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# Using Ecological Momentary Assessment to Clarify the Function of Hoarding

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USING ECOLOGICAL MOMENTARY ASSESSMENT TO CLARIFY THE  
FUNCTION OF HOARDING

by

Jennifer Krafft

A thesis submitted in partial fulfillment  
of the requirements for the degree

of

MASTER OF SCIENCE

in

Psychology

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2018

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## ABSTRACT

Using Ecological Momentary Assessment to Clarify the Function of Hoarding

by

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Utah State University, 2018

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Hoarding disorder is theorized to be maintained by both negative internal reinforcement (escape/avoidance) and positive internal reinforcement, but these processes have not been examined in the moment. In addition, the function of hoarding behaviors could theoretically be altered by psychological inflexibility. Initial findings suggest that those who hoard may have increased psychological inflexibility, but research is limited and not ecologically sensitive. This study examined the function of hoarding behaviors and the relationship between hoarding and psychological inflexibility in the moment using ecological momentary assessment.

A sample of 31 college students with elevated hoarding symptoms and a matched control group of 29 college students with below-average hoarding symptoms participated in this study. Participants completed a baseline survey, responded to brief questionnaires delivered over their mobile phones for one week, and completed a final online survey.

Emotional reactivity and experiential avoidance were both elevated in the higher

hoarding group compared to controls, while mindfulness was lower and the two groups did not differ in emotion differentiation. The two groups did not differ in what function they reported acquiring served, and positive internal reinforcement was the most commonly reported function in both groups. Engaging in hoarding-relevant behaviors did not predict change in positive or negative affect when controlling for previous affect. In general, the trajectory of affect did not change prior to or after hoarding behaviors, although some exceptions were found (for example, positive affect increased in the time after working with items for those in the hoarding group, but decreased for those in the control group).

Overall, these findings support the importance of psychological inflexibility in hoarding, but suggest that hoarding behaviors may not actually serve to regulate affect in the moment and may be driven largely by other processes. They also suggest a possible discrepancy between intended function of hoarding behaviors and the actual impact of these behaviors on affect. Finally, they highlight the importance of understanding positive affect in hoarding. It may be useful to evaluate processes such as clinging to positive affect in hoarding disorder in the future.

## PUBLIC ABSTRACT

## Using Ecological Momentary Assessment to Clarify the Function of Hoarding

Jennifer Krafft

Experts have argued that hoarding disorder occurs in part because hoarding behaviors help individuals avoid distress and feel positive emotions in the moment. For example, when people who hoard choose to save something rather than discard it, they may avoid feelings of anxiety, and when people who hoard acquire something new, they may feel excited. However, no previous studies have examined whether or not these changes actually occur in the moment. These processes could also potentially be altered by how individuals respond to their emotions in the moment. For example, individuals who hoard may have stronger emotional reactions, distinguish less between different emotions, tend to avoid their emotions more, or tend to be inattentive of their experience, which could change how their emotions in the moment affect their behavior.

Therefore, this study examined whether or not the anticipated effects of hoarding behaviors on mood occurred, and whether or not there were differences between those with higher and lower hoarding scores on how they respond to their emotions, in a sample of 61 college students. Participants completed two online surveys one week apart, and responded to questions on their mobile phone throughout the week.

As expected, the students with higher hoarding scores had stronger emotional reactions to stress, avoided their emotions more often, and were less attentive to their ongoing experience. Both those with higher hoarding scores and lower hoarding scores

reported that they acquired new items primarily to feel good. However, acquiring, discarding, working with items, and looking for items did not change either group's mood in the moment. Overall, these findings suggest that people who hoard do have differences in how they respond to their emotions, which could mean that treatments that target these responses may be useful for these people. They also show the importance of understanding why working to put yourself in a good mood through acquiring is problematic for some people and not others, and suggest that there may be a difference between how these behaviors are intended to perform and their actual results.

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Jennifer Krafft

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## **CHAPTER I**

### **INTRODUCTION**

In recent years research on hoarding disorder (HD) has accelerated, and HD has been identified as a distinct disorder in DSM-5 (American Psychiatric Association [APA], 2013b). However, research on how hoarding develops and is maintained is limited in important ways. Empirical investigations into the functions of hoarding behaviors are lacking, and previous research relies heavily on global self-report, limiting its generalizability. In addition, previous findings suggest that the psychological inflexibility model of psychopathology may be useful for developing a full understanding of the functions of hoarding. However, research applying this model to hoarding is very limited. This study is intended to clarify the function of hoarding behaviors by applying the psychological flexibility model and an ecologically valid study design in order to improve generalizability and better assess context. The primary aim of this study is to generate novel treatment targets that can potentially improve outcomes in hoarding.

## **CHAPTER II**

### **LITERATURE REVIEW**

#### **Hoarding Disorder**

Hoarding disorder has an estimated prevalence of 2-5% (Iervolino et al., 2009; Samuels et al., 2008) and is linked to high functional impairment, including impairment in work, home life, and relationships (Drury, Ajmi, Fernández De La Cruz, Nordsletten, & Mataix-Cols, 2014); higher rates of medical concerns, mental health utilization, and eviction (Tolin, Frost, Steketee, Gray, & Fitch, 2008); and family strain (Tolin, Frost, Steketee, & Fitch, 2008). However, research on HD is still limited. HD was identified as distinct disorder with the release of DSM-5 in 2013 (APA, 2013b). Previously, hoarding was considered solely a symptom of obsessive-compulsive disorder or obsessive-compulsive personality disorder; however, recent research has provided evidence that it is best understood as a distinct disorder (APA, 2013b).

The main diagnostic criteria for HD are difficulty discarding possessions due to distress associated with discarding, extensive clutter causing living areas to become unusable, and clinically significant distress or impairment caused by the hoarding. Excessive acquisition can be applied as a specifier (APA, 2013a).

#### **Treatment of Hoarding Disorder**

Despite the high prevalence and negative consequences of hoarding, there has been limited research on the treatment of HD to date. No treatments have sufficient

research evidence to be considered empirically supported for HD (Division 12 of the APA, 2018). The primary treatment that has been tested for HD is a modified form of CBT for hoarding, which includes motivational interviewing, decision-making training, exposure, and cognitive restructuring to address hoarding-related cognitions (Steketee, Frost, Tolin, Rasmussen, & Brown, 2010).

The efficacy of CBT for hoarding has now been tested in 10 clinical trials and a recent meta-analysis found that CBT for hoarding had large effect sizes in decreasing hoarding severity (Tolin, Frost, Steketee, & Muroff, 2015). However, rates of clinically significant change ranged from 24-43% and post-treatment scores were typically closer to the disordered range than normal range (Tolin et al., 2015). In addition, it is important to note that the mean number of sessions in these trials was 20.2, significantly higher than is typical for the treatment of anxiety disorders (for example, one systematic review reported a mean of 11.3 sessions in a total of 87 studies assessing CBT for anxiety; Loerinc et al., 2015). This indicates that there are serious limitations in hoarding treatment despite an intensive time commitment for the therapist and client. In addition, trials of CBT for hoarding have found high rates of treatment refusal (Steketee et al., 2010) and dropout (Tolin, Frost, & Steketee, 2007), and therapists report difficulty making progress due to low motivation and lack of compliance (Steketee et al., 2010). For example, one waitlist-controlled trial of CBT for hoarding reported that on average it took 49 weeks to complete 26 therapy sessions, although the sessions had been intended to occur weekly (Steketee et al., 2010).

These results show that CBT for hoarding is generally efficacious, but there are

persistent problems with dropout and compliance, and a significant proportion of participants do not show clear improvement even after treatment is complete. Researchers have noted that CBT for hoarding has not reached a level of success that would put it on par with other evidence-based interventions for anxiety and OCD (Muroff, Steketee, Frost, & Tolin, 2014). In order to treat hoarding more effectively, it is important to develop a strong theoretical understanding of the development and maintenance of hoarding symptoms. One route to develop a clearer understanding of hoarding is to rigorously investigate the functions of hoarding behaviors as they occur.

### **Function of Hoarding Behaviors**

Research on the function of hoarding behaviors is quite limited, and there is a particular lack of ecologically sensitive research. One theoretical perspective that may be especially helpful in examining the function of hoarding is that of contextual behavioral science (CBS; e.g. Vilaradaga, Hayes, Levin, & Muto, 2009). From a CBS perspective, it is important to focus on function because understanding function tells us about the conditions under which a behavior occurs, which in turn provides information about factors that can be targeted in treatment. Applying a contextual behavioral approach to hoarding research could greatly improve models of hoarding by clarifying the basic functions involved in hoarding symptoms in daily life and modifiable psychological processes that are linked to those functions.

Studying psychopathology from a functional perspective can provide novel insights into the conditions under which problem behaviors occur. For example, a study

investigating a functional understanding of non-suicidal self-injury found that it was performed far more often for intrapersonal reinforcement than interpersonal reinforcement, highlighting the importance of targeting intrapersonal processes in treatment (Nock, Prinstein, & Sterba, 2009). In the case of hoarding, clarifying common antecedents and consequences of hoarding symptoms as well as functional processes that are linked to hoarding symptoms may help to develop more effective interventions.

Avoidance is considered to be the central function of hoarding behavior in the cognitive-behavioral model (Frost & Hartl, 1996). By not discarding items, individuals can avoid making a decision, avoid harm that might arise from making an incorrect decision, avoid distress associated with discarding such as anxiety or grief, and avoid the effort involved in tackling clutter (Frost & Hartl, 1996). Steketee and Frost (2003) also note that individuals with HD may acquire items in order to avoid distress associated with not acquiring a desired object. Several studies have provided initial support for the hypothesized avoidance function of hoarding (Ayers, Castriotta, Dozier, Espejo, & Porter, 2014; Grisham, Norberg, Williams, Certoma, & Kadib, 2010; Müller et al., 2012; Wheaton, Abramowitz, Franklin, Berman, & Fabricant, 2011; Wincze, Steketee, & Frost, 2007). Two studies have found that individuals with hoarding problems reported greater anxiety than comparison groups both before and after categorization tasks, providing some support for the hypothesis that discarding may be particularly distressing for individuals with hoarding problems, and therefore not discarding may serve an avoidance function (Grisham et al., 2010; Wincze et al., 2007). In addition, Müller et al. found that negative affect decreased significantly, while positive affect did not change, after a

compulsive buying episode. However, this study only focused on compulsive buying, and it is not clear if the results can be generalized to those with HD.

Several correlational studies have also investigated the hypothesized avoidance function of hoarding. One survey study found that behavioral avoidance was related to clutter, and experiential avoidance was related to acquisition and difficulty discarding in a sample of individuals with HD (Ayers et al., 2014). Another study in a clinical community sample found no significant association between hoarding measures and AAQ-II total scores (Fernández de la Cruz et al., 2013); however, experiential avoidance was lower in the hoarding group than in controls. In addition, experiential avoidance was significantly associated with hoarding symptoms in one unscreened college student sample (Wheaton et al., 2011). However, in another study, experiential avoidance was not related to hoarding symptoms in hoarding patients after controlling for depression, anxiety and stress (Wheaton, Fabricant, Berman, & Abramowitz, 2013). These mixed findings may indicate that other functions should be considered in addition to avoidance.

Several hoarding researchers have noted that hoarding behaviors may serve other functions in addition to avoidance (Grisham & Barlow, 2005; Raines, Allan, Oglesby, Short, & Schmidt, 2015; Tolin, 2011); however, empirical studies are lacking on these hypothesized functions. Acquisition is often described as appetitive and positively reinforced, suggesting that this behavior may represent a problem of impulse control (Tolin, 2011). A psychometric investigation of the Saving Inventory-Revised (SI-R) using confirmatory factor analysis in a mixed-diagnosis outpatient sample found two distinct subfactors for acquisition, an urge-related factor and a distress-related factor,

which supports the hypothesis that positive and negative emotions may both play a role in acquisition behavior (Raines et al., 2015). It is also possible that not just acquisition but also saving behavior itself may be positively reinforced when the possessions are a source of enjoyment or comfort (Grisham & Barlow, 2005).

Hoarding researchers also note that individuals who hoard often consider possessions as an extension of one's identity, which suggests a possible automatic positive reinforcing function (Frost, Kyrios, McCarthy, & Matthews, 2007). Similarly, a recent case study on hoarding in individuals with Asperger syndrome suggests that hoarding may play a role in establishing personal identity (Skirrow, Jackson, Perry, & Hare, 2015).

In addition to intrapersonal functions, some qualitative research also suggests that hoarding may serve social functions. An ethnography of hoarding among older adults found that in addition to serving to relieve anxiety, several participants reported that they hoard items in part because of the belief that they may be useful to others (Andersen, Raffin-Bouchal, & Marcy-Edwards, 2008). However, it appears no other studies have considered possible social functions of hoarding.

The hypothesized functions of hoarding suggest that hoarding behaviors play an important role in managing emotions, particularly distress. Therefore, specific vulnerabilities in the area of emotion regulation (i.e., emotional intensity, deficits in coping) could contribute to escape or avoidance functions of hoarding. In recent years several studies have found evidence supporting the proposition that emotion regulation difficulties are related to hoarding (Shaw, Timpano, Steketee, Tolin, & Frost, 2015;

Timpano, Shaw, Cogle, & Fitch, 2014).

First, hoarding has been found to be associated with greater emotional reactivity. In an analogue study using an undergraduate convenience sample, participants who reported greater difficulty discarding and acquisition also reported higher intensity and intolerance of negative emotions when exposed to emotional film clip stimuli (Timpano et al., 2014). Another study using a sample of individuals with self-reported hoarding difficulties found that general emotional reactivity measured with the Emotion Reactivity Scale (ERS; Nock, Wedig, Holmberg, & Hooley, 2008) was associated with difficulty discarding and acquisition, although not clutter, after controlling for covariates (Shaw et al., 2015). A latent profile analysis also found that emotional reactivity was heightened in two of three latent classes (depressed and depressed-inattentive) among those with clinically significant hoarding (Hall, Tolin, Frost, & Steketee, 2013). This suggests that people who hoard may experience unusually intense emotional reactions, enhancing the avoidance function of acquiring or not discarding.

In addition, hoarding has been linked to lower emotional clarity. Scores on the 'Lack of emotional clarity' subscale of the Difficulties in Emotion Regulation Scale (DERS; Gratz & Roemer, 2004) were found to be higher in hoarding than control participants in Fernández de la Cruz et al. (2013) and Hayward (2011), indicating that people who hoard may have less clear knowledge of the emotions that they experience. However, lack of emotional clarity was not found to be significantly associated with hoarding symptoms in Fernández de la Cruz et al. Hayward also compared individuals with HD to controls on state emotion regulation measured by the Difficulties in Emotion

Regulation Scale-State Version (DERS-S; McLaughlin, Mennin, & Farach, 2007) during a series of sorting tasks. Individuals with HD had significantly lower scores on the 'Lack of emotional clarity' subscale of the DERS-S after a personally relevant sorting task that began with an anxiety induction than after a non-personally relevant sorting task that began with a relaxation induction, while controls did not significantly differ across conditions (Hayward, 2011).

The ability to recognize emotions with precision has important implications for how emotions affect behavior. People who are more skilled at differentiating emotions employ a wider variety of emotion regulation strategies when experiencing negative emotions (Barrett, Gross, Christensen, & Benvenuto, 2001). When a person can differentiate negative emotions clearly, for example as "angry" or "sad" rather than just feeling "bad," they gain important information about how they can respond. If people who hoard tend to experience undifferentiated, global distress when they consider discarding, this may contribute to rigid avoidance of discarding, while being able to differentiate their emotions more clearly could lead to recognizing alternative behavioral options.

As a whole, past studies provide some evidence to support the hypothesized avoidance function of hoarding behavior. However, systematic research is lacking on the other possible functions that hoarding may serve, including social functions. In addition, no ecologically valid research has been conducted on the function of hoarding behaviors or emotional processes that may be linked to these functions. For example, there is no systematic research on changes in mood before and after discarding or acquisition, which

could help to evaluate the hypothesized role of hoarding behaviors in regulating affect. Past studies of this nature have made significant contributions in clarifying the functions of problem behaviors such as compulsive buying (Müller et al., 2012) and binge eating (Haedt-Matt & Keel, 2011). It is also important to note that while managing distress is considered to be central to the function of acquisition and not discarding, CBT for hoarding does not include any techniques that are focused on enhancing emotion regulation, and to the best of my knowledge no studies have tested interventions for emotion regulation in hoarding. Understanding the functions of hoarding behavior in context, as well as how affect relates to these functions, may clarify the conditions which hoarding behavior is most likely to occur and how to effectively intervene.

### **Psychological Flexibility and Hoarding**

One major benefit to focusing on function is that a functional conceptualization of hoarding could suggest specific intervention strategies based on well-established behavioral principles. For example, if hoarding is reinforced socially through attention from family members, the individual who hoards could be taught appropriate social skills to seek attention in an alternative manner.

However, a growing body of research indicates that due to the nature of human language and cognition, stimuli can acquire new functions through verbal networks without direct learning experience (Hayes, Barnes-Holmes, & Roche, 2001). As a result, behavior may be guided by verbal networks rather than the contingencies in the environment (Hayes, Luoma, Bond, Masuda, & Lillis, 2006). In hoarding, this could

mean that a thought such as “I need to have this” could itself become anxiety-provoking and trigger avoidance of discarding, regardless of the contingencies of actual discarding. Therefore, considering psychological processes that may contribute to the functions of hoarding such as how individuals relate to their internal experiences could also help to identify novel treatment targets.

The psychological flexibility model of psychopathology, which is rooted in contextual behavioral science (Hayes, Strosahl, & Wilson, 1999), has the potential to organize the basic functions that hoarding may serve as well as psychological processes that are tied to those functions in a theoretically coherent manner. The psychological flexibility model is connected to a program of basic research on human language and cognition from a behavioral perspective called Relational Frame Theory (RFT; Hayes et al., 2001). RFT provides a framework for understanding how cognitive processes affect basic behavioral processes. The psychological flexibility model is also linked to an evidence-based psychotherapy, Acceptance and Commitment Therapy (ACT; Hayes et al., 1999).

ACT is organized around six core processes (acceptance, cognitive defusion, present-moment awareness, a transcendent sense of self, personal values, and committed action) that combine to alter the function of internal experiences and foster psychological flexibility: the ability to be in contact with the present moment as it is, without defense, and persist in behavior in order to pursue your values. ACT is theorized to work by targeting these six processes, largely using metaphors and experiential exercises (Hayes, Pistorello, & Levin, 2012). One advantage to applying this model is that there is

significant evidence from laboratory component studies that targeting these processes leads to theoretically consistent positive outcomes (Levin, Hildebrandt, Lillis, & Hayes, 2012). Therefore, investigating psychological flexibility in hoarding could suggest novel treatment targets that are already empirically supported as processes of change.

A comprehensive program of research is needed to understand whether or not psychological inflexibility contributes to hoarding disorder. However, at a conceptual level the psychological flexibility model suggests several psychological processes that may be connected to or alter the functions of hoarding (e.g., avoidance, social reinforcement, automatic positive reinforcement). For example, saving belongings may be linked to experiential avoidance, the unwillingness to remain in contact with certain private experiences such as sensations, emotions, or thoughts (Hayes et al., 2004). Importantly, experiential avoidance may occur in response to private events like thoughts. In the case of hoarding, this suggests that merely having a thought such as “I might make a mistake by getting rid of something I want later” could trigger experiential avoidance, whether or not this type of outcome has actually occurred.

Experiential avoidance may also interact with the heightened emotional reactivity that has been found in hoarding populations. If people who hoard experience especially intense negative emotional reactions, it is natural that they would engage in experiential avoidance more often. In addition, several studies have found that there are paradoxical effects of attempts to suppress emotions (Campbell-Sills, Barlow, Brown, & Hofmann, 2006; Levitt, Brown, Orsillo, & Barlow, 2004). Therefore, patterns of experiential avoidance may actually result in higher reactivity. Laboratory studies support the

hypothesis that individuals who engage in more experiential avoidance also have higher reactivity to emotional or anxiety-inducing stimuli (Feldner, Zvolensky, Eifert, & Spira, 2003; Sloan, 2004). Experiential avoidance is contrasted with acceptance, the active willingness to have internal experiences without making attempts to change them (Hayes et al., 2012).

Another process implicated in psychopathology by the psychological flexibility model is a lack of present-moment awareness. When attention is directed inflexibly, individuals can become absorbed in stories about the past or the future and miss important moment-by-moment information. In contrast, when attention is directed flexibly, individuals can experience difficult thoughts, feelings or sensations while still directing their attention and behavior in a purposeful manner (Hayes et al., 1999).

Individuals who hoard may pay attention to stories about the future, such as concerns that they might feel regret if they discard something, and not notice what is occurring in the present moment, internally or externally. Inflexible attention could alter the functions of hoarding behavior because individuals who hoard may pay more attention to expected consequences of acquiring or discarding than to how they actually feel when acquiring or discarding items. For example, Frost and Steketee (1999) describe a client who reported that she “[felt] like [she] wanted to die” when considering discarding a beloved book, but whose distress decreased so rapidly that she reported a Subjective Units of Distress Score of zero only two minutes later. Rigid attention to feared consequences of discarding may enhance the avoidance function of saving, making individuals who hoard insensitive to the actual consequences of discarding.

There are also theoretical links between present-moment awareness and emotion differentiation. When an individual brings more attention to their ongoing experience, they can notice their internal experiences in greater detail. Consistent with this theoretical connection, mindfulness has been found to be associated with greater emotion differentiation in previous research (Hill & Updegraff, 2012). Individuals who hoard may be less mindful of their ongoing experience, and therefore have more difficulty differentiating specific emotions, which leads to inflexible behavioral responses.

The psychological flexibility model also posits that cognitive fusion (the tendency for individuals to perceive thoughts literally and allow thoughts to exert rigid control over behavior; Hayes et al., 2012), rigid sense of self, lack of clarity around personal values, and lack of action consistent with values can contribute to problem behavior. It is important to mention that avoiding internal experiences and attending to thoughts about the past or future are not considered to be fundamentally pathological. Instead, it is rigid application of these processes, to the extent that an individual loses contact with actual environmental contingencies and can no longer pursue valued aims, that is dysfunctional (Plumb, Stewart, Dahl, & Lundgren, 2009).

As such, new insights into hoarding could be gained by testing not just whether or not hoarding is linked to greater experiential avoidance and decreased present-moment awareness, but also whether these processes are engaged rigidly, without sensitivity to the situation. For example, if an individual distracts herself to avoid discomfort while getting a filling at the dentist, but is open to the discomfort of not acquiring something she wants, this would be flexible, context-dependent engagement of avoidance and acceptance.

However, if an individual distracts herself from every uncomfortable experience, her behavior will be restricted. Therefore, it is important to assess not just the level of engagement in psychologically inflexible processes, but also the variability in engagement of these processes across different contexts.

### **Preliminary Research on Psychological Flexibility Processes and Hoarding**

Although research investigating psychological flexibility in hoarding behavior is very limited, several findings in the literature on hoarding provide indications that psychological flexibility may be linked to hoarding symptoms. Only one study has examined multiple components of psychological flexibility in the context of hoarding (Ong, Krafft, Levin, & Twohig, 2018). This study found that in a series of cross-sectional mediation models, psychological inflexibility, inattention, and values obstruction mediated the association between distress and hoarding symptoms, and that psychological inflexibility, cognitive fusion, and lack of values progress mediated the association between hoarding symptoms and life satisfaction (Ong et al., 2018). Although this study requires replication using longitudinal data in a clinical sample, it supports the potential role of psychological inflexibility as a process that may explain the context in which distress leads to hoarding symptoms.

As described above, experiential avoidance has been linked to hoarding behavior in several studies, with somewhat mixed results (Ayers et al., 2014; Fernández de la Cruz et al., 2013; Wheaton et al., 2011, 2013). Several survey studies have also connected

hoarding to the related construct of distress tolerance, an unwillingness or inability to tolerate negative emotions (Timpano, Keough, Traeger, & Schmidt, 2011; Timpano et al., 2014). While distress tolerance and experiential avoidance are two distinct concepts, they do share conceptual overlap in that they both involve the inability or unwillingness to remain in contact with unpleasant internal states.

There are also several studies in the literature that suggest a possible connection between hoarding and present-moment awareness, another process entailed in psychological flexibility. Inattention has been found to be related to hoarding in numerous studies (Burton et al., 2016; Fullana et al., 2013; Hall et al., 2013; Hartl, Duffany, Allen, Steketee, & Frost, 2005; McMillan, Rees, & Pestell, 2013; Raines, Timpano, & Schmidt, 2014; Tolin & Villavicencio, 2011). Timpano et al. (2013) also found that hoarding was linked to attentional impulsivity, and Carbonella and Timpano (2015) found specific deficits in cognitive flexibility, the ability to ignore irrelevant material and shift attention smoothly from task to task. While inattention and present-moment awareness are distinct concepts, present-moment awareness relies on focused and flexible allocation of attention.

While the connections linking hoarding to present-moment awareness and experiential avoidance are tentative, they suggest that the psychological flexibility model may be a useful way to conceptualize hoarding. Studying these processes could provide novel intervention targets in the treatment of hoarding disorder, particularly in the capacity to respond to emotion more effectively, which could alter the functions of hoarding behaviors. ACT contains many techniques that target processes like experiential

avoidance and rigid attention in order to enhance individuals' abilities to pursue valued actions even when experiencing difficult thoughts and feelings. In accordance with these theoretical aims, ACT has been found to have a decoupling effect in which the typical impact of internal experiences on outcomes is reduced, in 44 studies (Levin, Luoma, & Haeger, 2015).

In hoarding, this could mean that targeting psychological flexibility processes might help people with HD to engage in discarding or non-acquisition behavior even if they continue to experience emotional distress. The results of this study could indicate that targeting experiential avoidance and present-moment awareness to increase behavioral flexibility might be helpful in interventions for hoarding disorder. It is especially important to consider alternative treatment paradigms and targets given the limited success of existing treatments for HD.

### **Use of Ecological Momentary Assessment**

Some of the mixed findings on psychological processes related to hoarding such as experiential avoidance may be due to overreliance on global self-report for data collection. There are several well-known limitations to relying on global self-report including natural limitations of memory and recall bias (Shiffman, Stone, & Hufford, 2008). The validity of global self-report also depends heavily on someone's ability to accurately report their experiences over time. Individuals with HD are often described as having low insight into the severity of their hoarding problem (see Frost, Tolin, & Maltby, 2010, for a review). The finding of Fernández de la Cruz et al. (2013) that

individuals with HD may have low emotional clarity also suggests that providing accurate self-report may be especially difficult for individuals who hoard.

Given these issues of insight, using more immediate forms of assessment may enhance the accuracy of the data collected. In addition, global self-report measures and laboratory studies by their very nature are not designed to capture the dynamics of behavior across different situations. For instance, rather than using global self-report measures which require self-reflection to assess the ability to differentiate emotions, researchers have been able to capture emotion differentiation more directly by measuring the extent to which individuals distinguish between different negative or positive emotions at specific time points in their daily lives (Kashdan & Farmer, 2014).

Ecological momentary assessment (EMA) was used in this study to investigate these relationships in daily life and address these limitations. Although it may still rely on self-report, EMA has a number of advantages compared to other methods of data collection. The use of immediate assessment can increase the accuracy of the data collected by minimizing the effects of retrospective biases, enhance generalizability by collecting data in an ecologically valid manner, and help to identify context-specific relationships such as how daily stressors and mood relate to psychopathology symptoms (Ebner-Priemer & Trull, 2009). Gathering intensive longitudinal data also makes it possible to investigate variability in psychological processes over time and across different contexts, beyond overall levels, which can help answer questions about whether psychological processes are engaged rigidly or flexibly.

EMA results can provide an important complement to other forms of data

collection; for example, a meta-analysis of EMA studies on binge eating found that negative affect did not decline following binge eating, casting doubt on the affect regulation model of binge eating (Haedt-Matt & Keel, 2011). Unexpected results such as these highlight the importance of evaluating models of psychopathology in the context of daily life.

Using EMA permitted this study measure daily dynamics of mood and emotion regulation as they relate to hoarding symptoms, while avoiding the threats of retrospective bias and limitations to insight, and enhancing the ecological validity of the findings. In addition, this study assessed contextual factors and psychological processes in a naturalistic context to help provide information on variables that can be directly targeted in the treatment of HD. Overall this study aimed to use EMA to understand the function that hoarding behaviors serve in context and the relevance of psychological flexibility processes to hoarding in daily life.

### **Research Questions**

Several important gaps emerged from this review of the literature on hoarding disorder. First, multiple hypotheses existed about the function of hoarding behaviors. Yet, these hypotheses had not been examined in the context of daily behavior, and no studies had considered the full range of possible functions that hoarding behaviors might serve. Also, preliminary evidence from the literature suggested that conceptualizing hoarding from a psychological flexibility perspective may be useful. Finally, previous research on hoarding disorder had relied heavily on global self-report measures. Studying hoarding

symptoms and psychological processes in a more naturalistic context could capture environmental and contextual factors that affect how hoarding symptoms occur in daily life and enhance ecological validity.

This study proposed to investigate the function of hoarding and psychological flexibility processes relevant to hoarding in an EMA framework. The study utilized a matched subjects design, in which a group of individuals with elevated hoarding symptoms were compared with a matched control group, in order to answer the research questions below. Questions 1-4 regard investigating the relationship of hoarding to psychological flexibility, based on past findings which suggest these specific constructs may be relevant. Questions 5-7 regard clarifying the patterns of mood around hoarding behaviors for each group and better understanding the function of acquisition. The questions investigated by this study are:

1. Does the hoarding group have lower emotion differentiation?
2. Does the hoarding group have higher or less variable emotional reactivity?
3. Does the hoarding group report higher or less variable levels of experiential avoidance?
4. Does the hoarding group report lower or less variable levels of mindfulness?
5. Do the two groups report different functions of acquisition?
6. Does engaging in a hoarding-relevant behavior predict affect?
7. What is the trajectory of affect in the period before and in the period after a hoarding-relevant behavior?

## **CHAPTER III**

### **METHODS**

#### **Study Design**

This study utilized EMA in an analogue group comparison design. A group of participants with elevated hoarding symptoms were compared to a group of matched controls using self-report data collected at regular intervals over one week through a mobile app. This approach allowed for a direct comparison between the responses of the nonclinical hoarding group and controls.

#### **Participants**

This study used a convenience sample of undergraduate students. Inclusion criteria were: (1) being 18 years of age or older, (2) being a student at Utah State University, and (3) having a score of 34 or higher on the SI-R, or being matched on age and gender to a participant in the higher hoarding group and having a score of 21 or lower on the SI-R. Sixty-two individuals participated in this study. One was removed for completing the screening procedure twice with markedly different responses, and another participant was removed for failing to complete the minimum of five EMA questionnaires. This resulted in a final sample of 31 individuals in the high hoarding symptoms group and 29 individuals in the low hoarding symptoms group. Both groups were young, predominantly female, and mostly non-Hispanic and White, with a median income in the \$40,000-\$59,999 bracket (see Table 1 for details). In both groups, most

Table 1

*Demographic Information*

| Variable                     | Low hoarding group ( <i>n</i> = 29) |       |                     |      | High hoarding group ( <i>n</i> = 31) |          |       |                     | Difference |          |                              |
|------------------------------|-------------------------------------|-------|---------------------|------|--------------------------------------|----------|-------|---------------------|------------|----------|------------------------------|
|                              | <i>n</i>                            | %     | Mean                | SD   | Range                                | <i>n</i> | %     | Mean                |            | SD       | Range                        |
| Hoarding symptoms            |                                     |       | 17.65               | 4.88 | 7 to 1                               |          |       | 46.71               | 8.01       | 37 to 64 | $t(47.30) = 18.96, p < .001$ |
| Depression                   |                                     |       | .57                 | .56  |                                      |          |       | 1.24                | .93        |          | $t(49.84) = 3.35, p = 0.002$ |
| Age                          |                                     |       | 20.41               | 2.16 | 18 to 27                             |          |       | 22.74               | 4.88       | 18 to 37 | $t(41.95) = 2.41, p = 0.02$  |
| Gender                       |                                     |       |                     |      |                                      |          |       |                     |            |          | $\chi^2(1) = 0.02, p = 0.88$ |
| Female                       | 22                                  | 75.86 |                     |      |                                      | 23       | 74.19 |                     |            |          |                              |
| Male                         | 7                                   | 24.14 |                     |      |                                      | 8        | 25.81 |                     |            |          |                              |
| Ethnicity                    |                                     |       |                     |      |                                      |          |       |                     |            |          | $\chi^2(1) = 0.00, p = 0.96$ |
| Hispanic                     | 1                                   | 3.45  |                     |      |                                      | 1        | 3.23  |                     |            |          |                              |
| Non-Hispanic                 | 28                                  | 96.55 |                     |      |                                      | 30       | 96.77 |                     |            |          |                              |
| Race                         |                                     |       |                     |      |                                      |          |       |                     |            |          | $\chi^2(1) = 4.61, p = 0.26$ |
| Asian                        | 0                                   | 0     |                     |      |                                      | 2        | 6.45  |                     |            |          |                              |
| Biracial                     | 0                                   | 0     |                     |      |                                      | 1        | 3.23  |                     |            |          |                              |
| White                        | 29                                  | 100   |                     |      |                                      | 27       | 87.10 |                     |            |          |                              |
| Other                        | 0                                   | 0     |                     |      |                                      | 1        | 3.23  |                     |            |          |                              |
| Household income (median)    |                                     |       | \$40,000 - \$59,999 |      |                                      |          |       | \$40,000 - \$59,999 |            |          | $\chi^2(6) = 4.61, p = 0.59$ |
| Moving status                |                                     |       |                     |      |                                      |          |       |                     |            |          | $\chi^2(1) = 0.65, p = 0.42$ |
| Moved                        | 5                                   | 17.24 |                     |      |                                      | 8        | 25.81 |                     |            |          |                              |
| Have not moved               | 24                                  | 82.76 |                     |      |                                      | 23       | 74.19 |                     |            |          |                              |
| Living status                |                                     |       |                     |      |                                      |          |       |                     |            |          | $\chi^2(1) = 3.68, p = 0.06$ |
| Alone                        | 1                                   | 3.45  |                     |      |                                      | 6        | 19.35 |                     |            |          |                              |
| With roommate(s)             | 28                                  | 96.55 |                     |      |                                      | 25       | 80.65 |                     |            |          |                              |
| EMA questionnaires completed |                                     |       | 19.59               | 4.98 |                                      |          |       | 17.65               | 4.88       |          | $t(57.57) = -1.53, p = 0.13$ |

participants had not moved recently and most lived with roommates.

Multiple recruitment and screening methods were employed for this study. This study was advertised with flyers and class announcements and potential participants could complete a study-specific online screener. Students interested in another EMA study conducted by the researchers were concurrently screened for this study if they were willing. Finally, participants who completed a recent survey study conducted by the researchers were also contacted about participating if they met eligibility criteria and expressed interest in participating in additional studies. Participants were screened for age, gender, and hoarding symptoms in order to ensure eligibility and match groups appropriately. The experimenter matched the groups on age and gender as closely as possible depending on availability, and recruited and ran hoarding group and control group participants in close succession in order to limit the effects of time as a potential confound.

Participants were offered research credit and a gift card for their participation. Participants received up to 3.5 Sona research participation credits for completing participation in the study, including the post-assessment. Participants received 0.5-1 research participation credit after the initial meeting with the experimenter (depending on whether or not they had already provided baseline data in the previous survey study), 1 additional credit for completing at least 5 prompts, 0.5 bonus credits if they completed at least 80% of prompts, and 1 credit for completing the post-assessment. Participants also received an Amazon.com gift card for an amount commensurate to each step completed in the study (\$3 for initial meeting, \$0.25 for each prompt completed during the EMA

period, and \$5 for filling out the post-assessment, a possible total of \$15).

The hoarding group consists of those scoring above 33 on the Saving Inventory-Revised (SI-R; Frost, Steketee, & Grisham, 2004), a measure of hoarding symptoms, in the screening survey study. This cutoff was previously used in a similar analogue study, Timpano and Schmidt (2013). The control group was drawn from those scoring at or below 21. In previous studies with undergraduate students, means on the SI-R have ranged from 18.4 (Timpano, Buckner, Richey, Murphy, & Schmidt, 2009) to 24.1 (Wheaton et al., 2011). Therefore, selecting participants with scores of 21 or lower on the SI-R helped ensure that there were differences between the hoarding group and control group on hoarding symptoms.

Although it would have been preferable to use a clinical sample, the use of a nonclinical sample is acceptable because hoarding symptoms are distributed dimensionally in the population (Timpano et al., 2012). Many previous studies on hoarding symptoms have successfully used unscreened student samples (Coles, Frost, Heimberg, & Steketee, 2003; Timpano et al., 2009, 2014; Wheaton et al., 2011). In addition, retrospective studies have found an average age of onset of hoarding ranging from 14 to 20 (see Tolin, Meunier, Frost, & Steketee, 2010, for a review), with severity increasing over time. These results suggest that hoarding symptoms are likely to be present at this age, even if they are not yet severe.

A sample of 60 participants was proposed, which would have provided power = .97 to detect group differences for a medium effect size (Cohen's  $d = 0.5$ ) using a two-tailed paired samples  $t$  test. A total of 62 individuals participated in the study, and 2 of

those participants were removed from analyses, providing the full proposed sample. Although this is a small sample, the collection of intensive longitudinal data also helped to increase power. In addition, previous EMA studies have successfully used similar sample sizes to detect significant effects (Beckham et al., 2008; Fulford, Johnson, Llabre, & Carver, 2010; Knowles et al., 2007; Pfaltz, Michael, Grossman, Margraf, & Wilhelm, 2010).

### **Procedures**

Participants first met with the experimenter in person to provide informed consent and receive an explanation of the study procedure. The researcher provided assistance in installing the mobile app on the participant's phone, demonstrated how to make use of the app, described how to respond to prompts, explained the meaning of terms used in the prompts, emphasized the importance of responding to as many prompts as possible, and answered any questions. This training also clarified that the questions about acquisition and discarding refer to specific types of items (not true necessities or items that will be used promptly). The training also clarified that the question about function may be difficult to answer, as they may have acquired an item primarily for other reasons, but that they should select whichever response(s) fit best among the provided options, unless none of the responses were applicable. A phone was provided on loan to one participant who did not own an appropriate phone for use with the mobile app. In addition, the researcher contacted each participant one to two days later in order to identify and resolve any difficulties experienced in using the app and increase compliance. The researcher

also monitored compliance through the mobile app platform, and continued to send e-mail reminders every other day to enhance compliance if response rates were low.

This study used the LifeData software platform, which is designed to comply with HIPAA regulations. The mobile app prompted the participants to respond to a brief survey 4 times per day over a period of seven days. Participants had a 15-minute time window in which to respond, based on previous research finding that self-report data change qualitatively after 15 minutes (Delespaul, 1995).

The prompts were administered at random during four specified time intervals evenly distributed throughout the day: 10:00 AM to 1:00 PM, 1:00 PM to 4:00 PM, 4:00 PM to 7:00 PM, and 7:00 PM to 10:00 PM. Each EMA questionnaire included 15 questions. However, if a participant endorsed specific behaviors an additional 1-5 follow-up questions were initiated.

Participants were also asked to complete a brief post assessment, consisting of the SI-R and two questions regarding their living situation (asking if they had moved within the last 2 months and if they lived alone or with others).

Participation in this study was expected to require no more than 3 hours in total (approximately 30 minutes for initial meeting, 2 hours to respond to EMA prompts over one week, and 15 minutes for the post assessment).

## **Measures**

### **Global Assessment Measures**

**Demographic questionnaire.** Demographic information including age, gender,

race/ethnicity, and SES were requested from all participants.

**Saving Inventory-Revised.** The Saving Inventory-Revised (SI-R; Frost et al., 2004) is a self-report measure with 23 items designed to assess hoarding symptoms. Each item is measured on a 5-point scale. It covers the three major areas of hoarding symptoms: excessive acquisition, difficulty discarding, and significant clutter resulting in impairment. Sample items include: *“How much difficulty do you have throwing things away?”* *“To what extent does clutter prevent you from using parts of your home?”* and *“How strong is your urge to buy or acquire free things for which you have no immediate use?”* The SI-R has good internal consistency and acceptable test-retest reliability and has demonstrated good validity (Frost et al., 2004). SI-R results were obtained during the screening stage and at post. Internal consistency was excellent in the present sample ( $\alpha = 0.95$ ).

**Counseling Center Assessment of Psychological Symptoms-34.** The Counseling Center Assessment of Psychological Symptoms-34 (CCAPS-34; Locke et al., 2012) uses 34 items to assess various mental health concerns in college students. The measure has acceptable to good reliability and strong concurrent validity among college students (Locke et al., 2012). Only the depression subscale was used in this study. Sample items include *“I feel sad all the time”* and *“I feel isolated and alone.”* Internal consistency for the depression subscale was good in the present sample ( $\alpha = 0.88$ ).

### **Ecological Momentary Assessment Measures**

The following measures were completed solely through prompts delivered by the mobile app. (See Appendix for the complete list of questions delivered in these prompts.)

**Recent stressors.** Recent stressors were assessed by asking participants if they had experienced any stressful events since the last prompt. Instructions for this question included examples of multiple types of stressful events to provide a common reference for participants.

**Positive and negative affect.** Participants were asked to rate their affect in the present moment on a 5-point Likert scale, from *very slightly or not at all* to *extremely*. This measure included four items assessing positive affect (*content, relaxed, enthusiastic, and joyful*) and four items assessing negative affect (*anxious, angry, sad, and sluggish*). These items were developed by Kashdan and Farmer (2014) to encompass both high-energy and low-energy variants of positive and negative affect in accordance with the circumplex model of emotion (Barrett, 1998). One item was revised slightly for clarity.

**Experiential avoidance.** Experiential avoidance was measured using three items developed by Udachina, Varese, Myin-Germeys, and Bentall (2014) to assess state experiential avoidance (“Since the last prompt my emotions have got in the way of things which I wanted to do,” “Since the last prompt I’ve tried to block negative thoughts out of my mind,” and “Since the last prompt I’ve tried to avoid painful memories”). Each item is scored on a 7-point scale and a total score is calculated by taking the mean of each response. These items were found to have good internal consistency in Udachina et al. (2014) and were also used as an EMA measure in Varese, Udachina, Myin-Germeys, Oorschot, & Bentall (2011). In the present sample these items had adequate internal consistency ( $\alpha = 0.79$ ).

**State mindfulness.** State mindfulness was measured using the state version of the

MAAS (Brown & Ryan, 2003). This measure consists of five items adapted slightly from the MAAS, rated on a 7-point scale. A total score is calculated by averaging the responses. This version of the MAAS has been found to have good reliability and has adequate evidence for validity (Brown & Ryan, 2003). The state MAAS had good internal consistency in this sample ( $\alpha = 0.88$ ).

**Hoarding symptoms.** Hoarding symptoms were assessed by asking participants whether they had acquired new belongings, discarded any belongings, looked through or organized their belongings, and looked for new items to acquire since the last prompt. If participants reported any of these behaviors they were prompted with a follow-up question asking approximately how long ago the behavior occurred.

**Function of acquisition.** If participants indicated that they had acquired something, they were also prompted with a follow-up question asking about the intended function of the behavior. Participants could select multiple responses, with one response each indicating automatic positive reinforcement, automatic negative reinforcement, social positive reinforcement, and social negative reinforcement (Indicate why you bought/acquired the item(s): 1) “Distract myself from thought/feeling,” 2) “Made me feel good,” 3) “To get attention or to get a reaction from someone,” 4) “To escape from a task/people,” 5) “Other”). These items were based on the ones used in Nock et al. (2009) which were derived from the Functional Assessment of Self Mutilation (FASM) measure (Lloyd, Kelley, & Hope, 1997). However, items (1) (2) and (3) were adapted to be more relevant to the current sample and to the assessment of hoarding.

## **Analysis Plan**

Participants were considered nonresponders and excluded from further analysis if they failed to complete a minimum of five EMA questionnaires ( $n = 1$ ). It is standard practice to drop participants with very low response rates from EMA studies (e.g., Bylsma, Taylor-Clift, & Rottenberg, 2011; Kashdan & Farmer, 2014). Missing data were handled using maximum likelihood estimation.

### **Preliminary Analyses**

Demographic information for both groups was calculated and presented, including age (the mean, standard deviation, and range) as well as gender, ethnicity, SES, and living situation of the sample participants as percentages. Groups were compared on demographic variables and SI-R scores using t-tests to determine if there were any key differences on baseline variables. Preliminary analyses were also conducted to calculate compliance with the study procedure in each group and ensure that the groups did not differ significantly in terms of compliance.

It is possible that simply asking participants to report their affect, mental state, and behavior with frequent prompts could have itself caused changes in these variables. Therefore, potential changes in the EMA measures due to study reactivity were tested by computing linear mixed-effects models with time since beginning the study entered as a fixed effect and the EMA measures (negative affect, positive affect, experiential avoidance, mindfulness, and frequency of acquisition, discarding, organizing, and looking for new items) as dependent variables. Group status and age were entered as

covariates, and the interaction of group and time was included to determine if changes in dependent variables over time differed by group. This helped to identify potential changes in responses due to study reactivity.

### **Main Analyses**

First, descriptive statistics were calculated for each group to estimate the frequency and self-reported function of hoarding behaviors. For each group, the mean and standard deviation of the number of hoarding behaviors (acquisition, discarding, working with belongings, and planning acquisition) were calculated. Next, proportions were calculated indicating how often each individual endorsed each function relative to their total acquisition events. The mean and standard deviation of these proportions for each group were also calculated.

In the first main analysis, an overall score for emotion differentiation was calculated and compared for the two groups using a linear regression model.

Next, the hoarding group and control group were compared on emotional reactivity, experiential avoidance, and mindfulness in a series of models. These analyses employed mixed-effects location scale analyses, an extension of mixed-effects regression models that employs log-linear submodels to account for the influence of covariates on between-subjects and within-subjects variance (Hedeker, Mermelstein, & Demirtas, 2008). The MIXWILD program (Hedeker & Dunton, 2018) was used to compute all location scale analyses. Location-scale models allowed for comparisons between the two groups not only on the mean, but also on the variability in the dependent variables. For example, theoretically the hoarding group could have a higher mean for experiential

avoidance and simultaneously experience less variance in experiential avoidance. The models employed a random intercept to account for the multilevel nature of the data (time points within persons). Random slopes were also tested at the participant level to determine whether or not there was a significant amount of variation in the slopes by individual. Adding random slopes would allow the models to account for individual differences in the slope of the dependent variables over time due to study reactivity or other unmeasured individual-level variables. Each model was examined to confirm that it met the assumptions of homoscedasticity and normal distribution of residuals.

Finally, the relationship of hoarding to affect was investigated in two types of mixed-effects models with a random intercept for each participant. First, a series of models tested whether affect was significantly predicted by a hoarding-relevant behavior when controlling for affect at the previous time point. Next, a series of models tested whether there were changes in the trajectory of affect before or after a hoarding-relevant behavior.

For all mixed-effect models, likelihood ratio tests comparing nested models were used to confirm that models with statistically significant terms also improved upon simpler models (i.e., adding the terms resulted in a model that better fit the data). A criterion of  $\alpha = 0.10$  was applied given that these analyses are exploratory and the likelihood ratio test is very conservative (Anisimova, Bielawski, & Yang, 2001).

**Emotion differentiation.** Emotion differentiation was estimated by calculating the two-way random ICCs with absolute agreement between positive/negative affect descriptors across assessment points for each participant (cf., Kashdan & Farmer, 2014

for this method of calculating emotion differentiation). Higher ICCs indicate that an individual is engaging in less differentiation of specific emotions. Two emotion differentiation models were built, one predicting differentiation of positive emotions and another predicting differentiation of negative emotions. Group was entered as a predictor and age as a covariate in these models (due to baseline differences between groups on age). These models tested the question of whether the higher hoarding group differentiated less between specific emotions (positive or negative).

**Emotional reactivity.** Emotional reactivity was assessed by modeling the relationship between experiencing stressors and resulting negative affect. In the first step of the regression model, the presence/absence of recent stressors and group status (hoarding or control group) were entered as predictors, age as a covariate, and negative affect as the dependent variable (a similar method for modeling emotional reactivity has been used in previous studies such as Bylsma et al., 2011). This model tested whether those high in hoarding symptoms generally show higher levels of negative affect or less variable negative affect compared to the control group. Next, an interaction term was entered in the second step to test for an interaction between group status and stressor experience in predicting average levels of negative affect and variability in negative affect. This tested the hypothesis that the hoarding group may experience higher or less variable negative affect only in the context of stress.

**State experiential avoidance.** To compare the groups on state experiential avoidance, group status was entered as a predictor, age was entered as a covariate, and state experiential avoidance (reported during the EMA period) was entered as the DV in

the multilevel regression model. The results of this analysis indicate whether or not individuals high in hoarding engage in more experiential avoidance, or less variable levels of experiential avoidance, in daily life.

**State mindfulness.** To compare the groups on state mindfulness, group status was entered as a predictor, age was entered as a covariate, and state mindfulness (reported during the EMA period) was entered as the DV in the multilevel regression model. The results of this analysis indicate whether or not individuals high in hoarding have lower or less variable levels of mindfulness in daily life.

**Function of acquisition.** It was planned *a priori* to test group differences between the reported function of acquisition in each group by conducting a paired-samples t-test with proportions (number of times the function was endorsed divided by total acquiring events) as the dependent variable. However, the distribution of all proportions was highly non-normal (for some functions, extremely platykurtic and for others, extremely zero-inflated) which prohibited parametric tests. Therefore, these proportions were only reported descriptively. A *post hoc* analysis was added using a binomial mixed-effect model to test whether group significantly predicted endorsing a particular function, controlling for age as a covariate.

**Changes in affect predicted by hoarding-relevant behaviors.** Two approaches were used to assess changes in affect surrounding hoarding behaviors. First, mixed-effects models were employed with affect as a dependent variable, previous affect as a covariate, and the occurrence of specific hoarding-relevant behaviors as a predictor. This tested whether or not hoarding behaviors are predictive of changes in affect from before

to after the behavior. The interaction of group and the behavior was also added to allow for testing if affect changed differentially across the two groups.

**Changes in the trajectory of affect before and after hoarding-relevant**

**behaviors.** Next, mixed-effects models were employed to model changes in affect either before or after hoarding-relevant behavior (acquisition, discarding, organizing, and looking for new items). Past research has found affect to change as a linear, quadratic, and cubic function of problem behaviors such as binge episodes (Engel et al., 2013). Therefore, hours either before or after a hoarding behavior were entered in linear, quadratic, and cubic terms as predictors of positive and negative affect. This approach helps to test whether or not there are significant changes in positive and negative affect before or after hoarding-relevant behaviors occur. The interaction of group and the linear, quadratic, or cubic term for time was also entered as a predictor to determine if there were different trends in affect depending on the group.

## CHAPTER IV

### RESULTS

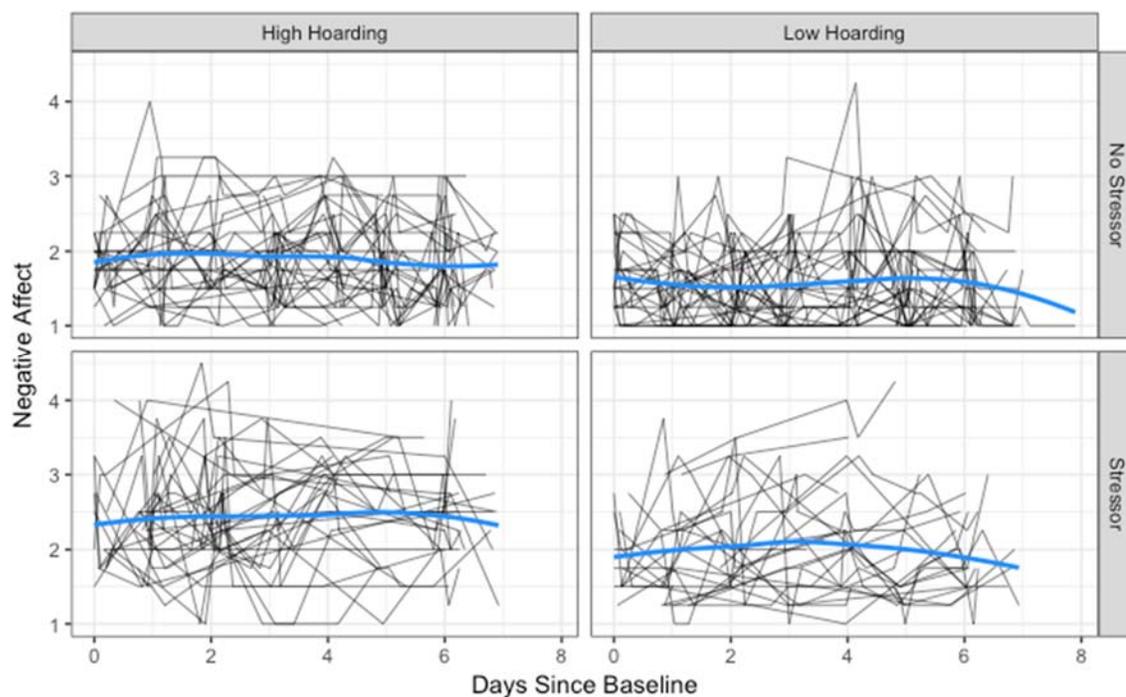
#### Preliminary Analyses

The low hoarding and high hoarding groups were compared on baseline variables to confirm that the two groups had significantly different scores on hoarding symptoms and determine if there were differences on any theoretically relevant variables other than hoarding score. Independent samples *t* tests were used to compare the two groups on numeric variables while chi-square tests of independence were used to compare the two groups on categorical variables (see Table 1 for detailed results). The high hoarding group had significantly higher scores for hoarding symptoms,  $t(47.30) = 18.96$ ; Cohen's  $d = 4.81$ ,  $p < .001$ ); and depression,  $t(49.84) = 3.35$ ,  $d = 0.85$ ,  $p = 0.002$ ; and was also significantly older,  $t(41.95) = 2.41$ ,  $d = 0.61$ ,  $p = 0.02$ . The two groups did not differ significantly on other baseline variables. Age was included as a covariate in subsequent analyses in which group was a predictor. Although there were significant baseline differences on depression, it was not covaried in subsequent analyses. Hoarding disorder is very commonly comorbid with depression, with more than half of those with hoarding disorder endorsing depression (Hall et al., 2013). Since depression very frequently co-occurs with hoarding in clinical samples, and it is unclear how controlling for depression might change the construct predicted, it was not controlled statistically. However, it should be considered in interpreting the results.

Compliance with the EMA procedure was also inspected. Those in the low

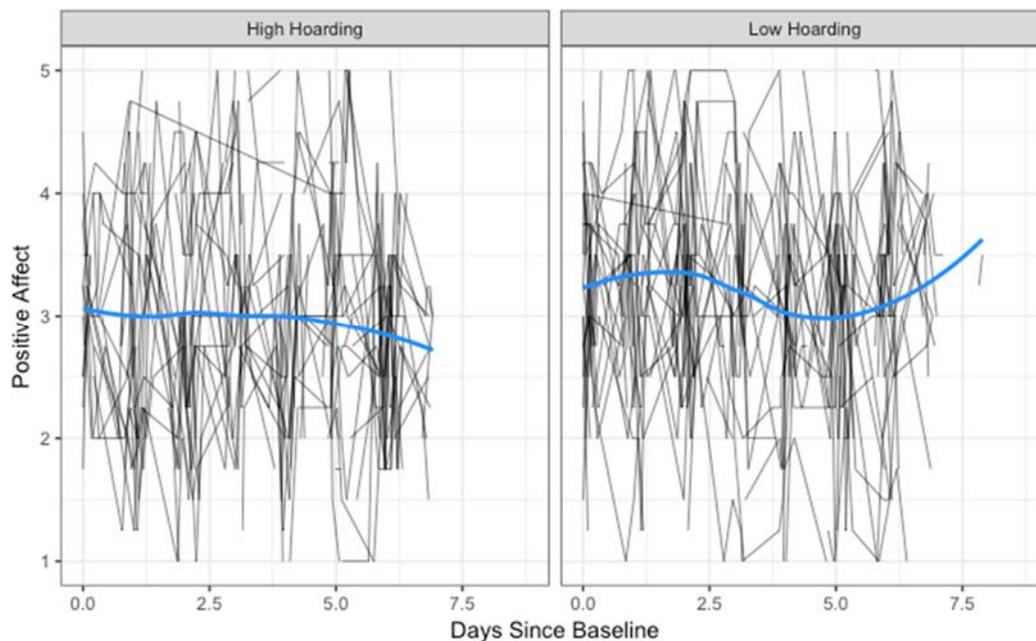
hoarding group completed an average of 19.59 EMA questionnaires, 69.96% of the questionnaires administered, while those in the high hoarding group completed an average of 17.65 EMA questionnaires, 63.04% of the questionnaires administered. The two groups did not differ significantly in terms of compliance.

Primary outcomes were also plotted with spaghetti plots (i.e., one line per participant; see Figures 1-4). Average trajectories were modeled on these plots with LOESS regression. The plots showed reasonable variability for the type of data collected. However, there appear to be some potential floor effects for negative affect and experiential avoidance, and a ceiling effect for mindfulness, in the control group.



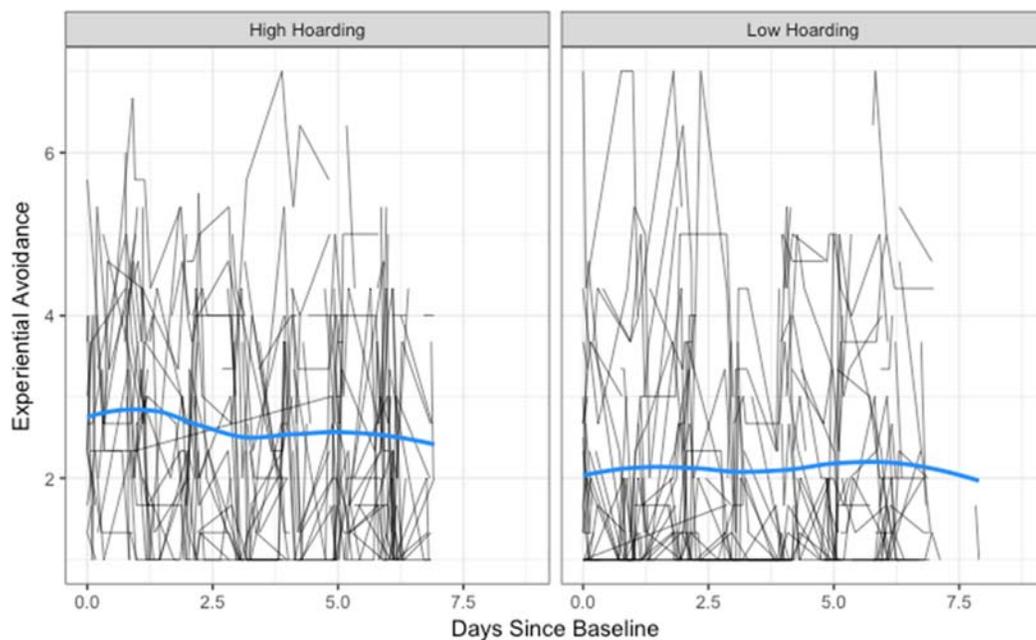
*Note.* Each line indicates a specific participant.

*Figure 1.* Raw data for negative affect by stressor presence and group with average trajectory predicted by LOESS regression.



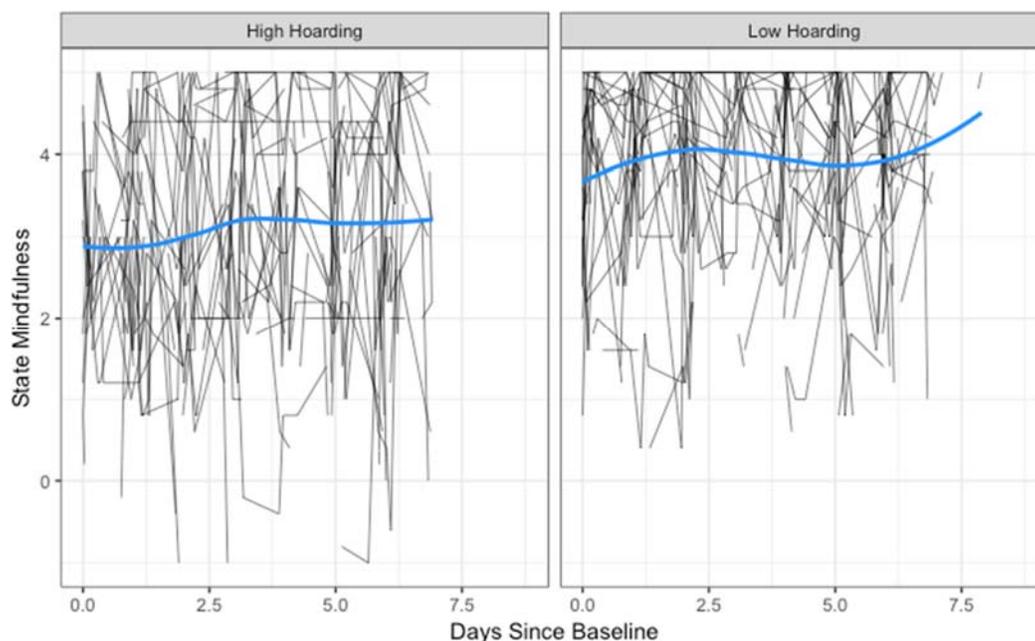
*Note.* Each line indicates a specific participant.

*Figure 2.* Raw data for positive affect by group with average trajectory predicted by LOESS regression.



*Note.* Each line indicates a specific participant.

*Figure 3.* Raw data for state experiential avoidance by group with average trajectory predicted by LOESS regression.



*Note.* Each line indicates a specific participant.

*Figure 4.* Raw data for mindfulness by group with average trajectory predicted by LOESS regression.

Potential reactivity was identified in positive affect and in working with items. Time since beginning the study predicted decreased positive affect ( $b = -0.04$ ,  $SE = 0.02$ ,  $p < 0.05$ ) and less working with items ( $b = -0.17$ ,  $SE = 0.06$ ,  $OR = 0.84$ ,  $p < 0.01$ ). Time since beginning the study did not interact with group in either case. It would be concerning if it appeared that one group had greater reactivity, as this could result in spurious findings. These results indicate that there were not any differences between the groups in reactivity over time. Since there were no group differences, and it is unclear if change over time is due to study reactivity or to other reasons, no changes were made to the analyses based on this possible reactivity. There were no changes in other study variables based on time since beginning the study, or the interaction of time and group.

### **1. Does the Hoarding Group Have Lower Emotion Differentiation?**

The average intraclass correlation (using a two-way random or 2k model with absolute agreement) for negative affect was  $M = 0.32$  ( $SD = 0.06$ ) in the higher hoarding symptom group and  $M = 0.17$  ( $SD = 0.06$ ) in the lower hoarding symptom group ( $M = 0.17$ ,  $SD = 0.06$ ). The two groups were very similar in their intraclass correlations for positive affect ( $M = 0.77$ ,  $SD = 0.05$  in the higher hoarding group compared to  $M = 0.77$ ,  $SD = 0.02$  in the lower hoarding group).

Linear regression models were also computed predicting the intraclass correlations for NA and PA with group as a predictor and age as a covariate to test if there were any significant differences on emotion differentiation between the two groups. After inspecting residuals, one outlier was removed from the model predicting PA. Group and age were not significant predictors of the intraclass correlations for either NA or PA, indicating that group did not significantly predict differentiation of positive ( $b = -0.05$ ,  $SE = 0.03$ ,  $p = 0.14$ ) or negative ( $b = -0.14$ ,  $SE = 0.09$ ,  $p = 0.12$ ) emotions.

### **2. Does the Hoarding Group Have Higher or Less Variable Emotional Reactivity?**

First, a null model was created with negative affect as the dependent variable and a random intercept for each participant. Next, age, group, and stressor presence were added as predictors of average negative affect, and adding these predictors improved fit significantly compared to a null model,  $\chi^2(3) = 166.85$ ,  $p < 0.001$ . Group and stressor were both statistically significant predictors as well ( $p < 0.001$ ), and therefore all three predictors were retained. In the following step, an effect was added for group predicting

within-subject variability in negative affect, which also improved model fit,  $\chi^2(1) = 68.42, p < 0.001$ , and was retained. Next, the interaction of stressor and group was added as a predictor of the level of negative affect and also improved model fit,  $\chi^2(1) = 9.18, p = 0.002$ . In the next step, the interaction was also added as a predictor of within-subject variability in negative affect, which improved the model as well,  $\chi^2(1) = 3.26, p = 0.07$ , and was retained. Finally, random slopes for time were added and also improved model fit significantly,  $\chi^2(1) = 9.15, p = 0.002$ . Adding random slopes predicted by time means that the model includes a different slope in negative affect over time for each participant (i.e., negative affect may have been increasing for some individuals, decreasing for others, and constant for others.) The fact that adding these slopes improved model fit indicates that there is variability in negative affect at the participant level over time and modeling this variability as random slopes helps the model to account for more variability in negative affect. These slopes are not predicted by any variables other than time and thus represent individual-level change due to unmeasured variables.

Based on the results described above, the final model predicting negative affect included the following effects: (1) main effects of group, age, and stressor on the mean level of negative affect, (2) an interaction of group and stressor predicting the mean level of negative affect, (3) a main effect of group on variability in negative affect, (4) an interaction of group and stressor predicting variability in negative affect, and (5) random slopes in negative affect for each participant over time. Group ( $b = 0.33, SE = 0.08, p < 0.001$ ) predicted significantly higher negative affect, meaning that those in the higher hoarding group experienced greater overall levels of negative affect. Stressor ( $b = 0.40,$

$SE = 0.03, p < 0.001$ ) also predicted negative affect, meaning that participants reported higher negative affect following a stressor regardless of group. Group significantly predicted variability in negative affect ( $b = 0.37, SE = 0.18, Odds Ratio = 1.45, p = 0.04$ ), such that those in the hoarding group experienced higher variability in negative affect. The interaction between group and stressor ( $b = 0.18, SE = 0.07, p < 0.001$ ) on level of negative affect was such that those in the higher hoarding group had greater increases in negative affect compared to those in the lower hoarding group when reporting stressful events (see Figure 5 for a model plot). Finally, although adding the interaction of group and stress as a predictor of within-subject variability improved the model fit, it was only a trend according to the Wald test ( $b = 0.38, SE = 0.21, Odds Ratio = 1.47, p = 0.07$ ) and, therefore, was retained but not interpreted as a significant effect.

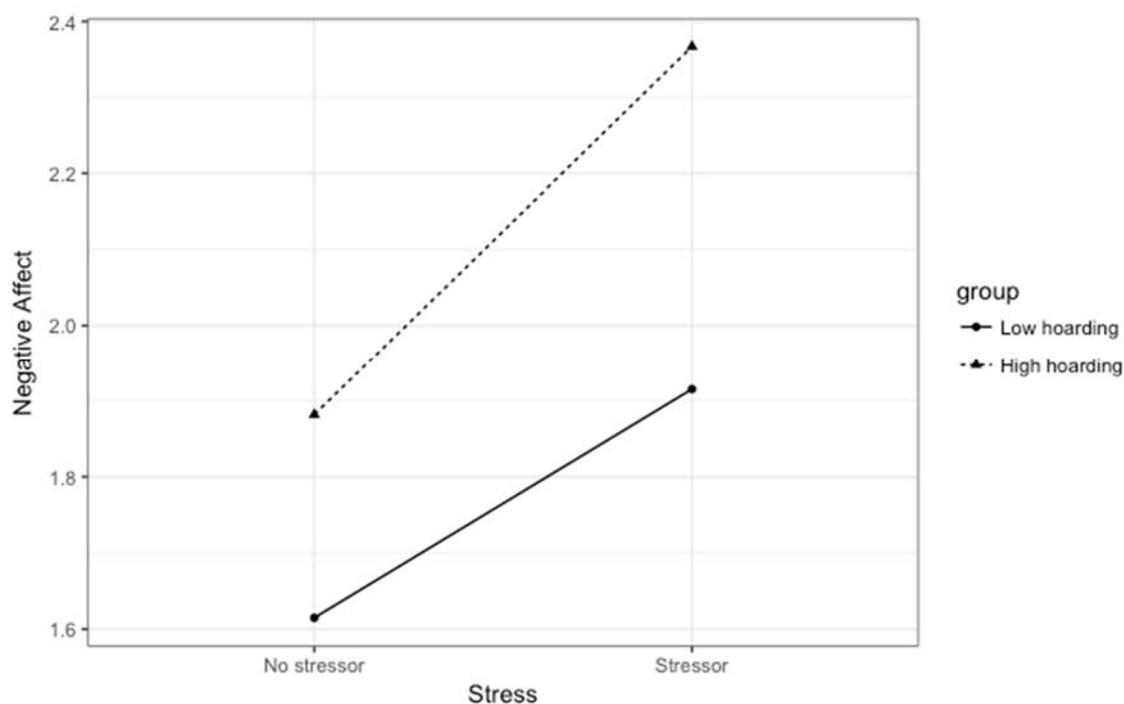


Figure 5. Predicted negative affect based on group and stressor.

### **3. Does the Hoarding Group Report Higher or Less Variable Levels of Experiential Avoidance?**

Adding group and age significantly improved model fit in predicting average experiential avoidance compared to a null model,  $\chi^2(2) = 6.93, p = 0.03$ . In the subsequent step an effect was added for group predicting within-subject variance in experiential avoidance, and also significantly improved the model,  $\chi^2(2) = 305.20, p < 0.001$ . Next, random slopes for time were added and also improved model fit,  $\chi^2(1) = 17.02, p < 0.001$ , and were, therefore, retained.

Group was a significant predictor in the final model ( $b = 0.88, SE = 0.30, p = 0.003$ ) while age ( $b = -0.04, SE = 0.04, p = 0.20$ ) was not. Experiential avoidance was higher among those in the higher hoarding group. Group also significantly predicted within-subject variance in momentary experiential avoidance in the log-linear submodel ( $b = 0.97, SE = 0.26, \text{Ratio} = 2.65, p < 0.001$ ) in the final model. This means that within-subject variance in momentary experiential avoidance is predicted to be 2.65 times higher in the higher hoarding group compared to the lower hoarding group. This is a significant effect that directly contradicts the study hypothesis that the hoarding group would have less variability in experiential avoidance.

### **4. Does the Hoarding Group Report Lower or Less Variable Levels of Mindfulness?**

Adding group and age significantly improved the prediction of average state mindfulness compared to a null model,  $\chi^2(2) = 15.06, p < 0.001$ . In the next step, an effect was added for group predicting within-subject variability in mindfulness, and this significantly improved the model,  $\chi^2(1) = 306.17, p < 0.001$ . Next, random slopes for

time were added and also improved model fit,  $\chi^2(1) = 7.77, p = 0.005$ , and were, therefore, retained.

Group was a significant predictor of mindfulness in the final model ( $b = -1.11, SE = 0.20, p < 0.001$ ) while age ( $b = 0.05, SE = 0.03, p = 0.08$ ) was non-significant. This indicates that mindfulness was significantly lower in the higher hoarding group.

In the final model, group also significantly predicted within-subject variance in state mindfulness ( $b = 0.88, SE = 0.29, \text{Ratio} = 2.41, p = 0.002$ ). This means that within-subject variance in state mindfulness is predicted to be 2.41 times higher in the higher hoarding group compared to the lower hoarding group. This is a significant effect that directly contradicts the study hypothesis that the hoarding group would have less variability in state mindfulness.

### **Hoarding-Relevant Behaviors and Functions**

The two groups were compared on four hoarding-relevant behaviors: acquiring new possessions, discarding possessions, working with possessions, and looking for items to acquire. The higher hoarding group reported higher levels of all four variables, reporting an average of 1.74 acquiring events (compared to 0.83 in the lower hoarding group), 0.84 discarding events (compared to 0.24), 3.00 working events (compared to 1.72), and 4.42 looking events (compared to 2.10). These sums have not been adjusted to account for missing time points, and thus, estimates of total hoarding-relevant behaviors would be approximately 50% higher in each group if the missing time points are similar to the obtained time points. Binomial mixed-effects models were also tested for each

dependent variable, and in each case group was a significant predictor of the behavior, age was not a significant predictor, and adding group and age significantly improved the model fit (see Table 2).

### 5. Do the Two Groups Report Different Functions of Acquisition?

Proportions were computed for how often a given function was endorsed relative to total acquiring events. In the higher hoarding group, a positive internal function was endorsed in 56% of acquiring events (compared to 43% in the lower hoarding group), a negative internal function was endorsed in 21% of acquiring events (compared to 5% in the lower hoarding group), a positive social function was endorsed in 15% of acquiring events (compared to 11% in the lower hoarding group), a negative social function was endorsed in 16% of acquiring events (compared to 6% in the lower hoarding group), and another unspecified reason for acquiring was reported in 44% of acquiring events

Table 2

#### *Binomial Mixed-Effect Models Predicting Hoarding-Relevant Behaviors by Group and Age*

| Variable                   | Acquisition                         | Discarding                        | Working                           | Looking                             |
|----------------------------|-------------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|
| Group <i>b</i>             | 0.93 **                             | 1.63 *                            | 0.81 **                           | 1.15 ***                            |
| Group SE                   | 0.29                                | 0.65                              | 0.29                              | 0.30                                |
| Group Odds Ratio (OR)      | 2.53                                | 5.10                              | 2.25                              | 3.16                                |
| Age <i>b</i>               | -0.01                               | -0.04                             | -0.02                             | -0.02                               |
| Age SE                     | 0.03                                | 0.07                              | 0.04                              | 0.04                                |
| Age Odds Ratio             | 0.99                                | 0.96                              | 0.98                              | 0.98                                |
| LRT compared to null model | $\chi^2(2) = 10.52,$<br>$p = 0.005$ | $\chi^2(2) = 6.66,$<br>$p = 0.04$ | $\chi^2(2) = 7.19,$<br>$p = 0.03$ | $\chi^2(2) = 13.26,$<br>$p = 0.001$ |

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

(compared to 55% in the lower hoarding group). Due to nonnormal distribution, differences between these proportions by group were not tested statistically.

Within each group, post hoc tests were also conducted to determine if any proportions for specific functions were significantly larger than others, indicating if any intended functions were endorsed more often compared to other possible intended functions. Paired sign tests were used due to nonnormal and nonsymmetrical distribution of the differences. In the hoarding group, the proportion of acquiring events with a positive internal function was significantly larger than the proportion of acquiring events with a negative internal function ( $p = 0.002$ , Cohen's  $d = 0.71$ ), positive social function ( $p = 0.004$ ,  $d = 0.80$ ), or negative social function ( $p = 0.001$ ,  $d = 0.84$ ). The proportion of acquiring events with a negative internal function (the next most commonly reported function in the hoarding group) was not significantly higher than the proportion with a positive social or negative social function ( $ps > 0.10$ ). In the control group, the proportion of acquiring events with a positive internal function was again significantly larger than the proportion of events with a negative internal function ( $p = 0.04$ ,  $d = 0.73$ ), positive social function ( $p = 0.03$ ,  $d = 0.68$ ), or negative social function ( $p = 0.04$ ,  $d = 0.62$ ). The proportion of acquiring events with a positive social function (the next most commonly reported function in the control group) was not significantly higher than the proportion with a negative internal or negative social function ( $ps > 0.10$ ).

Participants were able to report that acquiring served multiple functions, and the two groups were compared *post hoc* on the number of functions endorsed after acquiring. Those in the higher hoarding group endorsed relatively similar numbers of functions per

acquisition event ( $M = 1.54$ , compared to  $M = 1.25$  in the lower hoarding group), and group was not a significant predictor of the number of functions endorsed per acquisition event ( $b = -0.35$ ,  $SE = 0.19$ ,  $p > 0.05$ ) in a mixed-effect model with a random intercept and group and age entered as predictors.

Generalized linear mixed effects models with a logit link function were also employed *post hoc* to test if group significantly predicted the likelihood of endorsing each specific function after acquiring occurred, controlling for age. Group was not a statistically significant predictor of any function endorsed (all  $ps > 0.10$ ), so we cannot conclude that there are differences between groups in what function acquiring serves. However, the number of acquiring events was low ( $n = 78$ ), so power was limited to test questions specific to acquiring events.

## **6. Does Engaging in a Hoarding-Relevant Behavior Predict Affect?**

A series of mixed-effects models tested whether the occurrence of a hoarding-relevant behavior (acquiring, discarding, working with items, and looking for items) was associated with affect when controlling for previous affect (either positive or negative). An interaction term (Group x Behavior) was included to allow for modeling differential effects in the higher hoarding group and control group.

The occurrence of hoarding-relevant behaviors did not predict subsequent positive or negative affect when controlling for affect at the previous time point in any of the models. In other words, whether or not participants engaged in hoarding-relevant behavior did not appear to influence subsequent affect. There were also no significant

interactions between group and behavior, indicating that engaging in hoarding-relevant behaviors did not have a significantly different impact on positive or negative affect in the higher hoarding group compared to the control group.

### **7. What is the Trajectory of Affect in the Period Before and in the Period After a Hoarding-Relevant Behavior?**

Another series of models examined the trajectory of affect before or after a hoarding-relevant behavior. Positive or negative affect was the dependent variable in these models, and was predicted based how much time had elapsed either before or after a hoarding-relevant behavior. Because time to the behavior was the predictor, these models did not compare affect when a behavior had occurred to when it had not. Instead, they only modeled affect before or after the behavior (acquiring, discarding, working with items, or looking for items) occurred. As such, a null result means that there was no significant change in affect before the behavior, or after the behavior (i.e., affect was relatively flat). These models are not designed to show a contingent relationship between hoarding behaviors and affect, since they do not predict change in affect from before to after the behavior or make a comparison to affect when the same behavior did not occur. Instead, they are exploratory tests to examine the trajectory of affect before and after hoarding behaviors, which could help generate new hypotheses regarding the affective antecedents or consequences of hoarding behavior.

A total of 48 models were calculated with the following distinctions: (1) predicting either positive or negative affect as the dependent variable, (2) using either time before or after a relevant hoarding behavior as the predictor, in (3) linear, quadratic,

and cubic models, for (4) each of the four specific hoarding-relevant behaviors.

Interactions of group with time, time squared, and time cubed were included in the linear, quadratic, and cubic models respectively in order to model different trajectories of affect in the higher hoarding and control groups. Each model also included the appropriate lower-level effects (e.g., main effects of time, group, and age; lower-level interaction terms). Time variables were grand mean centered to reduce structural collinearity. If multiple models (e.g., linear and cubic) had statistically significant time predictors, the model with the best fit was selected.

Due to the low frequency of hoarding-relevant behaviors across the sample, the number of observations upon which these models were based was low in some cases. Models were not considered even if some time predictors were statistically significant if they were based on less than 30 observations given concerns about the reliability of the results. This was the case for two models: (1) predicting positive affect based on time before discarding, and (2) predicting negative affect based on time before discarding.

For the following models, the linear, quadratic, or cubic time predictors were not statistically significant, or the model failed to improve over a null model based on a likelihood ratio test: (1) predicting positive affect based on time before acquiring, (2) predicting positive affect based on time after discarding, (3) predicting positive affect based on time before looking for items, (4) predicting positive affect based on time after looking for items, (5) predicting positive affect based on time before working with items, (6) predicting negative affect based on time before acquiring, (7) predicting negative affect based on time after acquiring, (8) predicting negative affect based on time after

discarding items, (9) predicting negative affect based on time before looking for items, (10) predicting negative affect based on time after looking for items, and (11) predicting negative affect based on time before working with items.

There was a significant interaction between time after acquiring squared and group in predicting positive affect ( $b = -2.95$ ,  $SE = 1.31$ ,  $p < 0.05$ ; see Table 3 and Figure 6). The two groups both had relatively constant affect for about 12 hours after acquiring

Table 3

*Affect Predicted by Time Before or After Hoarding-Relevant Behaviors*

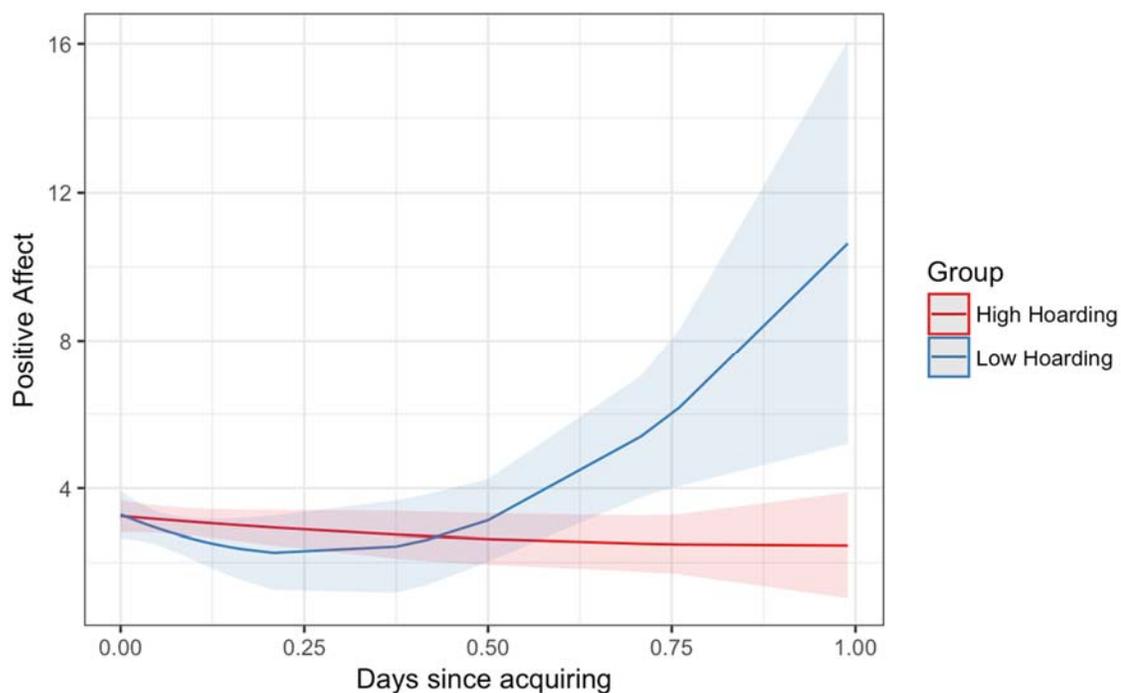
| Model                                     | <i>b</i> | <i>SE</i> | LRT compared to null model      |
|---|----------|-----------|---------------------------------|
| <i>Prediction of positive affect</i>      |          |           |                                 |
| Time after acquiring                      | -4.83    | 2.48      | $\chi^2(5) = 9.66, p = 0.09$    |
| Time after acquiring <sup>2</sup>         | 8.09*    | 3.62      |                                 |
| Group                                     | -0.04    | 0.40      |                                 |
| Time after acquiring x Group              | 6.55     | 5.04      |                                 |
| Time after acquiring <sup>2</sup> x Group | -14.92*  | 7.41      |                                 |
| Age                                       | -0.06    | 0.04      |                                 |
| <i>Prediction of positive affect</i>      |          |           |                                 |
| Time after working                        | -0.17    | 0.40      | $\chi^2(3) = 8.88, p = 0.03$    |
| Group                                     | -0.16    | 0.20      |                                 |
| Time after working x Group                | 2.27 **  | 0.81      |                                 |
| Age                                       | -0.04    | 0.03      |                                 |
| <i>Prediction of negative affect</i>      |          |           |                                 |
| Time after working                        | 1.20     | 0.65      | $\chi^2(6) = 101.08, p < 0.001$ |
| Time after working <sup>2</sup>           | -2.95*   | 1.31      |                                 |
| Group                                     | 0.27     | 0.16      |                                 |
| Time after working x Group                | -2.08    | 1.31      |                                 |
| Time after working <sup>2</sup> x Group   | 3.48     | 2.66      |                                 |
| Age                                       | 0.01     | 0.02      |                                 |

*Note:* Group and time were centered in these models.

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .



*Figure 6.* Prediction of positive affect by time after acquiring.

items, after which positive affect increased in the control group but not the hoarding group. The quadratic model improved model fit significantly compared to a null model,  $\chi^2(5) = 9.66, p = 0.08$ . Random slopes did not improve model fit compared to a null model ( $p > 0.10$ ) and they were therefore omitted. There was high collinearity in the quadratic model (highest VIF = 17.49 for the interaction of time after acquiring squared and group). A VIF of less than 10 is generally considered acceptable (Hair, Anderson, Tatham, & Black, 1995). High collinearity is common in polynomial models, and it indicates that the values of specific regression coefficients may be unstable and should be interpreted with caution (Smith & Sasaki, 1979). However, the overall model fit is still a useful indicator of the predictive value of the model (Morrow-Howell, 1994). In this case,

that means the likelihood ratio tests should be prioritized over the significance of regression parameters in interpreting the findings as they rely solely on model fit. Given that the likelihood ratio test indicated that this model predicted a significant amount of variance in the data, the overall model appears to have predictive value, although the regression coefficients should not be interpreted individually.

There was also a significant interaction between time after working with items and group on positive affect ( $b = 2.27$ ,  $SE = 0.81$ ,  $p < 0.01$ ; see Table 3 and Figure 7). Positive affect increased in a linear manner after working with items for those in the hoarding group (by about 1 point on a 5 point scale over the next day), while positive affect decreased after working with items for those in the control group (by about 1.3 points on a 5 point scale over the next day). Adding a linear interaction term and main

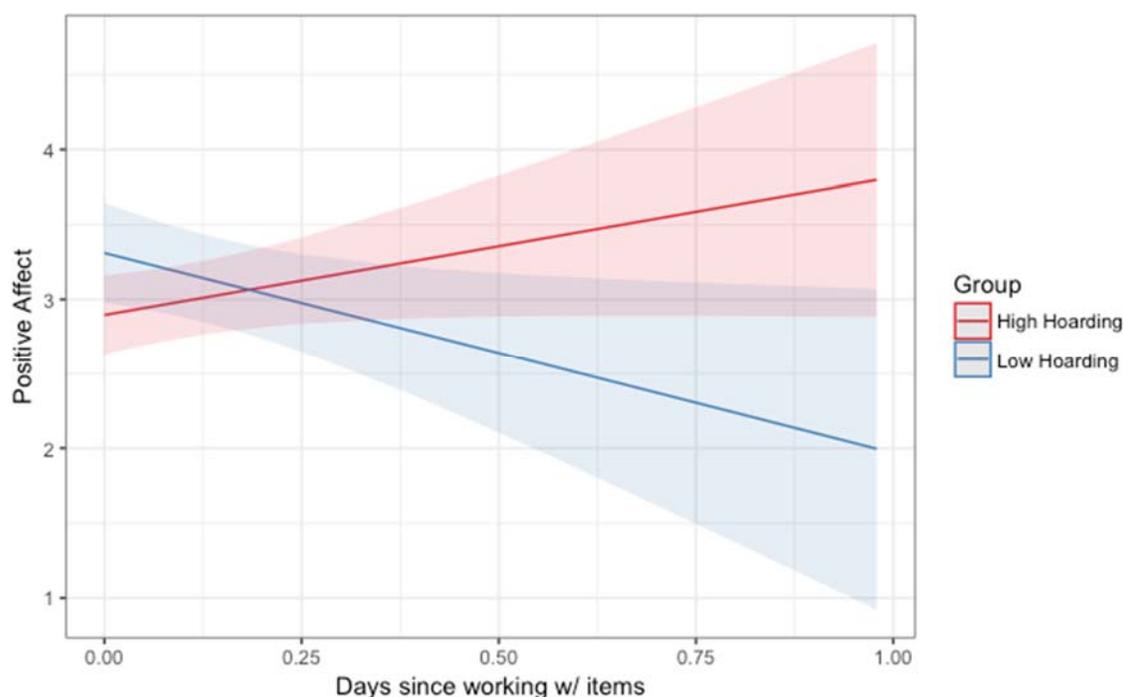


Figure 7. Prediction of positive affect by time after working with items.

effects improved model fit compared to a null model,  $\chi^2(3) = 8.88, p = 0.03$ . Random slopes did not improve model fit compared to a null model ( $p > 0.10$ ) and they were therefore omitted. Collinearity was acceptable in this model (highest VIF = 1.09 for group).

Finally, there was a significant quadratic effect, but not a significant interaction with group, for time after working predicting negative affect ( $b = -2.95, SE = 1.31, p < 0.05$ ; see Table 3 and Figure 8). Negative affect was relatively flat after working with items for about 12 hours in the hoarding group, and then decreased slightly for the next 12 hours, whereas in the control group negative affect increased for about 9 hours then decreased more sharply. As the interaction term was not significant, these separate trends for the two groups are still modeled but are not significantly different. Adding the

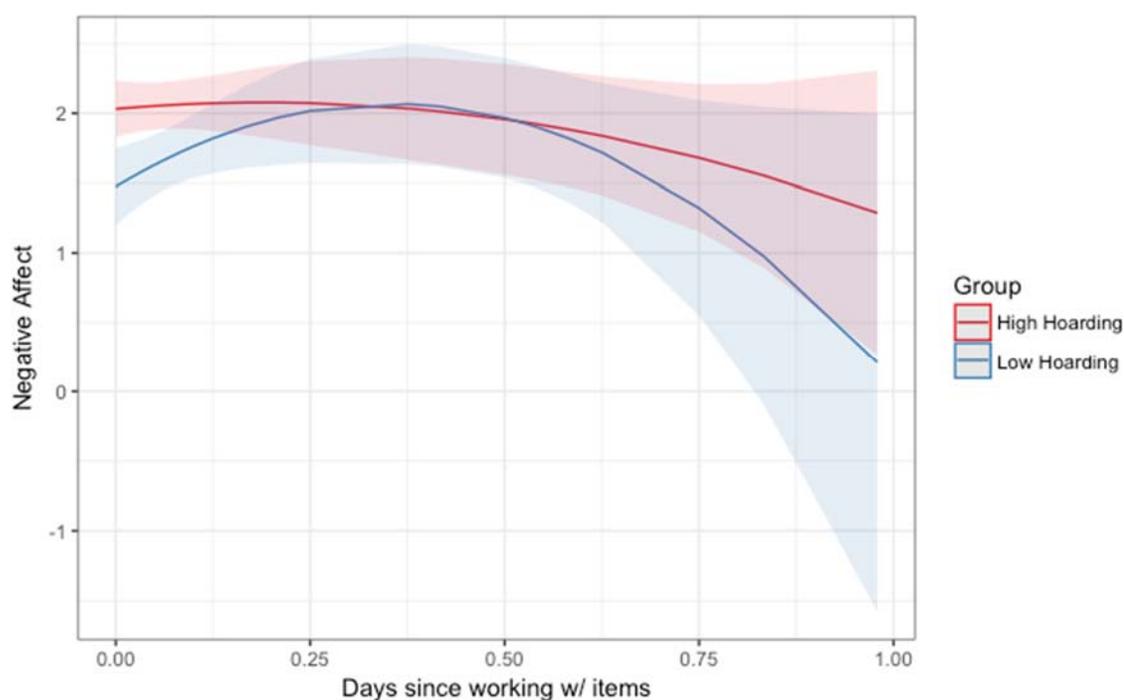


Figure 8. Prediction of negative affect by time after working with items.

quadratic terms significantly improved model fit compared to a null model ( $\chi^2(6) = 101.08, p < 0.001$ ). Collinearity was also high in this model (highest VIF = 6.05 for the interaction of time since working squared and group) but within acceptable limits (Hair et al., 1995)

These results should be interpreted cautiously given the large number of models tested and the increased possibility of Type I error.

## CHAPTER V

### DISCUSSION

#### Summary of Outcomes

Although acquiring and discarding have been hypothesized to serve several different functions, no prior studies have examined the function of hoarding behavior as it occurs. This study used ecological momentary assessment to attempt to identify the function of hoarding behaviors in context and to evaluate if psychological inflexibility may contribute to hoarding problems. The proposed sample ( $n = 60$ ) was recruited and compliance with study procedures was adequate in both groups.

Many of the study hypotheses were supported, particularly in regard to the potential role of psychological inflexibility in hoarding. Individuals in the hoarding group experienced more negative affect overall compared to the control group, and this difference was larger in the context of stress, indicating heightened emotional reactivity. Those in the hoarding group reported higher levels of experiential avoidance and lower levels of state mindfulness compared to controls. These findings support previous research regarding emotional reactivity (Shaw et al., 2015; Timpano et al., 2014) and experiential avoidance (Ayers et al., 2014; Fernández de la Cruz et al., 2013; Wheaton et al., 2011) and extend these findings into a naturalistic setting. These findings also support the importance of mindfulness as another variable that could help to explain vulnerability to hoarding problems.

There was no significant difference between the two groups in average

differentiation of positive or negative emotions, which suggests that the differences in negative affect cannot be explained by a skills deficit in distinguishing one's emotions. Also, in contrast to study hypotheses, individuals in the hoarding group had more variable experiential avoidance, state mindfulness, and negative affect in the context of stress. However, visual inspection of the raw data (Figures 1, 3, and 4) suggests that the difference in variability is likely attributable to ceiling effects in the control group. That is, many more individuals in the control group reported the lowest possible levels of negative affect and experiential avoidance, and the highest possible levels of state mindfulness, leaving little margin in which variability could occur.

The higher hoarding group reported greater levels of acquisition, discarding, working with items, and looking for items to acquire. As difficulty discarding is one of the key features of hoarding, it is surprising that the higher hoarding group reported more discarding. If these patterns hold among those with hoarding disorder, it would suggest that either discarding becomes less frequent and more difficult over time, or that discarding is insufficient to keep pace with the rate of acquisition, resulting in an increase in clutter. The hoarding group did not endorse any particular function of acquiring at significantly different rates compared to the control group. This could be due to limited power regarding acquiring events, but it could also suggest that the function of acquiring is actually relatively similar among those with more hoarding symptoms and those without. Within both groups, a positive internal function was endorsed significantly more often than any of the other specific functions (negative internal, positive social, and negative social). This supports the hypothesis that acquisition in hoarding is driven

largely by seeking to achieve positive internal states.

A series of models examined change in positive and negative affect from before to after engaging in a hoarding-related behavior, and found no significant changes in either group. Power was limited for these models as these behaviors were endorsed relatively infrequently. However, if these findings were replicated with sufficient power, it would suggest that hoarding behaviors are not maintained primarily through changes in affect, and that the actual impact of acquisition on affect may be different from its intended function—that is, individuals may acquire in order to achieve greater positive affect, but find that this does not actually occur.

Finally, another series of models examined the trajectory of positive and negative affect based on time before or time after a hoarding-related behavior. These models indicate if there is a change in the trajectory of affect prior to or after a particular behavior. No significant change in positive or negative affect was identified prior to or after most behaviors, which again suggests hoarding behaviors might not primarily serve to regulate mood. However, there were three significant findings. First, after acquisition positive affect remained stable in both groups for around 12 hours, then increased in the control but not hoarding group. Second, positive affect increased after working with items in the hoarding group, but not in the control group. Third, after working with items negative affect was relatively stable for 9-12 hours and then decreased in both groups. These findings suggest that acquisition and working with items may have distinct impacts on positive affect among those with and without significant hoarding symptoms, and that working with items may result in decreased negative affect regardless of hoarding

symptoms.

As a whole, these findings support the utility of considering acquisition as a process of intended positive internal reinforcement, and suggest that people who hoard and those who do not may experience some differential effects of hoarding behaviors on positive affect. While a large body of research exists on how people who hoard experience and respond to negative affect, there is relatively little research on the potential role of positive affect in hoarding. One factor analytic study found that hoarding symptoms were best fit with a two-factor model, an urge-focused factor and a distress-focused factor (Raines et al., 2015), which supports the importance of understanding positive affect in hoarding.

It is important to note that positive affect did not change significantly from before to after acquiring despite the intended function of acquisition (positive internal reinforcement), which suggests a possible discrepancy between how hoarding behaviors are expected to function and their actual effects. Such a discrepancy could theoretically be due to inattention (not noticing actual consequences of one's behavior) or cognitive fusion (verbal rules dominating over experienced contingencies), and future research should explore this possibility.

In addition, the intended function of acquisition was similar (i.e., most often positive internal reinforcement) in the higher hoarding and control groups. This suggests that there may be nothing unique about the intended function of acquisition among those who hoard. One previous study comparing people with hoarding disorder to collectors also found that they generally had similar reasons for saving and acquiring items

(Nordsletten, Fernández de la Cruz, Billotti, & Mataix-Cols, 2013). Given these similarities, it is possible that those who hoard experience similar thoughts about acquiring and discarding, and similar affect around these events, but the context of these experiences is different due to other factors such as cognitive fusion or attitudes to positive affect.

Attitudes toward positive affect have recently come to be understood as an important variable in psychopathology. For example, highly valuing happiness is associated with decreased well-being (Tamir & Ford, 2012) and major depression (Ford, Shallcross, Mauss, Floerke, & Gruber, 2014). Clinging to positive affect (e.g., fear and worry about losing happiness) is also associated with neuroticism, worry, distress, and depression (Swails, Zettle, Burdsal, & Snyder, 2016). Determining if those who hoard have a tendency to overvalue or ineffectively strive towards positive affect could help explain why certain people are more vulnerable to these urge-related aspects of hoarding.

The findings of this study are consistent with previous results indicating that those who hoard have higher generalized emotional reactivity (Shaw et al., 2015; Timpano et al., 2014), which could result in particular difficulty in effectively responding to emotions in the context of stress. In addition, these findings support the relevance of experiential avoidance and mindfulness to hoarding concerns, suggesting a general deficit in psychological flexibility. It is possible that heightened experiential avoidance and lower mindfulness contribute to both experiencing greater negative affect and putting more effort into achieving positive affect through acquisition or other means. However, it is surprising that no changes in negative affect were observed after hoarding behaviors,

given that they are commonly theorized to serve a negative internal reinforcing function (Frost & Hartl, 1996; Steketee & Frost, 2003). These findings require replication, but they cast doubt on the assumption that hoarding is largely driven by experiential or behavioral avoidance. One possible explanation would be that due to high levels of cognitive fusion, those who hoard are responding to verbal rules about affect (e.g., “Letting go of this would be overwhelming”) rather than actual experienced contingencies. Results for each specific research question as the overall limitations of this study and future directions for this research are discussed below.

**Research Question 1: Does the Hoarding Group Have Lower Emotion Differentiation?**

It was hypothesized that those in the hoarding group would have lower differentiation of positive and negative emotions. Emotion differentiation is considered to be an important process in responding to emotions effectively, as being able to differentiate distinct emotions may provide more useful information about what is occurring and how to respond. However, there were no statistically significant differences between the two groups in their differentiation of either positive or negative emotions. There are two potential explanations for the lack of effect: insufficient power, particularly to detect a smaller effect, and true similarity. Given the obtained sample size of 61 and an  $\alpha$  of 0.05, a medium effect with a Cohen's  $f$  of 0.27 would have been detectable with power of 0.95. Therefore, the possibility of a large difference in emotion differentiation between those with low and with higher hoarding symptoms can be ruled out, but replication in a larger sample is necessary to rule out a small to medium

difference. This suggests that, at least among subclinical hoarders, there is no large deficit in the ability to differentiate specific emotions, and therefore this may not be a useful target for treatment in general.

### **Research Question 2: Does the Hoarding Group Have Higher or Less Variable Emotional Reactivity?**

Emotional reactivity was defined as experiencing higher negative affect in the context of a recent stressor. Overall, those in the hoarding group had significantly higher negative affect. However, there was a significant interaction indicating that the hoarding group also has sharper increases in negative affect in response to a recent stressor. This indicates that those with higher hoarding symptoms experience unusually high negative affect after a stressful event occurs. In theory, this could lead to engaging in more ineffective coping methods, including hoarding behaviors as well as other forms of experiential avoidance, although hoarding behaviors were not found to regulate affect in the moment. Previous studies have also found connections between emotional reactivity and hoarding (e.g., Shaw et al., 2015; Timpano et al., 2014). However, this study appears to be the first to extend research on emotional reactivity in hoarding outside of self-report or laboratory methods and into a naturalistic setting. If this emotional reactivity does contribute to the development and maintenance of hoarding disorder, then it may be beneficial to target it in treatment using evidence-based methods like ACT that teach individuals how to refrain from ineffective responses to emotions and to engage in valued activities even when intense emotions are present (Hayes et al., 1999).

The hoarding group reported more variable negative affect, although variability in

negative affect did not depend on whether or not a recent stressor had occurred. This may be due to a floor effect in the control group, as individuals in the control group frequently reported minimal negative affect (see Figure 1). In the future variability in negative affect should be investigated using a revised set of items or response scale that would better capture a range of responses among those experiencing higher hoarding symptoms and among controls as well.

**Research Question 3: Does the Hoarding Group Report Higher or Less Variable Levels of Experiential Avoidance?**

Momentary experiential avoidance was significantly higher among those in the higher hoarding group, indicating that individuals with more hoarding symptoms engage in significantly more attempts to control or change their unpleasant internal experiences than others throughout their daily lives. This finding is consistent with several past studies (Ayers et al., 2014; Fernández de la Cruz et al., 2013; Wheaton et al., 2011) but extends these findings past global self-report, which may be particularly susceptible to recall biases (Shiffman et al., 2008). In contrast to expectations, experiential avoidance was actually more variable among those with higher hoarding. Once again, this may be due to a floor effect in the control group (Figure 3 presents the raw data). In order to better investigate differences in variability, it will be necessary to create or revise measures so that floor and ceiling effects are minimal among both groups of interest and healthy controls.

Experiential avoidance is well-established as a pathological process that is linked with depression, anxiety, posttraumatic stress disorder, physical health, and job

satisfaction (Hayes et al., 2006). Experiential avoidance has been demonstrated to be linked to greater negative affect (Campbell-Sills et al., 2006) as well as higher emotional reactivity (Feldner et al., 2003; Sloan, 2004). Therefore, it is possible that the high levels of negative affect and emotional reactivity among those with higher hoarding symptoms are paradoxically maintained by ineffective and draining attempts to control negative affect.

Experiential avoidance is a modifiable process that has been demonstrated to decrease following ACT (Bluett, Homan, Morrison, Levin, & Twohig, 2014; Hayes et al., 2006). Helping individuals recognize the paradoxical effects of avoidance and accept painful emotions as they occur could potentially help those with hoarding to get less caught up in negative affect and to behave in effective ways even in the presence of difficult emotions.

It is surprising that no relationships between hoarding behaviors and negative affect were found, given that the association between hoarding and experiential avoidance in the moment was confirmed. This suggests that although people with more hoarding symptoms generally have higher negative affect and ineffective responses to negative affect, hoarding behaviors may not be maintained through escape or avoidance in the moment.

**Research Question 4: Does the Hoarding Group Report Lower or Less Variable Levels of Mindfulness?**

As predicted, momentary mindfulness was significantly lower among those in the hoarding group compared to the control group. In other words, individuals with higher

hoarding symptoms reported doing things without paying attention and being on autopilot more frequently. This is the second study to find a connection between mindfulness and hoarding (Ong et al., 2018) and the first to do so using an in-the-moment assessment.

As with experiential avoidance, there was more variability in momentary mindfulness in the hoarding group compared to the control group, and this appears to be due to a ceiling effect (see Figure 4) in which the control group frequently reported maximum levels of momentary mindfulness. It is surprising that these items performed in such a skewed manner, given that these items had normal distributions when validated (Brown & Ryan, 2003), and suggests that they may have different distributions in a state version as compared to a trait version. Again, to better assess variability in the future, it will be necessary to develop or revise measures so that floor or ceiling effects are reduced.

#### **Research Question 5: Do the Two Groups Report Different Functions of Acquisition?**

The hoarding and control groups did not differentially endorse any specific function at statistically significant rates after controlling for acquiring in a between-group analysis. The most frequently endorsed functions in the hoarding group in order were: positive internal, negative internal, negative social, and positive social, while the most frequently endorsed functions in the control group in order were: positive internal, positive social, negative social, and negative internal. In each group, the proportion of acquiring events with a positive internal function was significantly higher than all other functions. The hoarding group reported a greater number of functions for each acquisition

event, but this was not a statistically significant difference. Power was somewhat limited in these analyses due to a relatively low total number of acquiring events. However, these results do indicate that acquiring is most often linked to a positive internal function among those with elevated hoarding symptoms. These findings highlight the importance of positive internal reinforcement in acquisition. Acquisition may be maintained mostly by attempts to achieve positive internal states. Although this has been hypothesized previously (e.g., Tolin, 2011), it appears only one study has previously explored the relationship between positive emotions and hoarding behaviors (Raines et al., 2015). Further research into positive affect and behavioral processes that those with hoarding symptoms engage in while attempting to achieve positive affect could shed more light on why people who hoard engage in acquisition for this purpose.

**Research Question 6: Does Engaging in a Hoarding-Relevant Behavior Predict Affect?**

There were no significant linear changes in positive or negative affect following acquiring, discarding, working with items, or looking for items to acquire, in the hoarding or control group when controlling for previous affect. One study on momentary effects of acquisition in a compulsive buying sample found that negative affect decreased after buying, while positive affect did not change (Müller et al., 2012), so this study replicates those findings on positive affect but did not replicate the findings on negative affect. However, compulsive buying and hoarding are not fully overlapping (Mueller et al., 2007), so the discrepant results could be attributable to differences in the samples.

The null findings in the present study could be due to limited power, as the

frequency of most of these behaviors was relatively low overall. However, in consideration of the previous finding that positive internal functions were commonly reported as the reason for acquiring in both groups, it raises the question of whether or not acquisition and other hoarding behaviors actually function as intended. Individuals may theoretically be insensitive to actual consequences of their behavior due to low present-moment awareness or high fusion with verbal content. In hoarding, this could mean that individuals believe strongly in a verbal rule such as, “Having this will make me happy,” and do not attend to the actual consequences of acquisition on whether or not they feel happy after the behavior. Similar questions have arisen with other problem behaviors such as binge eating (Haedt-Matt & Keel, 2011). Binge eating has long been hypothesized to occur as a way to reduce negative affect, but momentary research has not found any actual decrease following binge eating (Haedt-Matt & Keel, 2011). Future studies should investigate the degree of similarity between expected consequences of acquiring and discarding on affect, as well as their actual consequences, and the potential mediating role of cognitive fusion and present-moment awareness if there is significant discrepancy between these two.

**Research Question 7: What is the Trajectory of Affect in the Period Before and in the Period After a Hoarding-Relevant Behavior?**

A second series of models investigated change in affect either prior to or after a particular hoarding-relevant behavior, inspecting linear, quadratic, and cubic models for each outcome. There were few significant findings relative to the number of models run. In general, power was limited for these models, particularly as some required a large

number of predictor terms and interactions. However, this suggests that hoarding behaviors may occur relatively independently of actual changes in affect, casting doubt on the assumption that hoarding serves a primarily mood regulatory function. That said, there were three significant findings regarding the trajectory of affect.

After acquisition, positive affect was generally constant in both groups for approximately the next 12 hours, after which it increased in the control group but not in the hoarding group. This suggests that positive affect generally does not increase or decline notably right after acquisition. It is unclear why positive affect would increase in the control group around 12 hours after acquiring.

In a separate model, positive affect increased linearly after working with one's belongings for those in the hoarding group, but declined linearly in the control group. This suggests that interacting with one's belongings is positively reinforced among those with hoarding symptoms. This makes sense given that people who hoard often repetitively work to organize items with little apparent progress (Frost & Hartl, 1996). This behavior has sometimes been argued to be a form of behavioral avoidance (Kellett, Greenhalgh, Beail, & Ridgway, 2010) or to be due to information processing deficits (Frost & Hartl, 1996), but it appears that this behavior has not been hypothesized to be positively reinforced before. If these findings are replicated in clinical samples, it suggests that disrupting this reinforcement process or altering it by connecting it with one's values might be necessary to change this repetitive behavior.

Finally, in the third model there was no significant interaction with group, but there was a significant quadratic effect for time after working with items predicting

negative affect. Negative affect was relatively constant in both groups, then decreased after about 9-12 hours. Again, it is difficult to interpret why this would occur given how long it is after discarding, and it could be due to other correlates such as time of day rather than the effect of discarding.

### **Limitations and Future Directions**

This study is a preliminary investigation of the function of hoarding behaviors and the emotional processes involved in hoarding. As such, it has limitations that should be considered in interpreting the results. This study used an observational design, limiting the ability to draw causal conclusions. The study also used an analogue sample, which means that replication in a clinical population is necessary in order to ensure generalization. The sample is also largely White, mostly female, and all participants were students, so results may not generalize to other groups.

In addition, the EMA measures of daily stressors, affect, experiential avoidance, hoarding symptoms, and function of acquisition lacked thorough validation, so it is not possible to be certain that they are accurately measuring the desired constructs. However, all of these measures were selected because they have been used successfully in previous studies and appear to measure the intended constructs in a theoretically sound manner. In addition, while EMA improves on the use of global self-report in several ways, it can still be vulnerable to recall bias and other self-report biases like social desirability. Participants were restricted to a 15-minute response window in order to limit the effects of recall bias. To address issues of social desirability, participants were notified that data

would be de-identified and the initial training stressed the importance of provide accurate answers to minimize social desirability bias. The possibility of careless or rushed responding was also high, since participants were asked to respond to prompts quickly during their daily lives. Participants were informed that there was no penalty for non-response and were given the option to skip questions to help limit careless responding.

Another limitation of this study was the failure to achieve exactly matched groups due to difficulty finding age-matched controls for all hoarding participants. Age was controlled for statistically in all analyses reported. However, it is possible that the differences in age also resulted in differences in other unmeasured but important variables. Finally, although study compliance was acceptable, there were high rates of missing data, as is typical in studies that use ecologically valid methods. Maximum likelihood estimation was used to account for missing data, and it is able to estimate model parameters well even with large amounts of missing data when the data are missing due to observed variables (Hedeker & Gibbons, 2006). However, if data are missing due to other, unobserved variables, then it is possible that the resulting model parameters are inaccurate (Hedeker & Gibbons, 2006).

Another limitation to the current study is that power was limited to detect changes in affect and intended function linked to hoarding-related behaviors because relatively low rates of these behaviors occurred during the one-week study period. No other studies could be identified that examined the rate of acquiring, discarding or other hoarding-related behaviors in a naturalistic setting, and so it is not possible to conclude if the rates of acquiring and discarding were particularly low in this sample compared to a clinical

sample. However, future studies of this nature could use a larger sample, longer time period, or event-contingent responding in order to provide greater power to examine similar questions.

Overall, these results provide support for acquisition having an intended positive acquisition function, and for working with items being reinforced by actually improving mood in those with higher hoarding symptoms. These findings highlight the importance of better understanding positive affect in hoarding. Future studies should investigate whether levels of positive affect differ among those with a hoarding problem, if positive affect is altered by other behavioral processes such as mindfulness and experiential avoidance in those with a hoarding problem, and whether people with a hoarding problem tend to overvalue or cling to positive affect. Future studies should also investigate if there are similarities or discrepancies between the intended function of hoarding-related behaviors and their actual functions in the moment, and if those relationships are moderated by cognitive fusion or present-moment awareness. In general, hoarding behaviors did not appear to have contingent relationships to affect in the moment in this study. If this result is replicated, it would suggest that either hoarding behaviors are maintained by other consequences or that there is a discrepancy between what people who hoard expect to happen to their mood and what actually occurs in the moment.

This study provides additional support for the hypotheses that emotional reactivity, experiential avoidance, and mindfulness contribute are relevant to hoarding. Future studies should determine if these processes are predictive of the development of hoarding disorder or changes in its severity over time. It would also be beneficial to

investigate if altering these processes results in improvements in hoarding. This could be investigated by testing acceptance and mindfulness-based treatments for hoarding, by investigating whether adding interventions to directly target these processes improves current treatments for hoarding, or by investigating whether changes in hoarding outcomes in CBT or ACT are mediated by changes in emotional reactivity, experiential avoidance, or mindfulness.

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APPENDIX

ECOLOGICAL MOMENTARY ASSESSMENT QUESTIONS

| EMA Questions  |        | Response Options  |
|--|--------|---|
| 1. Have you experienced any stressful events since the last prompt? There are many types of stressful events. Examples include hurrying to meet a deadline, having an argument, being sick, etc. |        |   |
|  | a. Yes |   |
|  | b. No  |   |
| Rate how _____ you feel right now  |        | Response options: sliding scale, 1(very slightly or not at all), 2, 3, 4, 5 (extremely)   |
| 2a. Content  |        |   |
| 2b. Relaxed  |        |   |
| 2c. Enthusiastic   |        |   |
| 2d. Joyful   |        |   |
| 3a. Anxious  |        |   |
| 3b. Angry  |        |   |
| 3c. Sad  |        |   |
| 3d. Sluggish   |        |   |
| Rate how much this sentence is true for you right now: _____   |        | Response options: sliding scale, 1(not at all), 2, 3, 4, 5, 6, 7 (very much)  |
| 4a. Since the last prompt my emotions have got in the way of things which I wanted to do   |        |   |
| 4b. Since the last prompt I've tried to block negative thoughts out of my mind   |        |   |
| 4c. Since the last prompt I've tried to avoid painful memories   |        |   |
| Please indicate the degree to which you were having this experience when you received the notification:  |        | Response options: sliding scale, 1 (not at all), 2, 3, 4, 5, 6, 7 (very much)   |
| 5a. I found it difficult to stay focused on what was happening in the present.   |        |   |
| 5b. I rushed through activities without really being attentive to them.  |        |   |
| 5c. I did jobs or tasks automatically, without being aware of what I was doing.  |        |   |
| 5d. I found myself preoccupied with the future or the past.  |        |   |
| 5e. I found myself doing things without paying attention.  |        |   |
| 6. Have you bought or otherwise acquired any new belongings since the last prompt? "Belongings" refers to items that you plan to save and that are not necessities.                              |        |   |
|  | a. Yes |   |
|  | IF YES | 7. Approximately how long ago did you buy or acquire the item(s)?<br>Response options: ___ hours ___ minutes                            |
|  |        | 8. Indicate why you acquired the item(s). You can select multiple options. Only select "Other" if none of the first four options apply. |
|  |        | a. Distract myself from thought/feeling   |
|  |        | b. Made me feel good  |
|  |        | c. To get attention or to get a reaction from someone   |
|  |        | d. To escape from a task/people   |
|  |        | e. Other  |
|  | b. No  |   |

|  |   |   |
|--|---|---|
| 9. Have you thrown out or gotten rid of any belongings since the last prompt? "Belongings" refers to items that you were saving that are not necessities.          |   |   |
| a. Yes   |   |   |
| IF YES   | 10. Approximately how long ago did you throw out or get rid of the item(s)? | Response options: ___ hours ___ minutes |
| b. No  |   |   |
| 11. Have you looked through, sorted, or organized your belongings since the last prompt?   |   |   |
| a. Yes   |   |   |
| IF YES   | 12. Approximately how long ago did you look through your belongings?        | Response options: ___ hours ___ minutes |
| b. No  |   |   |
| 13. Have you looked for items you might buy or acquire since the last prompt? This refers to objects that you would plan to keep around, that are not necessities. |   |   |
| a. Yes   |   |   |
| IF YES   | 14. Approximately how long ago did you look for items you might acquire?    | Response options: ___ hours ___ minutes |
| b. No  |   |   |