjective emotional reactivity to the negative emotion induction. We then conducted two multiple regression analyses to examine whether SI-R discarding and acquisition scores predicted subjective negative emotional reactivity, controlling for DASS depression. Controlling for depressive symptoms, neither SI-R discarding,  $B = .31, SE = .28, \beta = .20, t(65) = 1.13, p = .26$ , nor SI-R acquisition,  $B = .37, SE = .29, \beta = .22, t(65) = 1.27, p = .21$ , significantly predicted subjective emotional reactivity to the negative emotion induction. Controlling for SI-R discarding, depressive symptoms did not predict

subjective emotional reactivity to the negative emotion induction,  $B = .18$ ,  $SE = .22$ ,  $\beta = .14$ ,  $t(65) = .81$ ,  $p = .42$ . Similarly, controlling for SI-R acquisition, depressive symptoms did not predict subjective emotional reactivity to the negative emotion induction,  $B = .17$ ,  $SE = .21$ ,  $\beta = .13$ ,  $t(65) = .771$ ,  $p = .44$ .

Next, ANOVA was utilized to examine whether groups differed on subjective emotional reactivity to the negative emotion induction. There was a significant difference between groups,  $F(2, 67) = 3.84$ ,  $p < .05$ . Post-hoc analyses revealed that participants with HD ( $M = 10.67$ ,  $SD = 13.96$ ) experienced significantly greater subjective emotional reactivity to the negative emotion induction compared to HCs ( $M = 1.61$ ,  $SD = 5.51$ ), although collectors ( $M = 6.48$ ,  $SD = 12.26$ ) did not differ significantly from either group (Figure 5). We next utilized ANCOVA, controlling for DASS depression, and no longer found a significant difference among groups on subjective emotional reactivity to the negative emotion induction,  $F(2, 64) = 1.33$ ,  $p = .27$ , partial  $\eta^2 = .04$ . Depressive symptoms were not a significant predictor of subjective negative emotional reactivity in this group-wise analysis,  $F(2, 64) = 1.18$ ,  $p = .28$ , partial  $\eta^2 = .02$ .

We next examined whether SI-R discarding and acquisition predicted physiological reactivity to the negative emotion induction (i.e., the HR change score). Neither SI-R discarding,  $r = -.12$ ,  $p = .32$ , nor SI-R acquisition,  $r = -.22$ ,  $p = .08$ , predicted physiological reactivity to the negative emotion induction. Furthermore, groups did not differ in physiological reactivity to the negative emotion induction,  $F(2, 64) = 1.38$ ,  $p = .26$ .

*Positive Emotion Induction.* Next, we examined whether SI-R discarding and acquisition predicted subjective emotional reactivity to the positive emotion induction (i.e., the ABS positive affect change score). Neither SI-R discarding,  $r = -.02$ ,  $p = .85$ , nor SI-R acquisition,  $r = .06$ ,  $p = .64$ , predicted subjective emotional reactivity to the positive emotion induction. Similarly, ANOVA indicated that groups did not differ on subjective emotional reactivity to the positive emotion induction,  $F(2, 68) = 1.23$ ,  $p = .30$ .

We next evaluated whether SI-R discarding and acquisition predicted physiological reactivity to the positive emotion induction (i.e., the HR change score). Neither SI-R discarding,  $r = -.01$ ,  $p = .91$ , nor SI-R acquisition,  $r = -.07$ ,  $p = .56$ , predicted physiological reactivity to the positive emotion induction. ANOVA indicated that groups did not differ on physiological reactivity to the positive emotion induction,  $F(2, 64) = .11$ ,  $p = .90$ .

#### *Testing Aim 2: Hoarding Symptoms and Regulation of Negative Emotions*

For Aim 2's primary analyses, we first present zero-order correlations between self-reported hoarding symptoms (i.e., SI-R discarding and acquisition) and use of emotion regulation strategies (i.e., rumination, suppression, distraction, and reappraisal) in Table 5. As predicted, greater levels of SI-R discarding and acquisition predicted using more rumination, suppression, and distraction during the negative emotion induction. Unexpectedly, greater levels of SI-R discarding and acquisition were also associated with engaging in *more* reappraisal during the negative emotion induction.

We next conducted a series of separate regression analyses, with DASS depression entered as the covariate in Step 1, either SI-R discarding or acquisition entered in Step 2, and each emotion regulation strategy as the DV. Controlling for DASS depression, SI-R discarding,  $B = .26$ ,  $SE = .09$ ,  $\beta = .36$ ,  $t(66) = 2.89$ ,  $p < .01$ , and SI-R acquisition,  $B = .23$ ,  $SE = .10$ ,  $\beta = .29$ ,  $t(66) = 2.33$ ,  $p < .05$ , remained significant predictors of rumination. Controlling for SI-R discarding, depressive symptoms also significantly predicted rumination,  $B = .25$ ,  $SE = .07$ ,  $\beta = .42$ ,  $t(66) = 3.39$ ,  $p = .001$ . Similarly, controlling for SI-R acquisition, depressive symptoms predicted rumination,  $B = .28$ ,  $SE = .07$ ,  $\beta = .47$ ,  $t(66) = 3.75$ ,  $p < .001$ .

Accounting for DASS depression, SI-R discarding,  $B = .25$ ,  $SE = .06$ ,  $\beta = .54$ ,  $t(65) = 4.04$ ,  $p < .001$ , and SI-R acquisition,  $B = .20$ ,  $SE = .07$ ,  $\beta = .40$ ,  $t(65) = 2.89$ ,  $p < .01$ , remained significant predictors of suppression. DASS depression did not predict suppression when controlling for SI-R discarding,  $B = .07$ ,  $SE = .05$ ,  $\beta = .17$ ,  $t(65) = 1.29$ ,  $p = .20$ , or SI-R acquisition,  $B = .11$ ,  $SE = .05$ ,  $\beta = .28$ ,  $t(65) = 1.99$ ,  $p = .05$ .

Controlling for DASS depression, SI-R discarding remained a significant predictor of distraction,  $B = .31$ ,  $SE = .10$ ,  $\beta = .51$ ,  $t(64) = 3.23$ ,  $p < .01$ ; DASS depression was not a significant predictor in this equation,  $B = .02$ ,  $SE = .08$ ,  $\beta = .03$ ,  $t(64) = .20$ ,  $p = .84$ . Conversely, the significant association between SI-R acquisition and distraction disappeared,  $B = .13$ ,  $SE = .11$ ,  $\beta = .19$ ,  $t(64) = 1.13$ ,  $p = .26$ , after accounting for DASS depression, which was not a significant predictor of distraction either,  $B = .13$ ,  $SE = .08$ ,  $\beta = .27$ ,  $t(64) = 1.61$ ,  $p = .11$ .

Controlling for DASS depression, SI-R discarding remained a significant predictor of reappraisal,  $B = .27$ ,  $SE = .12$ ,  $\beta = .39$ ,  $t(65) = 2.78$ ,  $p < .05$ , whereas SI-R acquisition no longer predicted reappraisal,  $B = .08$ ,  $SE = .13$ ,  $\beta = .11$ ,  $t(65) = .23$ ,  $p = .53$ . DASS depression did not predict reappraisal, when controlling for SI-R discarding,  $B = -.01$ ,  $SE = .10$ ,  $\beta = -.01$ ,  $t(65) = -.06$ ,  $p = .96$  or SI-R acquisition,  $B = .11$ ,  $SE = .10$ ,  $\beta = .20$ ,  $t(65) = 1.13$ ,  $p = .26$ . In sum, controlling for depressive symptoms, all of the associations between SI-R discarding and regulation of negative emotions remained, whereas SI-R acquisition only exhibited robust associations with rumination and suppression.

ANOVA was utilized to examine differences among groups on use of rumination, suppression, distraction, and reappraisal during the negative emotion induction. Results indicated that groups significantly differed on their use of rumination,  $F(2, 66) = 12.86$ ,  $p < .001$ , distraction,  $F(2, 66) = 5.95$ ,  $p < .01$ , and suppression,  $F(2, 65) = 9.35$ ,  $p < .01$ . As predicted, participants with HD ( $M = 10.40$ ,  $SD = 5.30$ ) reported greater use of rumination compared to both collectors ( $M = 6.00$ ,  $SD = 4.85$ ) and HCs ( $M = 3.65$ ,  $SD = 3.74$ ; Figure 6). However, collectors did not differ significantly from HCs in their use of rumination. A similar pattern emerged for distraction: participants with HD ( $M = 8.68$ ,  $SD = 5.02$ ) reported significantly greater use of distraction than both collectors ( $M = 5.25$ ,  $SD = 4.19$ ) and HCs ( $M = 4.64$ ,  $SD = 3.58$ ), but collectors and HCs did not significantly differ from one another (Figure 7). Participants with HD ( $M = 6.80$ ,  $SD = 2.96$ ) also reported more use of suppression than HCs ( $M = 3.00$ ,  $SD = 2.95$ ), but collectors ( $M = 4.75$ ,  $SD = 3.26$ ) did not differ from either group (Figure

8). In contrast, groups did not significantly differ on their use of reappraisal,  $F(2, 65) = 1.48, p = .24$ .

Next, ANCOVA (controlling for DASS depression) was utilized to examine the robustness of these group differences. Accounting for depressive symptoms, groups did not significantly differ on rumination,  $F(2, 65) = 1.84, p = .16$ , partial  $\eta^2 = .05$ , suppression,  $F(2, 64) = 1.27, p = .29$ , partial  $\eta^2 = .04$ , distraction,  $F(2, 63) = 1.83, p = .17$ , partial  $\eta^2 = .06$ , or reappraisal,  $F(2, 64) = .68, p = .51$ , partial  $\eta^2 = .02$ . In the context of these ANCOVA analyses, depressive symptoms significantly predicted rumination,  $F(2, 65) = 28.59, p < .001$ , partial  $\eta^2 = .31$ , suppression,  $F(2, 64) = 11.18, p = .001$ , partial  $\eta^2 = .15$ , and distraction,  $F(2, 63) = 4.20, p < .05$ , partial  $\eta^2 = .06$ . However, depressive symptoms did not predict reappraisal,  $F(2, 64) = 3.64, p = .06$ , partial  $\eta^2 = .05$ .

### *Testing Aim 3: Hoarding Symptoms and Regulation of Positive Emotions*

For Aim 3's primary analyses, we first present zero-order correlations between SI-R discarding and acquisition and use of emotion regulation strategies (i.e., dampening and savoring) during the positive emotion induction (Table 6). Unexpectedly, greater levels of SI-R discarding and acquisition significantly predicted *greater* levels of dampening, but did not predict savoring. We next examined the associations between dampening and SI-R scores controlling for DASS depression, by entering DASS depression into the first step of the regression equations. Controlling for DASS depression, neither SI-R discarding,  $B = .01, SE = .09, \beta = .02, t(66) = .11, p = .91$ , nor SI-R acquisition,  $B = -.04, SE = .10, \beta = -.06, t(66) = -.37, p = .71$ , significantly predicted dampening.

Controlling for SI-R discarding, depressive symptoms predicted dampening,  $B = .27$ ,  $SE = .07$ ,  $\beta = .55$ ,  $t(66) = 3.66$ ,  $p = .001$ . Depressive symptoms also predicted dampening accounting for SI-R acquisition,  $B = .30$ ,  $SE = .07$ ,  $\beta = .60$ ,  $t(66) = 4.05$ ,  $p < .001$ .

ANOVA was utilized to examine differences among groups on use of dampening and savoring during the positive emotion induction. There were no significant differences among groups on either dampening,  $F(2, 68) = 2.14$ ,  $p = .13$ , or savoring,  $F(2, 68) = 1.40$ ,  $p = .26$ . We next used ANCOVA to examine whether groups differed in dampening, controlling for DASS depression; there was no group difference,  $F(2, 65) = .81$ ,  $p = .45$ , partial  $\eta^2 = .02$ . DASS depression significantly predicted dampening in the context of ANCOVA,  $F(2, 65) = 26.54$ ,  $p < .001$ , partial  $\eta^2 = .29$ .

#### *Testing Aim 4: Hoarding-Related Emotional Reactivity and Saving and Acquiring Tendencies*

*Saving Tendencies.* First, we examined whether subjective negative emotional reactivity to the BDT (i.e., the ABS negative affect change score) predicted saving tendencies on the BDT (i.e., the percentage of items saved). Subjective negative emotional reactivity to the BDT did *not* predict the percentage of items saved,  $r = .15$ ,  $p = .23$ .

ANOVA was used to examine whether groups differed on subjective negative emotional reactivity to the BDT, and groups significantly differed,  $F(2, 65) = 3.30$ ,  $p < .05$ . Persons with HD ( $M = 11.25$ ,  $SD = 15.89$ ) exhibited greater subjective negative emotional reactivity to the BDT compared to HCs ( $M = 2.48$ ,

$SD = 7.07$ ), whereas collectors ( $M = 5.24$ ,  $SD = 10.98$ ) did not differ from either group (Figure 9). However, when we used ANCOVA to control for DASS depression, there was no significant difference among groups on subjective negative emotional reactivity to the BDT,  $F(2, 64) = .70$ ,  $p = .50$ , partial  $\eta^2 = .02$ . In the context of ANCOVA, DASS depression did not significantly predict subjective negative emotional reactivity to the BDT,  $F(2, 64) = 3.05$ ,  $p = .09$ , partial  $\eta^2 = .05$ .

Next, we examined whether physiological reactivity to the BDT (i.e., the HR change score) predicted saving tendencies on the BDT. Physiological reactivity to the BDT did not predict behavioral saving tendencies,  $r = -.00$ ,  $p = .99$ . Furthermore, ANOVA indicated no significant difference among groups in physiological reactivity to the BDT,  $F(2, 65) = .10$ ,  $p = .91$ .

*Acquiring Tendencies.* We examined whether subjective positive emotional reactivity to the BAT (i.e., the ABS positive affect change score) predicted acquiring tendencies on the BAT (i.e., the number of items acquired). Greater subjective positive emotional reactivity to the BAT significantly predicted acquiring more items,  $r = .24$ ,  $p < .05$ . Next, we used ANCOVA to examine whether groups differed on ABS positive affect directly after the BAT, controlling for baseline ABS positive affect prior to the BAT. Unexpectedly, groups did *not* differ on ABS positive affect following the BAT, when accounting for baseline ABS positive affect,  $F(2, 62) = .45$ ,  $p = .64$ , partial  $\eta^2 = .01$ .



Finally, we investigated whether physiological reactivity to the BAT (i.e., the HR change score) predicted acquiring tendencies on the BAT. Physiological reactivity to the BAT did not predict behavioral acquiring tendencies,  $r = -.05$ ,  $p = .71$ . ANOVA indicated no significant difference among groups in physiological reactivity to the BAT,  $F(2, 64) = .10$ ,  $p = .91$ .

## Chapter 6 Discussion

Although previous research has implicated emotional reactivity and emotion regulation difficulties in HD, this is the first multi-method study, using subjective, behavioral, and physiological indices, to examine these relationships using a dimensional sampling approach. Several of our findings were in line with our predictions. Greater self-reported difficulties with discarding and acquisition predicted greater subjective emotional reactivity to the negative emotion induction, as well as more spontaneous use of rumination, suppression, and distraction during the negative emotion induction. In contrast to our findings with subjective emotional reactivity, we did not find support for a link between physiological reactivity (as indicated by HR) and hoarding (either on self-reports or behavioral hoarding tasks). Overall, findings suggest that hoarding symptoms are linked with heightened negative emotional reactivity to criticism, and that hoarding symptoms are associated with using maladaptive strategies to regulate negative emotions. In contrast, heightened positive emotional reactivity was noted only in the context of acquiring, and not in response to praise.

Most of our findings, including reactivity to the negative emotion induction and all group differences in negative emotional reactivity and regulation, did not remain significant after controlling for current depressive symptoms. In analyses examining negative emotional reactivity, even though controlling for depressive symptoms reduced our findings to non-significance, depressive symptoms did not actually predict subjective emotional reactivity. In contrast, depressive symptoms did significantly predict rumination and dampening across analyses.

In our sample, the HD group exhibited moderate levels of current depressive symptoms and 40.0% of them met criteria for a past major depressive episode. We included current depressive symptoms as a covariate in analyses, which examined constructs that were correlated with depressive symptoms (e.g., subjective negative emotional reactivity, rumination), to account for the baseline difference among groups. Yet, controlling for depressive symptoms in analyses examining negative emotional reactivity and regulation of negative emotions was a particularly stringent test of the robustness of these effects, and could be factoring out a key aspect of HD. Mood disorders are the most common comorbid disorder in HD (Wheaton & Van Meter, 2014). A review of the literature indicates that 11.5 to 52.6% of persons with HD meet criteria for current Major Depressive Disorder (Wheaton & Van Meter, 2014). Future studies should carefully consider the best way to account for comorbid depression when examining negative emotions in HD. Below, for each analysis that controlled for depressive symptoms; we will explore potential explanations and implications of the role of depression in these relationships.

#### *Hoarding Symptoms and General Emotional Reactivity*

Our first aim examined whether self-reported difficulties with discarding and acquisition predicted heightened emotional reactivity (subjective and physiological) to two emotion inductions (negative and positive). As hypothesized, we found that greater difficulties with discarding and acquisition predicted heightened subjective negative emotional reactivity to the critical comments. Additionally, persons with HD exhibited heightened subjective

emotional reactivity to the critical comments compared to HCs. This is striking given that patients with BPD, who are known for heightened emotional reactivity, did not exhibit greater subjective emotional reactivity to the critical comments compared to HCs in a previous study (Hooley et al., 2010). We also examined the robustness of these effects, controlling for depressive symptoms. Controlling for depressive symptoms, difficulties with discarding and acquisition no longer predicted subjective negative emotional reactivity to the critical comments, and there was no longer a significant difference among groups. Although these findings were not robust, persons with HD did exhibit heightened subjective negative emotional reactivity. Heightened negative emotional reactivity could therefore reflect a non-specific risk factor for HD, which nevertheless may represent an important treatment target.

The finding that negative emotional reactivity was linked to difficulties with discarding and acquisition was in line with previous findings by our group (Shaw, Timpano, et al., 2015; Timpano et al., 2014). We expanded on these studies by using a carefully selected sample of participants with HD, collectors, and HCs and by using a more ecologically-valid negative emotion induction. Our finding that depressive symptoms accounted for the link between negative emotional reactivity and hoarding symptoms contrasts previous findings that demonstrated robust effects controlling for depressive and anxiety symptoms. Shaw, Timpano, et al. (2015) found that trait levels of emotional reactivity were associated with difficulties with discarding and acquisition, controlling for depressive and anxiety symptoms, age, and gender. Using emotional film clips, Timpano et al. (2014)

found that more intense ratings of sadness and disgust were significantly associated with greater acquisition, and that more intense ratings of fear were associated with greater difficulties with discarding, controlling for depressive and anxiety symptoms. These study findings may differ from the current study's results due to the use of different sampling approaches (e.g., undergraduates and participants with hoarding symptoms recruited online) and a different emotion induction technique.

Although subjective emotional reactivity to the negative emotion induction was linked to hoarding symptoms, physiological reactivity (as measured by HR) was not. Additionally, groups did not differ on physiological reactivity to the critical comments. There are two potential explanations for these non-significant findings. First, no study has examined whether critical comments can elicit expected changes in HR. Follow-up analyses found that the critical comments did not lead to significant increases in HR (data available upon request;  $p > .05$ ). The critical comments may have failed to elicit increases in HR, due to the complex activation patterns associated with sadness, which is the primary negative emotion elicited by criticism. Sadness can activate either an activating response, characterized by increased cardiovascular sympathetic control and sometimes crying, or a deactivating response, which is characterized by sympathetic withdrawal (Kreibig, 2010). Given that our participants, particularly the HD group, reported engaging in suppression and distraction during the critical comments, it is possible that participants exhibited a deactivating, rather than activating, sadness response in reaction to the critical comments. Perhaps,

different emotion inductions, such as autobiographical recall tasks (e.g., Tsai et al., 2002), which have been found to elicit increased HR (Kreibig, 2010), could be utilized in future studies.

A second, related consideration is that HR may not be the best physiological indicator of negative emotional reactivity. While it is outside of the aims of the current study, we also collected data on facial electromyography (EMG), which may be a better objective indicator of responding to the emotion inductions because it can reliably differentiate between reactivity to negative versus positive induced emotions (Schwartz et al., 1976a). In particular, corrugator EMG is a measure of facial expressive behavior associated with increased negative affect (for a review, see Kreibig et al., 2007) and decreased positive affect (Schwartz et al., 1976a, 1976b). Thus, future analyses will examine the associations between corrugator EMG and hoarding symptoms.

In contrast to our findings with negative emotional reactivity, we found that self-reported difficulties with discarding and acquisition did not predict either subjective or physiological emotional reactivity to the positive emotion induction. Similarly, groups did not differ in subjective or physiological emotional reactivity to the positive emotion induction. We considered whether there were any methodological explanations for these non-significant findings. In terms of subjective emotional reactivity to the positive emotion induction, participants rated the comments as very positive, moderately emotionally stimulating, and somewhat relevant to them. Overall, the positive emotion induction was effective at increasing subjective ratings of positive affect, but not HR (data available upon

request;  $p > .05$ ). HR may not be the best objective indicator of positive emotional reactivity, since it can also reflect increased negative affect (Schwartz et al., 1976a). Zygomatic EMG is a measure of facial expressive behavior associated with heightened positive affect (Schwartz et al., 1976a), which was also collected as part of the current study. In the future, we will examine the associations between zygomatic EMG and hoarding symptoms.

It is also possible that patients with HD truly do not exhibit heightened subjective or physiological reactivity to positive emotional stimuli, such as praise, outside of the acquisition context. If this is true, our findings are interesting to consider, given that other clinical groups, such as patients with depression, exhibit *reduced* reactivity to positive emotional stimuli compared to HCs (Rottenberg et al., 2002). Given that the HD group in our study experienced moderate levels of depressive symptoms and high rates of past major depressive episodes, we might expect the HD group to have displayed *less* positive emotional reactivity compared to HCs. Yet, the HD group exhibited equivalent levels of reactivity (both subjective and physiological) to praise as HCs. It is possible that this represents an adaptive, normative response in HD patients. Perhaps, normative levels of positive emotional reactivity play a role in how depression manifests in HD, such as lower rates of anhedonia or fewer total episodes of major depression. Further research on this topic is warranted.

### *Hoarding Symptoms and Regulation of Negative Emotions*

Our second aim examined whether self-reported difficulties with discarding and acquisition predicted spontaneous use of various emotion regulation strategies during a negative emotion induction. Very few studies have examined this relationship, and none has examined whether persons with HD use specific strategies to regulate negative affect during a negative emotion induction. As hypothesized, we found that greater self-reported difficulties with discarding and acquisition predicted using more rumination, suppression, and distraction during the critical comments. Furthermore, each of these associations remained significant controlling for depressive symptoms, except for the association between acquisition and distraction. We also found significant group differences in the use of rumination, suppression, and distraction. Persons with HD reported greater use of both rumination and distraction than HCs and collectors. Participants with HD also reported more use of suppression than HCs. However, these group differences in use of emotion regulation strategies did not remain after controlling for depressive symptoms.

Overall, when controlling for depressive symptoms, the majority of the associations between hoarding symptoms and use of rumination, suppression, and distraction remained, but the group-wise analyses for these same strategies were no longer significant. This is most likely because group-wise analyses are not as powerful as dimensional analyses. Additionally, although depressive symptoms significantly predicted rumination across dimensional and group-wise analyses, depressive symptoms only significantly predicted suppression and



distraction in the group-wise analyses. Overall, group differences on rumination, suppression, and distraction were better accounted for by comorbid depressive symptoms.

When relationships were considered dimensionally, our findings suggest that difficulties with discarding and acquisition were robustly associated with using strategies to regulate negative moods that are generally considered ineffective at reducing negative affect in the long-term (i.e., rumination, distraction, and suppression). These associations are in line with the only study on rumination in hoarding (Portero et al., 2015), and expands the finding to participants with clinically-significant manifestations of HD. Our finding that difficulties with discarding and acquisition were linked to greater levels of suppression is in line with findings that hoarding symptoms were associated with more use of escape/avoidance coping strategies (Yorulmaz & Dermihan, 2015). Longitudinal or ecological momentary assessment studies are needed to understand whether these maladaptive strategies might maintain chronic saving and excessive acquiring behaviors.

We also examined whether self-reported difficulties with discarding and acquisition were associated with using reappraisal during the negative emotion induction. In contrast to our predictions, greater levels of difficulties with discarding and acquisition predicted using *more* reappraisal during the negative emotion induction. However, the use of reappraisal did not differ among groups and the association between acquisition and reappraisal did not remain controlling for depressive symptoms. This robust positive association between

reappraisal and difficulties with discarding was unexpected. However, endorsing engaging in reappraisal during the critical comments does not indicate whether participants were *effectively* engaging in reappraisal. Another possible explanation for this unexpected finding involves the high rates of treatment-seeking participants in our HD group. Our program offers no-cost facilitated self-help groups, more advanced cognitive-behavioral group interventions (with home visits), and individual therapy to all participants who meet criteria for HD during the screening visit. 36% of our HD sample participated in one or more of these treatments, during which they would have learned how to engage in reappraisal. Thus, replication of this finding is warranted in a more treatment-naïve sample.

#### *Hoarding Symptoms and Regulation of Positive Emotions*

For our third aim, we examined whether self-reported difficulties with discarding and acquisition predicted two strategies to regulate positive emotions. In contrast to our hypotheses, greater levels of difficulties with discarding and acquisition predicted *greater* levels of dampening, and did not predict savoring. However, the associations between hoarding symptoms and dampening did not remain, controlling for depressive symptoms. Furthermore, groups did not differ in the use of dampening or savoring during the positive emotion induction. As depressive symptoms were a significant predictor of dampening across analyses, the associations between dampening and hoarding symptoms were best accounted for by comorbid depressive symptoms.

This represents the first study to consider how hoarding symptoms related to the regulation of positive emotions. Given the significant zero-order correlations of dampening with difficulties with discarding and acquisition, future studies should continue to examine how this strategy plays a role in HD and its comorbidity. The current study did not find that hoarding symptoms were related to savoring positive emotions in the context of praise. Yet, future studies could consider whether savoring plays a role in the context of acquiring new items and saving cherished possessions. Similar to our findings with positive emotional reactivity, it is interesting to consider how we might expect groups to differ on regulation of positive emotions, given the moderate levels of depressive symptoms in the HD group. Persons with moderate depressive symptoms would be expected to use *more* dampening (i.e., the down-regulation of positive emotions) and *less* savoring (i.e., the up-regulation of positive emotions) than HCs (Feldman et al., 2008). Yet, in our sample, groups did not differ in levels of dampening and savoring. This could further support the possibility that depression presents differently in HD, with less anhedonic features.

#### *Hoarding-Related Emotional Reactivity and Saving and Acquiring Tendencies*

For our fourth and final aim, we examined whether (1) subjective negative emotional and physiological reactivity to a discarding task predicted behavioral saving tendencies and (2) subjective positive emotional and physiological reactivity to an acquiring task predicted behavioral acquiring tendencies. We found mixed results for the link between negative emotional reactivity and saving tendencies. When considered continuously, neither subjective nor physiological

reactivity to the BDT predicted behavioral saving tendencies. However, group-wise analyses revealed that participants with HD exhibited greater subjective, but not physiological, negative emotional reactivity to the BDT than HCs. This significant group difference did not remain controlling for depressive symptoms.

There are several possible explanations for these mixed findings. First, in our study, the outcome variable of the BDT, percentage of items saved, was not significantly associated with SI-R discarding, which suggests that the task may lack convergent and/or predictive validity. Additionally, groups did not significantly differ on percentage of items saved on the BDT. Although this task has been used in several previous investigations, it is worth noting that the psychometric properties of the task have never been reported. Perhaps, the BDT is not truly measuring saving behavior, and should be modified to be more ecologically valid for future studies. For example, for improved iterations of the task, participants should (1) not be given a time limit for decision-making, (2) be able to talk through their decision-making process, and (3) be able to touch their items as they consider whether to save or discard them. Future research is warranted with improved discarding paradigms.

A second possible explanation for our non-significant findings with reactivity to the BDT is that a third of our HD sample had some previous experience with discarding exposures due to participation in our treatment program, which may have lessened their reactivity to the task. However, we conducted exploratory follow-up analyses excluding these HD participants, and the results remained the same (data available upon request). Third, chronic

saving can allow persons with HD to *avoid* experiencing negative emotions associated with discarding. Thus, it is possible that the participants who saved the most items were able to avoid experiencing intense negative emotions because they quickly decided to save most of their items.

We also examined whether subjective positive emotional and physiological reactivity to an acquiring paradigm predicted behavioral acquiring tendencies. As expected, we found that greater subjective positive emotional reactivity to the BAT predicted acquiring more items. Yet, physiological reactivity to the BAT did not predict behavioral acquiring tendencies. Additionally, groups did not differ in subjective positive affect ratings following the BAT or in physiological reactivity to the BAT. The non-significant findings with physiological reactivity may be explained by our physiological index of reactivity, and future analyses will examine whether zygomatic EMG predicts acquiring tendencies on the BAT.

Subjective positive emotional reactivity was associated with acquiring tendencies when the sample was considered continuously, but a group difference did not emerge. Again, this is likely because group-wise analyses are less powerful than dimensional analyses. Also, groups did not significantly differ on the number of items acquired on the BAT, so it is possible that positive emotions motivate acquiring new items even in those with normative acquiring tendencies. Our findings on positive emotional reactivity and acquiring tendencies differ from results from a study that indicated that greater positive trait

affect predicted *less* impulse buying (Thompson & Prendergast, 2015). These findings most likely diverge due to the sampling differences, and the fact that the other study examined trait, rather than state, levels of positive affect.

Overall, our finding that subjective positive emotional reactivity to the BAT predicted greater acquiring behavior supports the inclusion of positive emotional reactions as a key component in the CBT model of hoarding. Our results suggest that being faced with an opportunity to acquire new possessions leads to increased positive emotional reactions, which results in increased acquisition. Future studies should examine one prediction of the CBT model, that this positive reinforcement pattern actually maintains future excessive acquiring tendencies (Grisham & Barlow, 2005). In sum, it appears that positive emotional reactivity is most relevant to the acquiring context, as we did not find support for a relationship between hoarding symptoms and emotional reactivity to praise.

#### *Limitations and Future Directions*

The results of the current study should be interpreted in light of several methodological limitations. First, while our dimensional sampling approach was a novel aspect of the current study, it is also a potential limitation in that there is a lot we still do not know about collectors. Because there are only a few investigations who have studied collectors in comparison to HD participants (Mataix-Cols et al., 2013; Nordsletten, Fernandez de la Cruz, et al., 2013; Nordsletten & Mataix-Cols, 2012), the group-wise comparisons between the HD and collectors groups were somewhat exploratory. It would have been useful to include a clinical control group with similar levels of depressive symptoms,

particularly given the influential role of depressive symptoms in our analyses predicting negative emotional reactivity and regulation. Future studies on emotional reactivity and regulation in HD should include a clinical control group.

Our diagnostic evaluation presents a second limitation. The SCID-IV does not assess for BPD or Autism Spectrum Disorders (ASD). Given that the emotion inductions were originally designed for women with BPD (Hooley et al., 2010), the intense emotional reactions of some participants may be explained by comorbid BPD. The fact that we did not assess for ASD is relevant given that restricted interests are a symptom of ASD, and can commonly take the form of collections. It is possible that some of the collectors in our sample met criteria for high-functioning ASD. Third, participants did not rate the critical comments as emotionally stimulating or personally relevant as anticipated. Also, neither emotion induction elicited expected increases in HR. Future studies on emotional reactivity in HD could develop critical and praising audio clips that are specific to the participant by speaking with a family member and recording their comments prior to the laboratory session (Hooley et al., 2012). Making the comments more personally relevant could better elicit physiological reactivity. Fourth, internal consistency for the suppression and distraction scales was low, and the suppression subscale only included two items. We created brief emotion regulation scales so that participants could rate the items quickly after each emotion induction. Future studies, in which time is not a constraint, should use validated measures of suppression and distraction to more carefully assess the use of these strategies in HD.

Despite its limitations, the current study lays the groundwork for future research on HD. For example, we only assessed one's immediate emotional reactions to emotional scenarios. Hoarding behaviors may be brought on by persistent negative moods, such as recurrent or chronic depression. Future investigations, such as longitudinal and ecological momentary studies, should carefully examine the relationship between HD and depression. In particular, researchers should investigate the temporal association between depression and HD, as well as the impact of comorbid depression on treatment response (Wheaton & Van Meter, 2014). Similarly, one component of emotional reactivity that was not captured in the current study was how long emotions last prior to returning to baseline (Nock et al., 2008). Some researchers have proposed that prolonged recovery from negative emotions may be more important than reactivity in giving rise to psychological disorders (Brosschot & Thayer, 2003). Thus, future studies should measure how long it takes participants to recover from emotion inductions. We only examined one physiological indicator of emotional reactivity for this preliminary study. Future studies could compare groups on brain activation patterns during the negative and positive emotion inductions, given previous findings of different brain activation patterns using these tasks in clinical subjects compared to HCs (Hooley et al., 2009; Hooley et al., 2005).



### *Implications*

This study has implications for both the etiology and treatment of HD. Our results support several aspects of the CBT model of hoarding. For example, our findings support the role of intense negative emotions in difficulties with discarding and acquiring. We also found that intense positive emotions may spur acquiring behaviors. Additionally, the finding that suppression was linked to both difficulties with discarding and acquisition supports theories of emotional avoidance patterns in hoarding. To date, neither distraction nor rumination has been included in the CBT model of hoarding, but these strategies may perpetuate avoidance of discarding by elongating the decision-making process and decreasing efficiency during sorting sessions.

This investigation also has intriguing treatment implications. The current study suggests that negative emotional reactivity, depressive symptoms, and ineffective emotion regulation strategies should be targeted in treatment for HD. Given that negative emotional reactivity can predispose patients to maladaptive behaviors (Nock et al., 2008), and that it is relatively modifiable, negative emotional reactivity could be a key target of intervention for persons with HD. Although discarding exposures could reduce negative emotional reactivity to discarding, current treatments for HD do not address negative emotional reactivity in interpersonal situations, such as criticism. To target depressive symptoms, therapists could incorporate behavioral activation (e.g., pleasant activity scheduling) into treatments for HD to enhance patient's mood at the start of treatment and to reward them for engaging in discarding and non-acquiring

exposures. The findings that hoarding symptoms predicted three emotion regulation strategies that inadvertently maintain negative affect suggest that patients with HD would benefit from training in effective emotion regulation, using components of dialectal behavior therapy (Linehan, 1993).

Our finding that positive emotions spurred acquiring items suggests that HD patients should be exposed to experiencing positive emotions and letting them pass, without engaging in acquisition. It seems relevant to ask both about subjective units of distress and level of positive affect throughout non-acquiring exposures. Overall, the current study implicates several aspects of emotional reactivity and regulation in HD, which could be targeted in treatment.

### *Conclusion*

This was the first comprehensive, multi-method study of negative and positive emotions across persons with HD, collectors, and HCs. We found that negative emotional reactivity was linked to both difficulties with discarding and acquisition, and that positive emotional reactivity can influence acquiring behavior in the moment. We also found that difficulties with discarding and acquisition predicted greater use of rumination, distraction, and suppression to regulate negative emotions. The current study opens up interesting lines of future research, such as longitudinal investigations, to further clarify whether emotional reactivity and regulation increase risk and/or maintain hoarding symptoms. Overall, negative and positive emotional reactivity, as well as ineffective regulation of negative emotions, appear to play a role in hoarding, and warrant further investigation in etiological and treatment research.

## Figures

Figure 1

*The Cognitive Behavioral Model of Hoarding.*

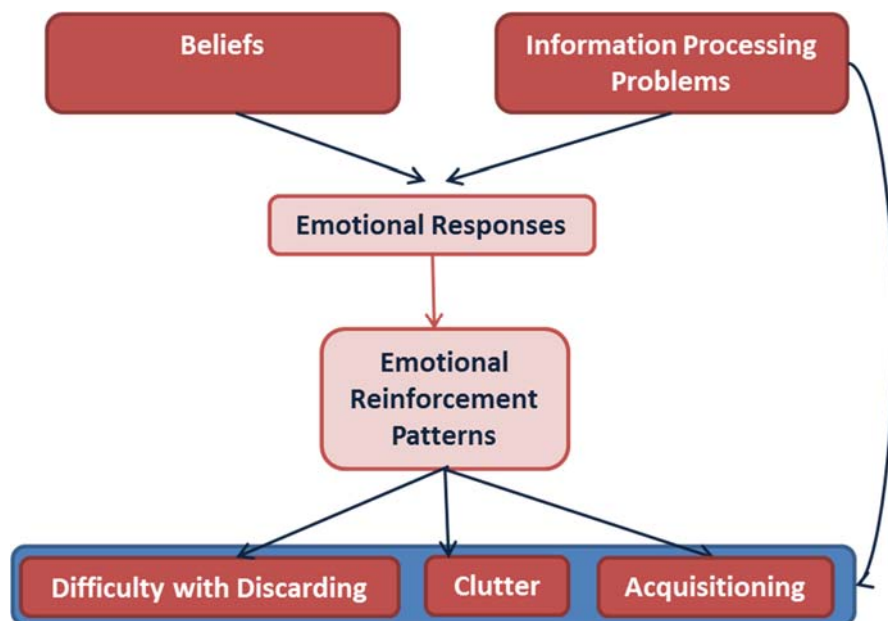
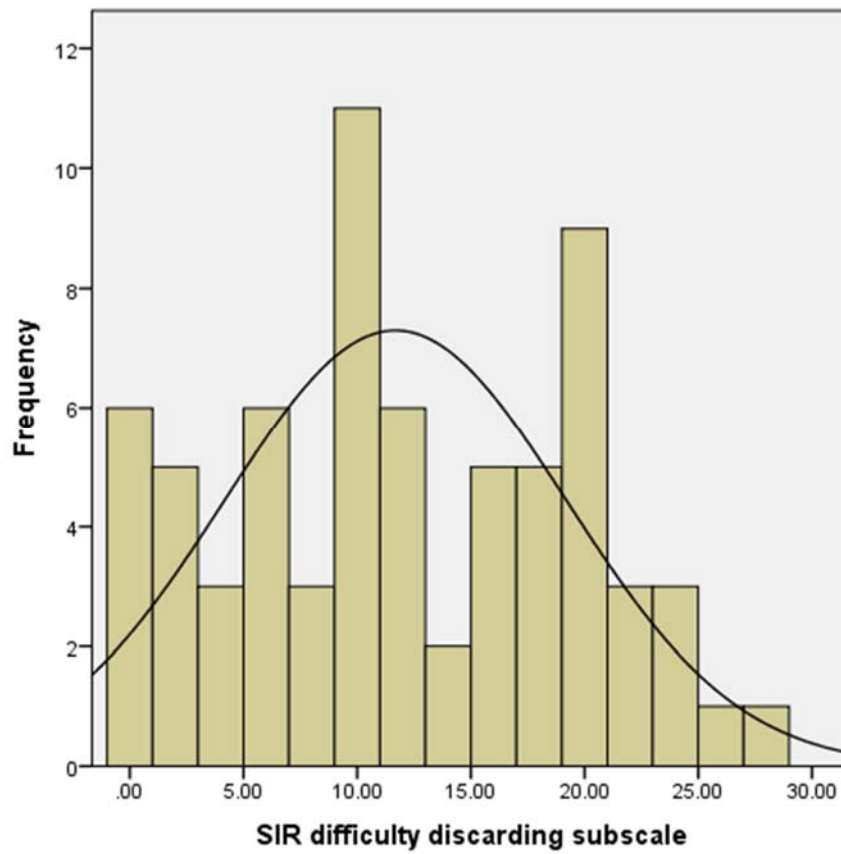


Figure 2

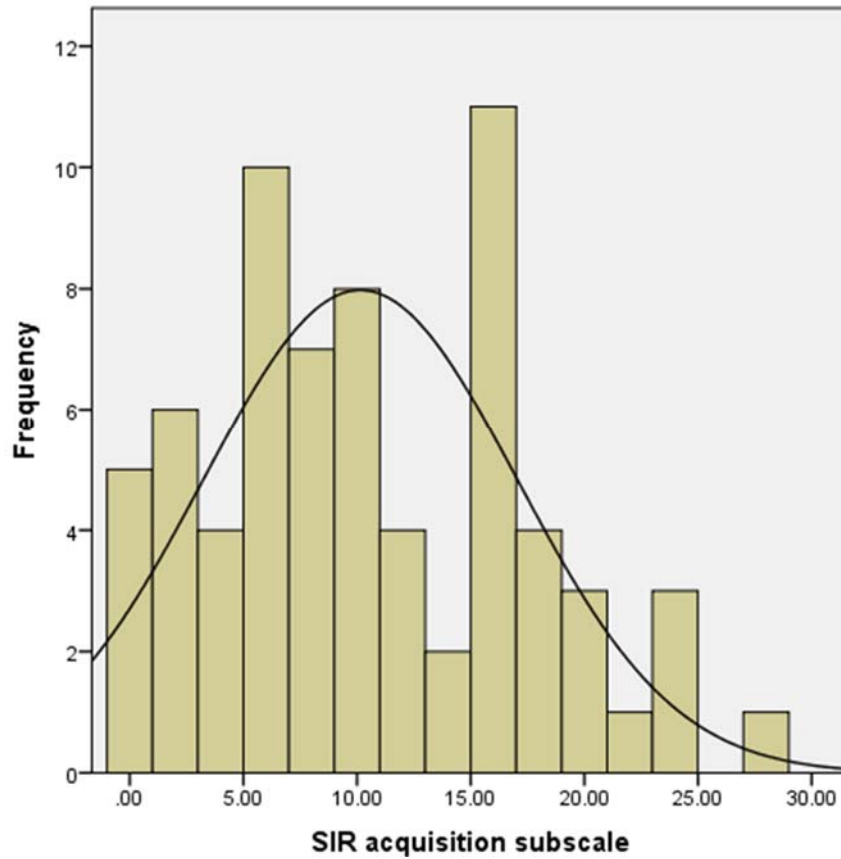
*Scatterplot of the SI-R Difficulty Discarding Subscale.*



*Note.* SI-R = Saving Inventory-Revised.

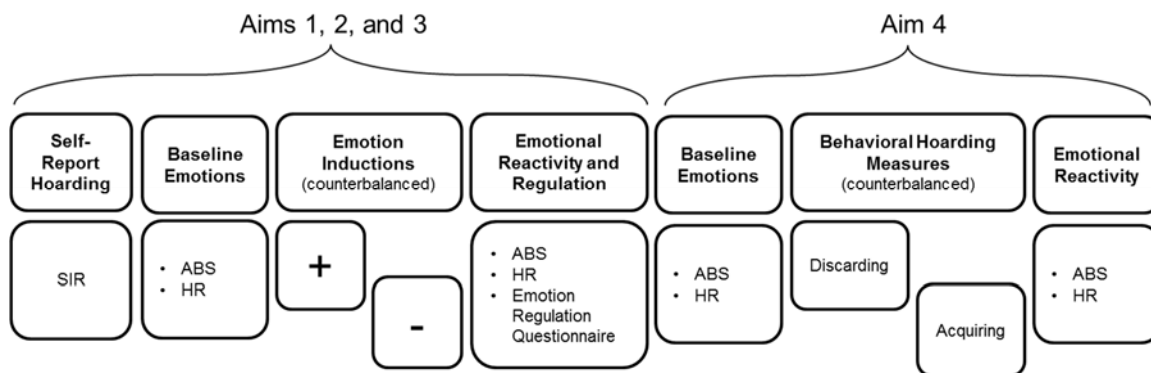
Figure 3

*Scatterplot of the SI-R Acquisition Subscale.*



*Note.* SI-R = Saving Inventory-Revised.

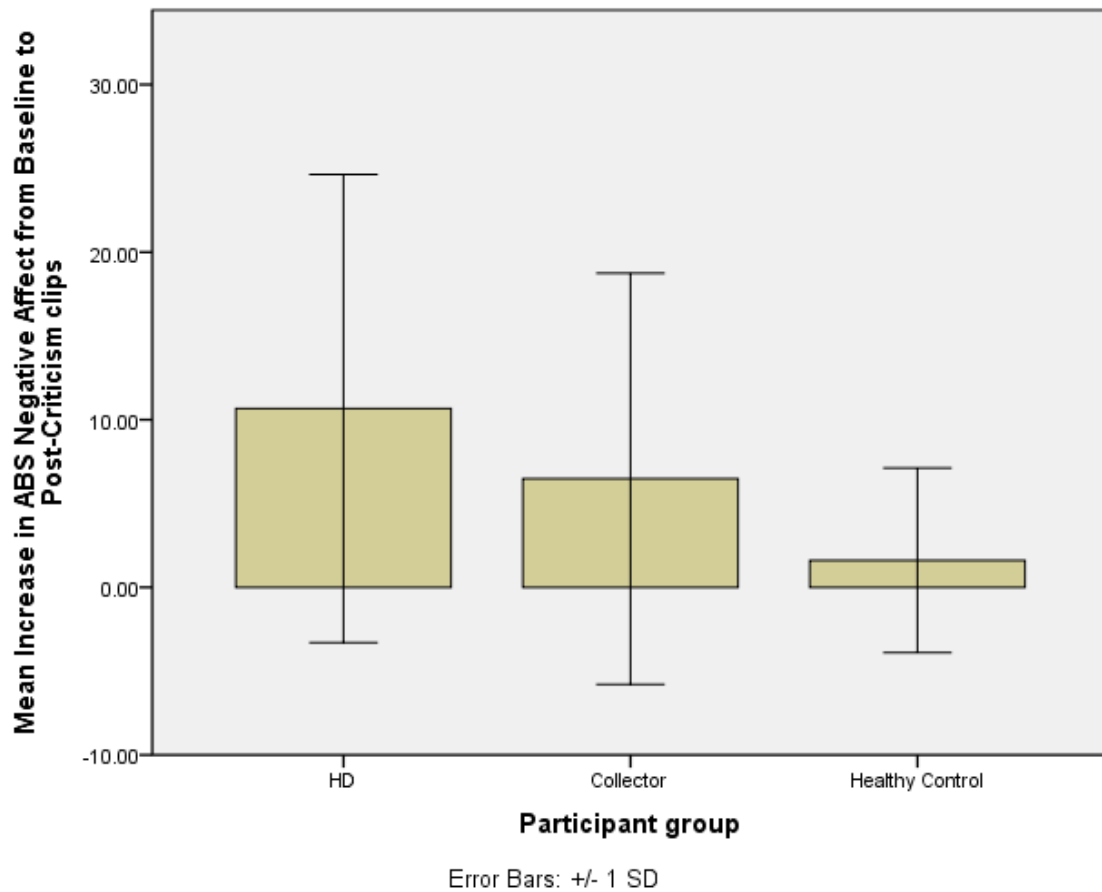
Figure 4

*Study Schemata.*

*Note.* SIR = Saving Inventory-Revised; ABS = Affect Balance Scale; HR = Heart Rate; + = Positive Emotion Induction; - = Negative Emotion Induction.

Figure 5

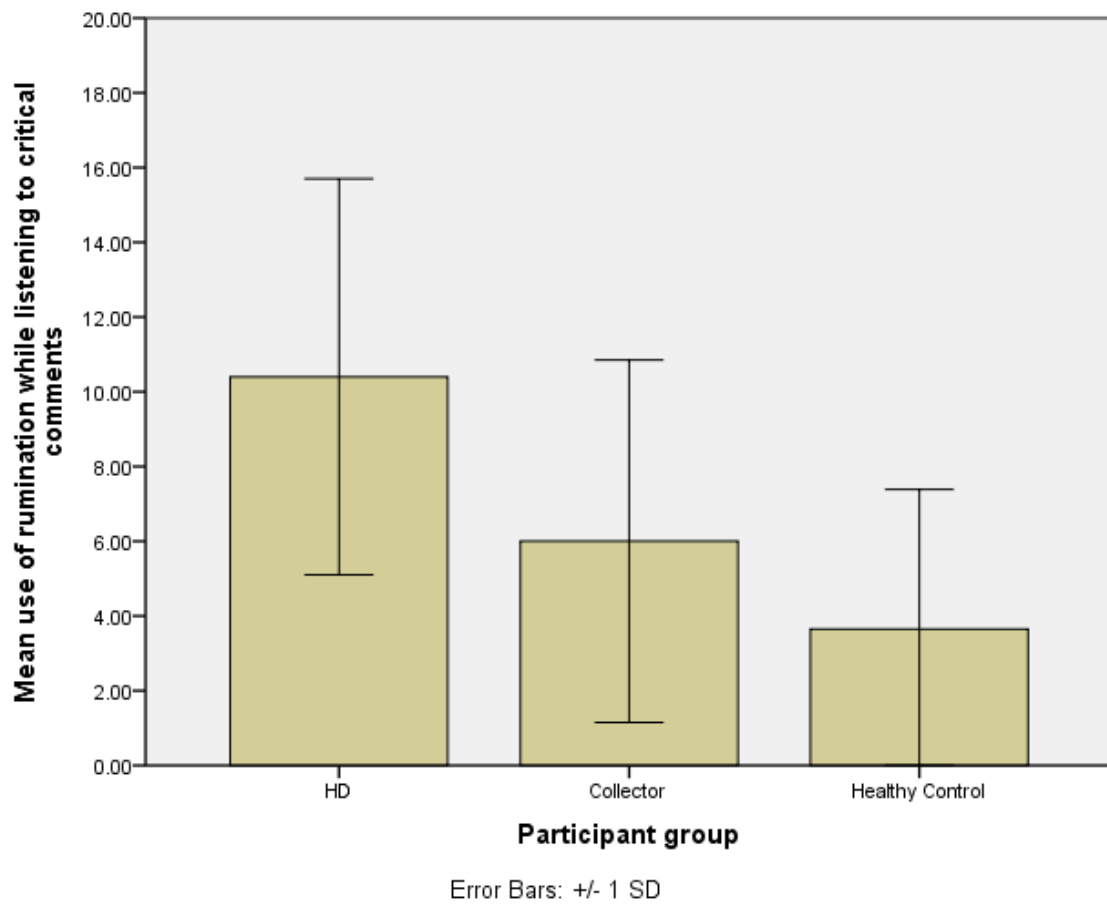
*Mean Increase in ABS Negative Affect during the Negative Emotion Induction across Groups.*



*Note.* ABS = Affect Balance Scale; HD = Hoarding Disorder.

Figure 6

*Mean Use of Rumination during the Negative Emotion Induction across Groups.*

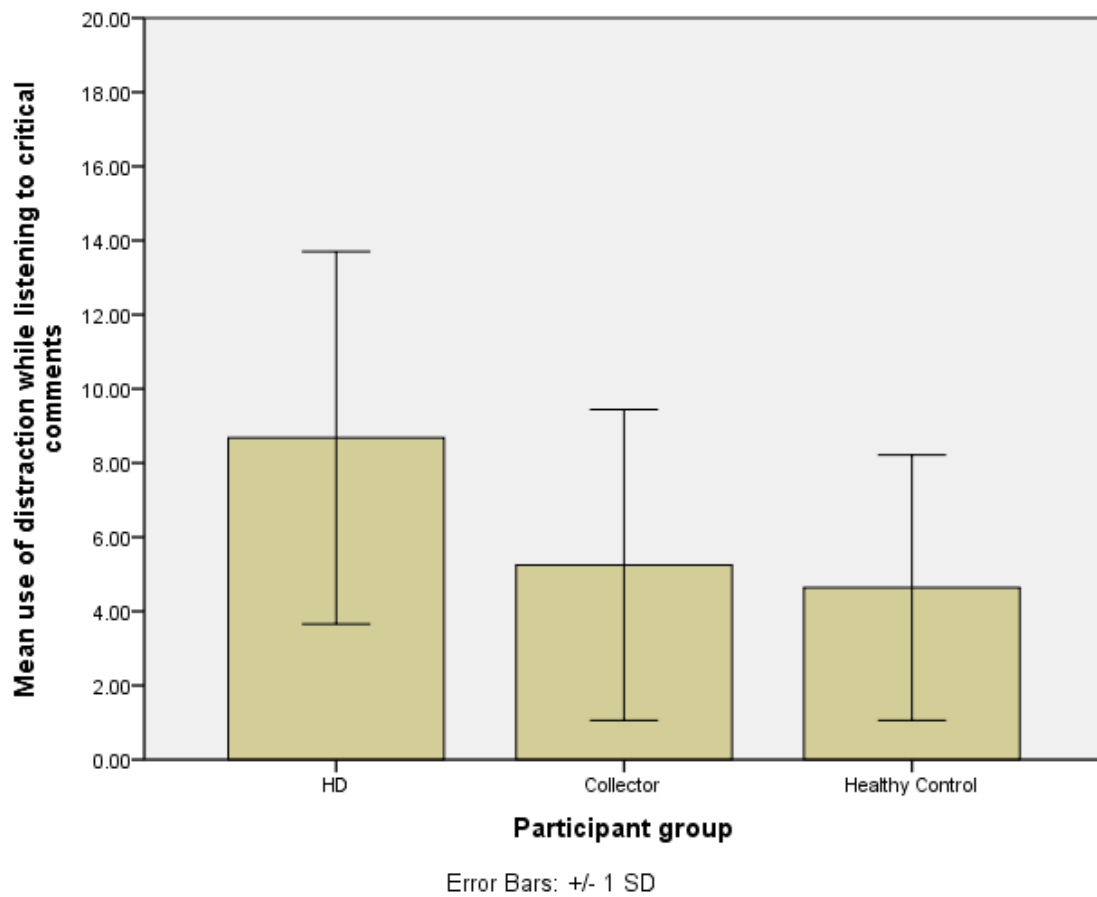


*Note.* HD = Hoarding Disorder.



Figure 7

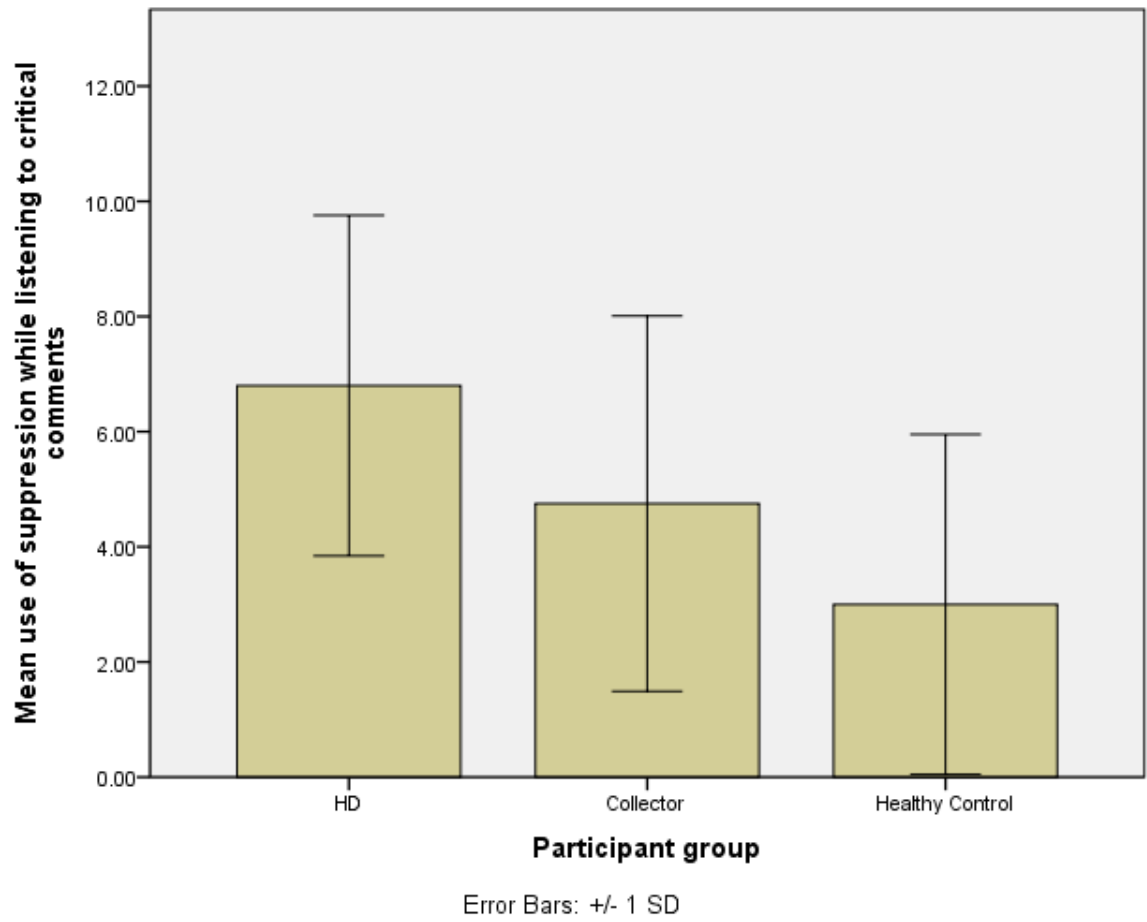
*Mean Use of Distraction during the Negative Emotion Induction across Groups.*



*Note.* HD = Hoarding Disorder.

Figure 8

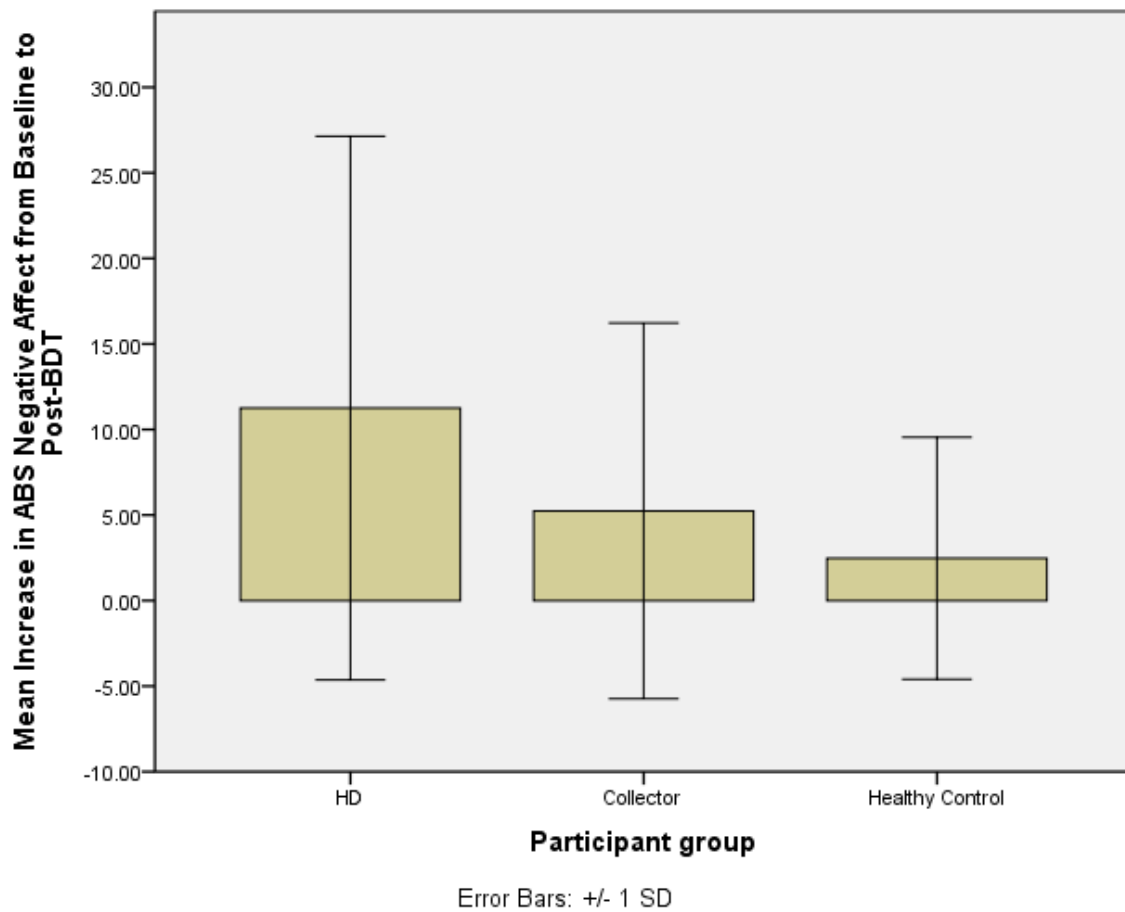
*Mean Use of Suppression during the Negative Emotion Induction across Groups.*



*Note.* HD = Hoarding Disorder.

Figure 9

*Mean Increase in ABS Negative Affect during the BDT across Groups.*



*Note.* ABS = Affect Balance Scale; HD = Hoarding Disorder; BDT = Behavioral Discarding Task.

## Tables

Table 1

### *Demographics and Baseline Characteristics by Group.*

<i>Baseline characteristic</i>	Overall sample <i>N</i> = 69	HD <i>n</i> = 25	Collectors <i>n</i> = 21	HC <i>n</i> = 23	Statistic $\chi^2$ , <i>F</i>
<b><i>General demographics</i></b>					
Gender – female %	50.7	64.0	28.6 ‡	56.5	6.2*
Ethnicity					4.5
Not Hispanic or Latino, %	71.0	64.0	66.7	82.6	
Hispanic or Latino, %	27.5	36.0	28.6	17.4	
Unknown or Not Reported, %	1.4	0.0	4.8	0.0	
Race					5.8
White/Caucasian, %	81.2	84.0	81.0	78.3	
Black/African American, %	13.0	8.0	19.0	13.0	
Asian, %	2.9	4.0	0.0	4.3	
Other, %	2.8	4.0	0.0	4.3	
Medication use – yes, %	53.6	60.0	38.1	60.9	2.9
Caffeine use – yes, %	60.9	56.0	57.1	69.6	1.1
Chronic medical conditions – yes, %	43.5	48.0	52.4	30.4	2.5
Age, M (SD)	56.3(15.7)	56.2(14.6)	52.7(16.2)	59.7(16.2)	1.1
<b><i>Comorbidity</i></b>					
DASS depression, M(SD)	8.1(9.3) †	14.5(9.0)	7.5 (9.5)	1.6(2.7)	16.9***
MDD, current, %	2.9	8.0	0.0	0.0	3.6
MDD, past, %	18.8 †	40.0	14.3	0.0	12.9**
PD w/ Agoraphobia, current, %	1.4	4.0	0.0	0.0	1.8
Agoraphobia w/o PD, current, %	1.4	4.0	0.0	0.0	1.79
Specific Phobia, current, %	4.3	8.0	4.8	0.0	1.86
Social Anxiety Disorder, current, %	7.2	16.0	4.8	0.0	4.84
OCD, current, %	5.8	8.0	9.5	0.0	2.17
PTSD, current, %	2.9	4.0	4.8	0.0	1.05
GAD, current, %	4.3	4.0	9.5	0.0	2.41
<b><i>Hoarding relevant variables</i></b>					
SI-R total, M(SD)	34.7(23.3) †	58.0(12.5)	31.7(18.5)	12.7(9.5)	65.4***
SI-R: discarding, M(SD)	11.6(7.5) †	18.4(4.2)	11.0(6.8)	5.0(4.2)	40.8***
SI-R: acquisition, M(SD)	10.2(6.9) †	16.0(4.8)	10.0(6.0)	3.9(3.0)	38.9***
HRS, M(SD)	10.8(11.1) †	24.2(5.1)	4.9(4.2)	1.5(2.0)	224.8***
BIR: Value, M(SD)	52.1(32.2)	59.8(29.0)	48.9(31.7)	47.0(36.1)	1.7
BIR: Emotion, M(SD)	50.3(33.4)	59.0(29.9)	49.5(32.5)	41.4(36.7)	1.1

*Note.* HD=Hoarding Disorder; HC=Healthy Controls; Medication Use=Took medication day of the experiment; Caffeine Use=Consumed caffeine the day of the experiment; DASS=Depression Anxiety Stress Scales; MDD=Major Depressive Disorder; PD w/ Agoraphobia=Panic Disorder with Agoraphobia; Agoraphobia w/o PD=Agoraphobia without PD; OCD=Obsessive-Compulsive Disorder; PTSD=Post-traumatic Stress Disorder; GAD=Generalized Anxiety Disorder; SI-R=Saving Inventory-Revised; HRS=Hoarding Rating Scale; BIR: Value=Baseline Item Ratings Value of Items; BIR: Emotion=Baseline Item Ratings Emotional Attachment to the Items.

† All three groups significantly differed from one another ( $p < .05$ ).

‡ Collectors were significantly different from HD participants ( $p < .05$ ).

\*  $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .

Table 2

*Means, Standard Deviations, and Range for ABS, Emotion Regulation Use, and Behavioral Hoarding Tasks.*

Measure	<i>n</i>	<i>M</i>	<i>SD</i>	Range
ABS Negative EI T1	68	16.66	10.04	10 - 45
ABS Negative EI T2	69	23.78	17.49	10 - 79
ABS Negative EI Change Score	68	6.31	11.67	-13 - 43
ERQ: rumination	69	6.81	5.45	0 - 18
ERQ: suppression	68	4.92	3.41	0 - 12
ERQ: distraction	67	6.33	4.66	0 - 17
ERQ: reappraisal	68	8.22	5.35	0 - 18
ABS Positive EI T1	69	39.26	22.71	10 - 95
ABS Positive EI T2	69	48.13	23.67	10 - 95
ABS Positive EI Change Score	69	8.87	17.60	-31 - 73
ERQ: dampening	69	4.93	4.61	0 - 16
ERQ: savoring	69	10.12	4.90	0 - 18
BDT: Percent of Items Saved	68	50.95	28.17	0 - 100
ABS Negative BDT T1	69	16.00	9.82	10 - 54
ABS Negative BDT T2	68	22.51	16.46	10 - 73
ABS Negative BDT Change Score	68	6.43	12.38	-24 - 43
BAT: Items Acquired	69	4.22	2.27	0 - 9
ABS Positive BAT T1	69	32.48	22.46	10 - 90
ABS Positive BAT T2	68	37.85	25.48	10 - 97
ABS Positive BAT Change Score	68	5.26	16.44	-31 - 84

*Note.* ABS Negative = Affect Balance Scale Negative Affect Subscale; ABS Positive = Affect Balance Scale Positive Affect Subscale; EI = Emotion Induction; T1 = Baseline, Pre-Task; T2 = Post-Task; ERQ = Emotion Regulation Questionnaire; BDT = Behavioral Discarding Task; BAT = Behavioral Acquiring Task.

Table 3

*Means, Standard Deviations, and Range for Heart Rate Variables.*

Heart Rate Variable	<i>n</i>	<i>M</i>	<i>SD</i>	Range
Negative EI T1	68	71.13	12.64	48.36 – 104.30
Negative EI T2	67	70.58	12.79	48.12 – 106.04
Negative EI Change Score	67	-0.38	3.15	-9.47 – 9.47
Positive EI T1	69	70.75	12.70	48.04 – 105.38
Positive EI T2	67	70.73	12.81	47.40 – 105.55
Positive EI Change Score	67	-0.14	2.71	-6.75 – 8.55
BDT T1	69	70.69	12.94	45.35 – 107.52
BDT T2	68	72.11	13.15	48.38 – 107.35
BDT Change Score	68	1.30	3.43	-8.53 – 9.87
BAT T1	68	71.06	13.59	46.41 – 109.66
BAT T2	67	72.64	13.04	47.81 – 105.92
BAT Change Score	67	1.48	4.04	-14.53 – 11.39

*Note.* EI = Emotion Induction; T1 = Baseline, Pre-Task; T2 = Reactivity; BDT = Behavioral Discarding Task; BAT = Behavioral Acquiring Task.

Table 4

*Inter-correlations between DASS Depression Scores and DVs.*

<i>DV</i>	<i>Correlation with DASS depression</i>
ABS Negative EI Change Score	.29*
HR Negative EI Change Score	-.20
ERQ: Rumination	.69***
ERQ: Suppression	.56***
ERQ: Distraction	.40***
ERQ: Reappraisal	.28*
ABS Positive EI Change Score	-.13
HR Positive EI Change Score	-.08
ERQ: Dampening	.56***
ERQ: Savoring	-.23
BDT: Percent of Items Saved	.15
ABS Negative BDT Change Score	.34**
HR BDT Change Score	-.14
BAT: Items Acquired	.20
ABS Positive BAT T2	-.10
HR BAT Change Score	-.12

*Note.* ABS Negative = Affect Balance Scale Negative Affect Subscale; EI = Emotion Induction; HR = Heart Rate; ERQ = Emotion Regulation Questionnaire; ABS Positive = Affect Balance Scale Positive Affect Subscale; BDT = Behavioral Discarding Task; BAT = Behavioral Acquiring Task; T2 = Post-Task.

\*  $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .

Table 5

*Inter-correlations between SI-R scores and Emotion Regulation Use during the Negative Emotion Induction.*

	2	3	4	5	6
1. SI-R: discarding	.86***	.67***	.66***	.53***	.38***
2. SI-R: acquisition	1	.64***	.60***	.38***	.25*
3. ERQ: Rumination		1	.57***	.33**	.16
4. ERQ: Suppression			1	.64***	.44***
5. ERQ: Distraction				1	.62***
6. ERQ: Reappraisal					1

*Note.* SI-R = Saving Inventory-Revised; ERQ = Emotion Regulation Questionnaire.

\*  $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .



Table 6

*Inter-correlations between SI-R scores and Emotion Regulation Use during the Positive Emotion Induction.*

	2	3	4
1. SI-R: discarding	.86***	.42***	-.20
2. SI-R: acquisition	1	.39***	-.09
3. ERQ: Dampening		1	-.04
4. ERQ: Savoring			1

*Note.* SI-R = Saving Inventory-Revised; ERQ = Emotion Regulation Questionnaire.

\*\*\*  $p < .001$ .

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