Hoarding symptoms correlate with the endowment effect

Helen Pushkarskaya[a], Peter Lenkic[b], Brent Stewart[b],

David Tolin[a,c] and Sheila R. Woody[b]

[a]Department of Psychiatry, Yale School of Medicine, New Haven, CT 06519, USA

[b]Department of Psychology, University of British Columbia, Vancouver, BC Canada V6T 1Z4

[c]Anxiety Disorders Center & Center for Cognitive Behavioral Therapy, Institute of Living, Hartford Hospital, Hartford, CT 06106, USA

Corresponding author

Helen Pushkarskaya, PhD

Phone: 203-737-2779

Email: helen.pushkarskaya@yale.edu

Abstract

Distorted judgments of the value of possessions are believed to drive excessive acquisition and difficulty discarding in hoarding. Aberrant valuation in hoarding disorder may manifest in an exaggerated *endowment effect*. We tested this supposition in two studies, using between- (Study 1) and within- (Study 2) subjects designs. We used nonparametric 2x2 ANOVA to contrast the strength of the endowment effect between healthy individuals and those with hoarding disorder. We also used quantile regression analysis to examine the relation between severity of hoarding symptoms and the endowment effect. The data did not reveal an elevated endowment effect among participants with hoarding disorder in either study. However, in both studies self-reported difficulty discarding, the hallmark feature of hoarding, as well as severity of overall hoarding symptoms, positively correlated with between-subject variations in the endowment effect. Symptom improvement following cognitive-behavioral therapy for hoarding did not correspond to a decrease in the endowment effect, potentially indicating a dissociation between hoarding severity and the endowment effect over the course of treatment. Overall, our results suggest the potential value in further study of the endowment effect in hoarding, particularly its trait versus state features and modifiability.

Keywords: Endowment effect, Compulsive Hoarding Disorder, Difficulty discarding, Individual differences, CBT, Quantile regression analysis

The hallmark feature of hoarding disorder (HD) is difficulty discarding due to strong urges to save or distress associated with discarding (American Psychiatric Association [APA], 2013). Excessive acquisition is also present in most cases (Frost et al., 2009). These behaviors result in the accumulation of clutter that compromises use of living areas in the home. Current models of HD propose several core impairments: information processing deficits, distorted beliefs about possessions, and difficulties in emotional processing (Frost & Hartl, 1996; Gilliam & Tolin, 2010; Steketee & Frost, 2003). Available psychological treatments, principally CBT, are efficacious, but rates of clinically significant change are modest (Tolin et al., 2015). Faced with these challenges, there is a need for new insights into the disorder.

Emotional attachment to possessions is not unique to HD, but it does correlate with saving behavior and acquisition of free objects (Grisham et al., 2009; Steketee & Frost, 2003; Timpano & Shaw, 2013). Distorted judgments of the value of possessions are believed to drive excessive acquisition and difficulty discarding in HD (Frost & Hartl, 1996). The endowment effect (EE) reflects a type of value distortion that is broadly present in the general population. Briefly stated, the endowment effect (EE) is the *tendency to value an owned object more highly than an identical object that is not owned* (Thaler, 1980). Tolin and Villavicencio (2011) first suggested that HD may manifest in an exaggerated endowment effect. Here, we empirically test this supposition in two studies of participants with clinical levels of hoarding.

The EE has been demonstrated in the general population using a variety of different methods, including hypothetical and incentivized assessments in between-subjects designs (Horowitz & McConnell, 2002, 2003), trade experiments (De Sousa &

Munro, 2012), and within-subjects designs (Drouvelis & Sonnemans, 2017; Jefferson & Taplin, 2011). Between-subject paradigms contrast how much individuals who are randomly assigned to be “owners” would be willing to accept (WTA) for an endowed item in comparison with how much participants assigned to be “buyers” would be willing to pay (WTP) for the same item. Within-subject paradigms compare individual participants’ WTA and WTP for the same items. In research using between-subject WTA-WTP paradigms, owners often ask for nearly three times more than buyers are willing to pay (Horowitz & McConnell, 2002); the WTA–WTP disparity is smaller in within-subject designs (Sayman & Öncüler, 2005).

Empirical studies demonstrated that the EE varies greatly among individuals from general population (Kogut & Kogut, 2011; Maddux et al., 2010). Individual loss aversion remains a leading explanation of the mechanism behind the EE (Kahneman, Knetsch, & Thaler, 1991). However, others propose that emotional attachment developed through item ownership might be also responsible for the EE (Morewedge & Giblin, 2015). Importantly, emotional attachment is often given as a reason for retaining items in HD (Frost et al., 2015), and emotional attachment correlates with self-reported difficulty discarding and other symptoms of HD (Yap & Grisham, 2019). This raises the possibility that the EE could serve as a quantifiable index of aberrant valuation in clinically significant hoarding, and that changes in the EE may be a useful measure of the outcome of cognitive-behavioral therapy (CBT) that aims to regulate emotional attachment to objects.

This paper describes two studies that use between- and within-subject EE paradigms to test a series of hypotheses. Participants with HD were expected to show a stronger EE than healthy control participants. Furthermore, hoarding symptoms,

specifically difficulty discarding, were expected to positively correlate with the EE. Finally, treatment-related reductions in hoarding symptoms, and in particular difficulty discarding, were expected to be linked to a corresponding decrease in the EE.

Method

We tested our hypotheses in two separate studies in a between-subject design (Study 1) and a within-subject design (Study 2).

Study 1: Between-subject paradigm

Participants. All Study 1 participants were recruited through Centre for Collaborative Research on Hoarding at the University of British Columbia (UBC), Canada. All procedures were approved by the UBC Office of Research Ethics. All participants gave written informed consent after hearing the study procedure and prior to the participating.

Eighty-five adults (58 females; age range = 20-70, mean age = 49 ± 2 years) participated. Of these, data from 23 healthy controls (HC) and 43 individuals with HD were used for analyses of diagnostic group differences. Participants who did not qualify for those two groups (i.e., 10 with other psychiatric diagnoses, and 9 with subclinical hoarding symptoms) were only included in dimensional analyses of the hypothesized correlation between difficulty discarding and the EE. This approach allowed exploring the hypothesized link between difficulty discarding and the EE dimensionally as well as the categorical comparison between HD and HC.

Hoarding diagnoses were based on DSM-5 diagnostic criteria following the structure of the Mini-International Diagnostic Interview (MINI; Sheehan et al., 1998) and aided by the use of photographs of the participant's home. Interviews were conducted by graduate-

level examiners. A licensed psychologist (SRW) trained the interviewers and reviewed recordings of all interviews; diagnostic disagreement was resolved by discussion.

Procedure. Study participants completed an experimental procedure to evaluate the EE, in which each participant was randomly assigned to be either an "owner" (N = 43) or "buyer" (N = 42). Two objects were used for the EE procedure: (1) a mug with logos of the university Psychology Department and (2) a custom-made individually-wrapped Belgian chocolate with the Department's logo. Though a mug is often used to evaluate EE, we additionally used a chocolate as some individuals with hoarding might be mindful not to bring anything home, therefore having evaluated the EE with a consumable item (the chocolate) might help avoid this possible confound.

Before arriving at the lab, participants were emailed a reminder about the study, and the owners (but not the buyers) received an additional note informing them that they would be receiving a mug in appreciation of their participation. Upon arriving at the lab, owners were asked to hold the mug and inspect it closely while the experimenter explained that the mug was designed as a special thank-you gift for participating in Psychology Department research, emphasizing the personal keepsake meaning of the logo. Buyers were shown several mugs arranged on a shelf at the back of the room but were not given an opportunity to hold a mug; the experimenter explained that the mugs were left over from a previous study, and that they would later have an opportunity to buy one.

Next, all participants completed a mug valuation questionnaire in which they chose between various amounts of money or the mug. The price options ranged from $0.50 to $10.00 in increments of $0.50 (20 price options total). This range of possible values was

chosen to center the retail price of the mug ($4.25) at the midpoint of the range. Participants were informed that one of the choices presented in the questionnaire (mug versus a specific dollar amount) would be randomly selected to be played out for real outcomes. That is, if participants chose this amount of money over the mug then they would receive the money and if they chose the mug they would receive the mug (Becker et al., 1964). This incentives schedule is commonly used in EE studies to maximize validity of the valuations.

After completing the mug valuation questionnaire, all participants were shown a chocolate which had not been mentioned up to this point. Owners were told that the chocolate was an additional thank-you gift, and the experimenter emphasized the personal commemorative meaning of the logo on the chocolate in connection with the psychology study they were participating in. Buyers were simply told that they had an opportunity to buy the chocolate in the same way as the mug. Participants then completed a chocolate valuation questionnaire; they made a series of choices between the chocolate and dollar amounts that ranged from $0.10 to $2.00 in increments of $0.10 (20 price options total). As with the mug valuation questionnaire, this range of possible values was chosen to center the actual price of the chocolate ($0.70) at the midpoint of the range.

In filling out the mug and chocolate valuation questionnaires, owners indicated which price would be high enough for them to sell the mug and the chocolate to the experimenter (WTA mug and WTA chocolate), and buyers indicated which price would be the highest they would pay to acquire the mug and the chocolate (WTP mug and WTP chocolate).

Next, the experimenter tossed a 20-sided die in view of the participant to determine which one of the 20 choices presented on the mug and the chocolate valuation questionnaires was to be enacted (with the 1-dot side on the die corresponding to the lowest-value option and the 20-dot side of the die corresponding to the highest-value option). Participants received the mug/chocolate if they had circled the good for the line item corresponding to the die throw; if they had circled money on that line item, then this amount was added to (for owners) or subtracted from (for buyers) the $40 participation incentive payment.

Measures. Dimensional severity of HD symptoms was assessed using the Saving Inventory-Revised (SI-R; Frost et al., 2004), a well-established self-report measure of hoarding symptom severity. Both the Total score and the Difficulty Discarding subscale (DD) were examined in analyses. WTP and WTA were derived separately for the mug and the chocolate using the valuation questionnaires described above.

Study 2: Within-subject paradigm

Participants. All Study 2 participants were recruited through the Anxiety Disorders Center & Center for Cognitive Behavioral Therapy at the Institute of Living of Hartford Hospital, United States. All procedures were approved by the Hartford Hospital Institutional Review Board. After the study procedure was explained, all participants gave written informed consent prior to the study.

One hundred forty-three adults (111 females; age range = 22 – 65 years, mean = 54 ± 1) participated: 59 healthy adults (HC) and 84 with HD. Diagnoses were established using the Diagnostic Interview for Anxiety, Mood, and Obsessive-Compulsive and

Related Disorders (DIAMOND; Tolin et al., 2018) and confirmed by doctoral-level clinicians.

Procedure. The experiment was a part of a larger treatment study (Tolin et al., 2019). The treatment consisted of 16 weekly 90-min group sessions of CBT that emphasized in-session practice of discarding and refraining from acquiring, decision-making and problem-solving training, emotional distress tolerance, motivational interviewing strategies, and contingency management.

All study participants completed two parts of a WTP-WTA survey. HC participants were assessed only at intake, whereas HD participants were assessed both at intake and after 16 weeks of CBT. The WTA part of the survey instructed participants to imagine that they were having a yard sale and asked them to indicate the minimum amount, in dollars and cents, that they would be willing to accept for each item on the list. The WTP part instructed participants to imagine that they were going to a yard sale to buy items for themselves or as a gift for someone they know. It further asked them to indicate the maximum amount that they would be willing to pay for each item from the same list. The order of WTA and WTP was counterbalanced.

Items included in the survey varied in market price: bookshelf, drill, coffeemaker, iPod, TV, dining table, casserole dish, and table clock. The EE has previously been shown to be stronger for items with a higher market price (Carmon & Ariely, 2000; Knutson et al., 2008).

Measures. As in Study 1, DD was assessed using the SI-R difficulty discarding subscale. The EE was calculated for each item from the survey for every participant. To account for differences in market price across items, we used a normalized measure of the EE

$\left(\frac{WTA-WTP}{WTP}\right)$. The resulting value can be either positive or negative on an individual level but tends to be positive on a group level (Jefferson & Taplin, 2011).

Data analysis.

HD diagnosis and the EE. To examine the relation between discrete HD diagnosis and the EE, we employed nonparametric ANOVAs. In Study 1, we used a 2 x 2 ANOVA ('aligned.rank.transform' routine in R) with between-subjects factors of ownership condition and diagnostic group. A post hoc power analysis indicated that for 23 HC and 43 HD participants, 0.8 power ($p<.05$) is achieved for detecting medium-to-large effects ($d=0.45$ or greater) assuming Gaussian distribution of error terms; for non-Gaussian distributions the minimum detectable effect size is likely to be larger (Lehmann, 2009).

In Study 2, we used a series of 2 x 1 nonparametric multivariate ANOVAs with 15,000 permutations ('nonpartest' routine in R) with the EE for low-cost, medium cost, and high cost items as the dependent variables each examined separately, and with diagnostic group as the between-subject factor. A post hoc power analysis indicated that for 59 HC and 84 HD participants, 0.8 power ($p<.05$) is achieved for detecting medium effects ($d=0.30$ or greater) assuming Gaussian distribution of error terms. Although 2 x 3 repeated measures nonparametric ANOVA would have been preferable for our research design, we were unaware of a statistical package that allows for such analysis.

Dimensional hoarding symptoms and the EE. To examine the relation between dimensional hoarding symptoms and the EE we used linear regression modeling. In Study 1, we used models:

Mug value ~ Owner + SI-R DD + Owner x SI-R DD (1a)

Mug value ~ Owner + SI-R Total + Owner x SI-R Total (1b)

A significant interaction term *Owner x SI-R (DD or Total)* would indicate that the difference between WTA and WTP (i.e. the EE) increases with hoarding symptoms.

In Study 2, we used models:

EE ~ SI-R DD (2a)

EE ~ SI-R Total (2b)

In both studies, we utilized quantile regression, a statistical approach that does not impose restrictions on the distribution of the error terms ('quantreg' package in R; Koenker, 2005). In Study 1, data for the mug and chocolate conditions were analyzed separately. In Study 2, mean within-subject EE for low-cost items, medium-cost items, high-cost items, and all items together, were analyzed separately. Follow up analyses (using 'frame_distance' routine in the quokar package R) revealed presence of outliers in the 30th percentiles for the mug condition, but no outliers for the chocolate condition.

Results

Study 1

Sample characteristics. Participants assigned to the two experimental conditions did not differ in terms of gender, years of education, income, or HD severity (*p*s > .19). However, owners were significantly older than buyers (M = 53 ± 2 vs. 46 ± 3, p = .04). Severity of hoarding was broadly distributed among study participants, with notable overlap of SI-R distributions across diagnostic groups (with ranges for HC: 9 - 54 and for HD: 27 - 73; see Supplementary Materials 1). Clinical controls and subclinical HD participants' SI-R scores ranged from 10-69, suggesting that diagnostic group analyses

are not redundant with dimensional analyses of the correlation between self-reported hoarding severity and the EE.

Floor and ceiling effects. Neither WTP nor WTA were normally distributed in this sample (Shapiro-Wilk test p-values < 0.01), and the variances were not equal across groups, Levene's test $F(1,76) > 10.03$, $p < .01$. Further inspection revealed a bimodal distribution with both floor and ceiling effects (27% of participants selected the minimal price in both mug and chocolate conditions; 15% and 19% of participants selected the maximal price in mug and chocolate conditions, respectively)**.** Thus, we relied on non-parametric techniques (as described above).

The endowment effect and HD diagnosis. First, we analyzed data from 23 HC and 43 HD participants to examine diagnostic group differences on the EE. Consistent with our expectation, 'owners' valued the items higher than 'buyers' as the results indicated a significant main effect of ownership on the value of the items, $F = 24.43$, $p < .001$, median-based Cohen's $d = 0.22$. However, contrary to our expectations, HD diagnosis did not affect the EE, as the interaction with diagnostic group was not significant, $F = 0.54$, $p = .47$, median-based Cohen's d = 0.10 (Supplementary Materials 2).

The endowment effect and HD symptoms. Second, we took a dimensional approach to analyze data from all 85 study participants (i.e., including those who did not meet criteria for the HD or HC groups) to examine the hypothesized link between hoarding symptoms and the EE cross-diagnostically rather than exclusively in individuals with clinically significant HD.

Confidence intervals for the quantile model were estimated by increments of 0.1 from 0.10 to 0.90 quantiles. For the sample size of $N = 85$ and a model with three

estimated parameters, the lower and higher quantiles (≤ 0.20 and ≥ 0.80) had unreliable 95% confidence intervals (Cade et al., 2006), and thus are not reported here. For both mug and chocolate, the median regression revealed that the EE positively correlated with DD severity ($p < .05$), consistent with our expectations (Table 1, Figure 1). For the mug, this effect was also significant for the 60th and 70th percentiles (Cohen's $f^2 = 0.05$); for the chocolate, this effect was also significant for the 40th, 60th, and 70th percentiles (Cohen's $f^2 = 0.07$). For the mug, a one-point increase in the SI-R DD subscale was associated with a $0.22 increase in difference between WTA and WTP (median effect). For the chocolate, a one-point increase in the SI-R DD subscale was associated with a $0.04 increase in the WTA-WTP difference. Also, note that our data were subject to both ceiling and floor effects, which may impact the accuracy of the estimate of the EE.

Similarly, for both mug and chocolate, the median regression revealed that the EE positively correlated with SI-R severity ($p < .05$), consistent with our expectations (Supplementary Materials 3). For the mug, this effect was also significant for the 60th and 70th percentiles (Cohen's $f^2 = 0.05$); for the chocolate, this effect was also significant for the 40th, 60th, and 70th percentiles (Cohen's $f^2 = 0.06$).

Follow up analyses revealed presence of outliers in the 30th percentiles for the mug but no outliers for the chocolate. Detected outliers may have affected results of the regression for the lower percentiles in the mug condition.

Study 2.

Sample characteristics. HC and HD did not differ in terms of age, years of education, or income (ps > .10, Table 3). The proportion of women in the HD group was significantly higher than in the HC group (HD: 0.86 vs. HC: 0.66, $p = .006$). Severity of hoarding was

broadly distributed among study participants (with ranges for HC: 0 - 53, and for HD: 31 - 88, Supplementary Materials 1).

The endowment effect and HD diagnosis. As in Study 1, we first examined the effect of the discrete HD diagnosis on the EE. Three items (casserole, coffeemaker, and clock) were priced at a low level (median WTP = $2, $5, and $5 respectively), two items (bookshelf, and drill) were priced at a medium level (median WTP = $15 and $15), and three items (iPod, TV, and dining table) were priced at a high level (median WTP = $50, $100, and $200, respectively). We contrasted the EE between diagnostic groups separately for each price group, as in Knutson and collegues (2008). Contrary to our expectations, the EE did not differ significantly between diagnostic groups (test stat < 2.35 permutation $p > .07$, Supplementary Materials 5).

The endowment effect and HD symptoms. Confidence intervals for the quantile model were estimated by increments of 0.1 from 0.10 to 0.90 quantiles. For the sample size of $N = 143$ and a model with two estimated parameters, the lower and higher quantiles (≤ 0.20 and ≥ 0.80) had unreliable 95% confidence intervals (Cade et al., 2006), and thus are not reported here. The median regression revealed that hoarding symptoms (both SI-R DD and Total) positively correlated with the EE only for the high cost items (Cohen's $f^2 = 0.01$). These effects were also significant for 60^{th} and 70^{th} percentiles (Table 2, Supplementary Materials 6). The median effect of a one-point between-subject difference in the SI-R DD subscale translated to a $0.01 difference in the EE for high-cost items, based on WTP of $100. Follow-up analyses did not reveal any outliers. Analyses of low- and medium-cost items, and for the average across all items revealed no statistically significant effects.

The endowment effect and CBT. To test the hypothesized effect of CBT on the EE in individuals with clinically significant hoarding, we compared the EE before and after therapy on a group level for 70 participants who were taking part in CBT for hoarding. We also examined whether pre-post difference scores in hoarding symptoms (SI-R DD and Total) correlated with pre-post differences in the EE. Despite significant reductions in symptom severity following CBT (pre-post d = 0.63 for SI-R DD subscale and d = 0.78 for SI-R Total; Tolin et al., 2019), EE did not show significant changes on a group level for any of the eight items (related-samples Friedman's two-way test for the coffeemaker p > .07, and for the remaining items p > .23). Furthermore, contrary to our expectations, treatment-related changes in hoarding symptoms did not correlate with individual changes in the EE for any item (Spearman's ps > .28). Interestingly, quantile regression analyses (equations 2 above) did not showed any significant correlations between post-treatment EE and post-treatment SI-R DD or Total. Note, however, that our sample was relatively underpowered for nonparametric analyses (Li & Racine, 2007).

Discussion and Conclusion

Using between- (Study 1) and within-subject (Study 2) designs, we tested Tolin and Villavicencio's (2011) hypothesis that the endowment effect is exaggerated among individuals with HD. Contrary to our expectations, we did not find elevated EE among participants with HD in either study. However, consistent with our expectations, in both studies we found that self-reported difficulty discarding, the hallmark feature of HD, as well as overall self-reported severity of HD symptoms, positively correlated with the between-subject variations in the endowment effect in samples that included individuals with HD, healthy participants, and those with other clinical diagnoses. Of note, this is

consistent with neuroimaging findings that activation in the right insula correlates with individual differences in EE in the general population (Knutson et al., 2008) and also is elevated among individuals with HD during decisions about whether to discard their possessions (Tolin et al., 2012).

Importantly, we detected significant relation of hoarding symptoms with the EE in both between and within-subject designs. Prior studies suggested that the WTA–WTP disparity is smaller in within- than in between-subjects paradigms (Sayman & Öncüler, 2005). Our results are consistent with these prior findings. In Study 1, using a between-subjects design we found a small-to-medium effect size of the correlation between hoarding severity and the EE (Cohen's f^2 = 0.05 and 0.07, for mug and chocolate, respectively); in Study 2, this effect, though still significant for high-cost items, was smaller (Cohen's f^2 = 0.01). The within-subject WTA-WTP paradigms could potentially be useful in deriving a quantifiable index of subjective overvaluation of possessions and in tracking the effects of CBT for hoarding.

The effect sizes of the association between HD symptoms and the EE were relatively weak. This is not an uncommon finding in behavioral economics or clinical research. For instance, the positive associations between difficulty discarding and self-reported emotional attachment to inanimate objects are also small in magnitude (Frost et al., 2015; Yap & Grisham, 2019). Also recall that in within-subject designs, which may potentially be more useful for clinical purposes, a significant correlation between hoarding symptoms and the EE was observed only for high-cost items. This is somewhat inconsistent with clinical observations and preliminary empirical evidence that individuals with HD appear to overvalue items that are objectively of very low worth (Welsted, 2014).

Such inconsistency is not unexpected; findings from behavioral economics repeatedly demonstrate discordance between self-report and behavioral measures of the same constructs, as they assess different features of these constructs (Dislich et al., 2015). That the link between hoarding symptoms and EE was replicated across two studies with very different designs and in two distinct samples, however, suggests the potential value in further study of EE, particularly its trait versus state features and the extent to which it is malleable by a targeted therapy.

In Study 2, contrary to our expectations, even though HD symptoms decreased on a group level among individuals who received CBT for HD, the magnitude of EE did not change over the course of CBT. Post-therapy, neither self-reported DD nor overall HD severity correlated significantly with strength of the EE. There are several potential explanations of this negative finding. One possibility is that a more sensitive assay of EE is necessary. Another possibility is that the EE is a trait-level characteristic that may serve as a risk factor for the development of the HD rather than a malleable state-level attribute. Finally, it is possible that exaggerated EE is indeed malleable, but that the CBT used in this protocol (as most CBT used in the treatment of HD) did not sufficiently target the phenomenon. Recall that the CBT emphasized in-session practice of discarding and refraining from acquiring, decision-making and problem-solving training and did not address individual tendencies to overvalue possessions. It is possible that focusing on behaviors rather than on underlying cognitive biases may explain modest effects found for CBT in the treatment of HD. We suggest that novel CBT may use the EE as a new precursor for cognitive restructuring. We also suggest that including psychoeducation about the EE in CBT could be clinically beneficial, particularly with an experiential

exercise. The EE may also serve as a mechanistic target to be examined in clinical trials of novel CBT approaches that specifically address overvaluation rather than decisions about whether keep or discard possessions.

Notably, in both studies, a diagnosis of HD did not predict an increased EE but self-reported severity of hoarding symptoms did. One possibility for this unexpected result is that our samples were underpowered (the minimum detectable effect size was d=0.45 in Study 1 and d = 0.30 in Study 2). Another possibility is that individual difficulties with discarding of possessions do not solely determine the clinical hoarding diagnosis. Hoarding behaviors are continuously distributed in the general population (Timpano et al., 2013). In our samples, distributions of SI-R scores notably overlap across diagnostic groups. To receive an HD diagnosis, one needs more than simply to experience difficulty discarding possessions; rather, such difficulties must result in an amount of clutter that it is extreme enough to cause severe *functional impairment* in the home or *distress* to those who live there. Many factors, in addition to the overvaluation of possessions, contribute to such a situation including the size of the home and the potential protective effect of other people helping to keep clutter at bay. In contrast, self-report instruments (which did show an association with the EE) take less account of home size or actions of others in the home than do clinical interviews. Thus, such measures may be a more appropriate lens than a *distress-centric* clinical dichotomous diagnosis for investigating the role of the EE in hoarding. Considering individual tendencies to overvalue possessions as a continuous transdiagnostic dimension is well aligned with the RDoC approach to investigating mental disorders (Krueger & DeYoung, 2016).

Future studies could build on our findings and improve our designs to investigate further the role of the EE in HD. For instance, avoiding the floor effect in the between-subject designs might not be realistic, but avoiding the ceiling effect is feasible. Surveying both healthy individuals and individuals with hoarding about possessions of different market prices that are particularly valuable to them (including those of a very low objective worth) may help to select appropriate items and scenarios for use in a within-subjects design. Examining neural antecedents of the EE in relation to hoarding symptoms in both healthy and clinical populations may help to identify neural biomarkers of HD. Studies in the general population have found that the endowment effect is significantly affected by factors such as length of ownership, physical contact, and reference prices (Morewedge & Giblin, 2015; Morewedge et al., 2009; Weaver & Frederick, 2012). Examining how these facets of an object interact with hoarding symptoms is not only of general interest but also may provide new insights into the disorder and potentially suggest innovative approaches to HD treatment. For example, if physical contact were found to affect the EE more strongly in individuals with hoarding, people with HD may be advised to limit handling of objects when making discarding decisions. Such approaches may serve as useful additions to current cognitive behavioral approaches to treatment. Overall, our findings suggest that deeper understanding of aberrant object valuation in HD can inform new cognitive and neurobiological models of the hoarding disorder and offer new approaches for therapeutic interventions.

Tables:

Table 1. Demographic and Clinical Characteristics of Study 1 Participants, M (SEM) or Frequency (%).

	Owners		Buyers		2x2 ANOVA F or χ^2		Owners	Buyers	1x2 ANOVA F or χ^2
	HC	HD	HC	HD	HD vs HC	Owner vs. Buyer	Full sample		Owner vs. Buyer
N	12	24	11	19	0.08		43	42	3.4
Demographics									
Age	51.3 (5.7)	54.5 (2.2)	36.7 (4.7)*	51.7 (2.3)	7.3*	5.2*	46.7 (2.3)	50.8 (2.3)	1.6
Male	4 (33.3%)	7 (29.2%)	3 (27.3%)	2 (10.5%)	0.7		11 (26%)	16 (37%)*	13.1*
Educations (years)	15.3 (0.9)	16.0 (0.4)	15.4 (0.6)	15.3 (0.4)	0.5	0.1	15 (0.3)	15.4 (0.4)	0.4
Saving Inventory Revised									
Difficulty Discarding	8.2 (1.4)	17.7 (1.0)	7.0 (1.2)	17.7 (1.4)	59.9*	0.2	13.6 (1.2)	14.7 (1.1)	0.3
Total score	22.3 (3.7)	54.3 (2.6)	21.9 (2.2)	54.9 (3.3)	101.1*	<0.01	42.4 (3.1)	42.7 (3.1)	0.02

Note: HC - Healthy Controls, HD- Hoarding disorder; * - between group difference is significant at $p < 0.05$ level

Table 2. The Association of Mug/Chocolate Value with Owner Condition, Saving Inventory Difficulty Discarding Score (DD), and Owner x DD Interaction at Selected Quantile Levels of Mug/Chocolate Values among Study 1 Participants (N = 81).

Table 1A: Mug

	Intercept	**Owner**	**DD**	**Owner x DD**
quantile	β [95% CI]	β [95% CI]	β [95% CI]	β [95% CI]
30th	0.50 [0.50, 1.48]*	1.00 [-3.41, 2.30]	<0.001 [-0.06, <0.001]	0.08 [-0.01, 0.33]
40th	1.11 [0.75, 1.75]*	1.43 [-3.05, 3.44]	-0.03 [-0.06, >10^{308}]	0.12 [-0.03, 0.45]
50th, median	1.70 [0.98, 2.01]*	1.13 [-2.15, 2.21]	-0.05 [-0.06, -0.02]*	0.22 [0.11, 0.42]*
60th	2.00 [1.58, 2.38]*	1.28 [-0.80, 2.01]	-0.06 [-0.07, 0.02]	0.30 [0.14, 0.38]*
70th	2.00 [1.58, 4.12]*	1.22 [0.79, >10^{308}]*	<0.001 [-0.09, 0.14]	0.26 [0.13, 0.43]*

Table 1B: Chocolate

	Intercept	**Owner**	**DD**	**Owner x DD**
quantile	β [95% CI]	β [95% CI]	β [95% CI]	β [95% CI]
30th	0.22 [0.12, 0.41]*	0.64 [-0.17, 0.98]	-0.01 [-0.02, 0.01]	0.01 [-0.03, 0.04]

40th	0.26 [0.15, 0.47]*	0.74 [-0.14, 0.77]	-0.01 [-0.02, -0.01]*	0.01 [0.01, 0.05]*
50th, median	0.41 [0.24, 0.74]*	0.44 [0.06, 0.55]*	-0.01 [-0.02, -0.003]*	0.04 [0.02, 0.10]*
60th	0.56 [0.37, 1.01]*	0.20 [-0.37, 0.47]	-0.02 [-0.03, 0.03]	0.06 [0.03, 0.09]*
70th	0.50 [0.49, 1.18]*	0.32 [-0.49, 3.37]	<0.001 [-0.04, 0.02]	0.06 [0.02, 0.11]

Note: lower and higher quantiles (≤ 0.20 & ≥ 0.80) had unreliable 95% confidence intervals and are not reported here; * - effects are significant at $p < 0.05$ level; the the model specification test described in Hsiao et al. (2007).

Table 3. Demographic and Clinical Characteristics of Study 2 Participants, M (SEM) or Frequency (%).

	HC, N = 56	HD, N = 84	ANOVA F or χ^2, HD vs HC	HD sub sample that completed 8-week CBT, N = 70		ANOVA F, pre CBT vs post CBT
				Pre CBT	Post CBT	
Demographics						
Age	54.1 (1.0)	53.8 (1.0)	0.1	54.7 (0.9)		
Male	18 (32.1%)	12 (14.3%)	5.3*	11 (15.7%)		
Educations (years)	16.7 (0.3)	16.8 (0.3)	0.1	17.0 (0.3)		
Saving Inventory Revised						
Difficulty Discarding	4.0 (0.5)	19.7 (0.4)	577.4*	20.0 (0.5)	17.0 (2.3)	15.5*
Total score	10.6 (1.3)	61.5 (1.3)	695.5*	62.3 (1.4)	51.1 (1.7)	25.1*

Note: HC - Healthy Controls, HD- Hoarding disorder; CBT – Cognitive- behavioral therapy; * - between group difference is significant at $p < 0.05$ level

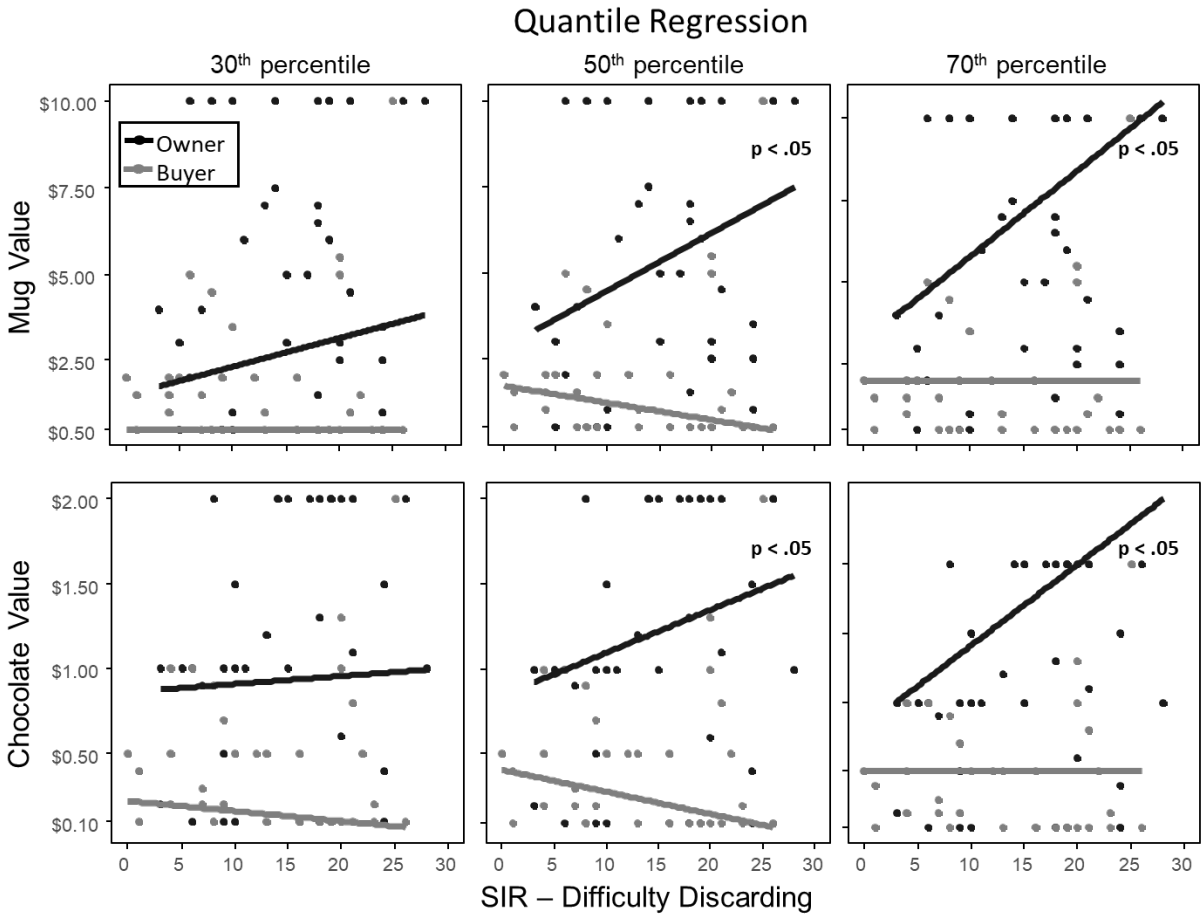
Table 4. Association of Endowment Effect with Saving Inventory-Revised (Difficulty Discarding Subscale) Across Quantile Levels of Endowment Effect Values in Study 2 (N = 143).

	Low cost items		Medium cost Items		High Cost items	
	Intercept	Difficulty Discarding	Intercept	Difficulty Discarding	Intercept	Difficulty Discarding
quantile	β [95% CI]	β [95% CI]	β [95% CI]	β [95% CI]	β [95% CI]	β [95% CI]
30th	-0.23 [-0.60, 0.06]	0.011 [-0.01, 0.03]	-0.47 [-0.64, -0.18]*	0.01 [-0.01, 0.02]	-0.09 [-0.37, -0.002]*	0.004 [-0.01, 0.02]
40th	-0.001 [-0.28, 0.07]	0.001 [-0.004, 0.01]	-0.15 [-0.50, -0.04]*	0.002 [-0.01, 0.01]	-0.03 [-0.15, 0.01]	0.004 [-0.002, 0.01]
50th, median	0.04 [-0.01, 0.11]	0.005 [-0.002, 0.01]	-0.06 [-0.18, 0.15]	0.003 [-0.01, 0.01]	-0.02 [-0.09, 0.05]	0.01 [0.002, 0.02]*
60th	0.09 [0.05, 0.23]*	0.005 [-0.002, 0.01]	-0.02 [-0.11, 0.13]	0.01 [-0.02, 0.01]	0.03 [-0.04, 0.07]	0.02 [0.01, 0.02]*
70th	0.29 [0.08, 0.53]*	0.001 [-0.01, 0.02]	0.06 [-0.06, 0.41]	0.01 [-0.01, 0.02]	0.07 [0.02, 0.25]*	0.02 [0.01, 0.02]*

Note: lower and higher quantiles (≤ 0.20 and ≥ 0.80) had unreliable 95% confidence intervals and are not reported here; * - effects are significant at $p < 0.05$ level; the model specification test described in Hsiao et al. (2007).

Figures:

Figure 1. Positive relation between Difficulty Discarding and the Endowment Effect in Study 1.



Note: Quantile regression - results for the 30th, 50th (median), and 70th percentiles of mug/chocolate values. Mug values (top) and chocolate values (bottom) show greater differences between owners and buyers (i.e., greater endowment effect) with increases in severity of difficulty discarding (Difficulty Discarding subscale of Saving Inventory Revised, DD). Results indicates that the difference in values between owners and buyers increases as DD increases (*p*-values indicate significance of this effect).

References:

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC.

Becker, G. M., DeGroot, M. H., & Marschak, J. (1964). Measuring utility by a single-response sequential method. *Behavioral science, 9*(3), 226-232.

Carmon, Z., & Ariely, D. (2000). Focusing on the forgone: How value can appear so different to buyers and sellers. *Journal of consumer research, 27*(3), 360-370.

De Sousa, Y. F., & Munro, A. (2012). Truck, barter and exchange versus the endowment effect: Virtual field experiments in an online game environment. *Journal of Economic Psychology, 33*(3), 482-493.

Dislich, F. X., Zinkernagel, A., Ortner, T. M., & Schmitt, M. (2015). Convergence of direct, indirect, and objective risk-taking measures in gambling. *Zeitschrift für Psychologie/Journal of Psychology*.

Drouvelis, M., & Sonnemans, J. (2017). The endowment effect in games. *European Economic Review, 94*, 240-262.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior research methods, 39*(2), 175-191.

Frost, R. O., & Hartl, T. L. (1996). A cognitive-behavioral model of compulsive hoarding. *Behaviour research and therapy, 34*(4), 341-350.

Frost, R. O., Steketee, G., & Grisham, J. (2004). Measurement of compulsive hoarding: saving inventory-revised. *Behaviour research and therapy, 42*(10), 1163-1182.

Frost, R. O., Steketee, G., Tolin, D. F., Sinopoli, N., & Ruby, D. (2015). Motives for acquiring and saving in hoarding disorder, OCD, and community controls. *Journal of obsessive-compulsive and related disorders, 4*, 54-59.

Frost, R. O., Tolin, D. F., Steketee, G., Fitch, K. E., & Selbo-Bruns, A. (2009). Excessive acquisition in hoarding. *J Anxiety Disord, 23*(5), 632-639. doi: 10.1016/j.janxdis.2009.01.013

Gilliam, C. M., & Tolin, D. F. (2010). Compulsive hoarding. *Bulletin of the Menninger Clinic, 74*(2), 93-121.

Grisham, J. R., Frost, R. O., Steketee, G., Kim, H.-J., Tarkoff, A., & Hood, S. (2009). Formation of attachment to possessions in compulsive hoarding. *Journal of anxiety disorders, 23*(3), 357-361.

Horowitz, J. K., & McConnell, K. E. (2002). A review of WTA/WTP studies. *Journal of environmental economics and Management, 44*(3), 426-447.

Horowitz, J. K., & McConnell, K. E. (2003). Willingness to accept, willingness to pay and the income effect. *Journal of Economic Behavior & Organization, 51*(4), 537-545.

Jefferson, T., & Taplin, R. (2011). An investigation of the endowment effect using a factorial design. *Journal of Economic Psychology, 32*(6), 899-907.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1991). Anomalies: The endowment effect, loss aversion, and status quo bias. *Journal of Economic perspectives, 5*(1), 193-206.

Knutson, B., Wimmer, G. E., Rick, S., Hollon, N. G., Prelec, D., & Loewenstein, G. (2008). Neural antecedents of the endowment effect. *Neuron, 58*(5), 814-822.

Koenker. (2005). *Quantile Regression (Econometric Society monographs; no. 38)*: Cambridge university press.

Kogut, T., & Kogut, E. (2011). Possession attachment: Individual differences in the endowment effect. *Journal of Behavioral Decision Making, 24*(4), 377-393.

Krueger, R. F., & DeYoung, C. G. (2016). The RDoC initiative and the structure of psychopathology. *Psychophysiology, 53*(3), 351-354.

Lehmann, E. L. (2009). Parametric versus nonparametrics: two alternative methodologies. *Journal of Nonparametric Statistics, 21*(4), 397-405.
Li, Q., & Racine, J. S. (2007). *Nonparametric econometrics: theory and practice*: Princeton University Press.
Maddux, W. W., Yang, H., Falk, C., Adam, H., Adair, W., Endo, Y., . . . Heine, S. J. (2010). For whom is parting with possessions more painful? Cultural differences in the endowment effect. *Psychological Science, 21*(12), 1910-1917.
Morewedge, C. K., & Giblin, C. E. (2015). Explanations of the endowment effect: an integrative review. *Trends in cognitive sciences, 19*(6), 339-348.
Morewedge, C. K., Shu, L. L., Gilbert, D. T., & Wilson, T. D. (2009). Bad riddance or good rubbish? Ownership and not loss aversion causes the endowment effect. *Journal of Experimental Social Psychology, 45*(4), 947-951.
Sayman, S., & Öncüler, A. (2005). Effects of study design characteristics on the WTA–WTP disparity: A meta analytical framework. *Journal of Economic Psychology, 26*(2), 289-312.
Sheehan, D., Lecrubier, Y., Sheehan, K., Amorim, P., Janavs, J., Weiller, E., & Dunbar, G. (1998). The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *J Clin Psychiatry, 59*(Suppl 20), 22-23.
Steketee, G., & Frost, R. (2003). Compulsive hoarding: current status of the research. *Clinical psychology review, 23*(7), 905-927.
Thaler, R. (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior & Organization, 1*(1), 39-60.
Timpano, K. R., Broman-Fulks, J. J., Glaesmer, H., Exner, C., Rief, W., Olatunji, B. O., . . . Schmidt, N. B. (2013). A taxometric exploration of the latent structure of hoarding. *Psychol Assess, 25*(1), 194-203. doi: 10.1037/a0029966
Timpano, K. R., & Shaw, A. M. (2013). Conferring humanness: The role of anthropomorphism in hoarding. *Personality and Individual Differences, 54*(3), 383-388.
Tolin, D. F., Frost, R. O., Steketee, G., & Muroff, J. (2015). Cognitive behavioral therapy for hoarding disorder: A meta-analysis. *Depression and Anxiety, 32*, 158-166.
Tolin, D. F., Stevens, M. C., Villavicencio, A. L., Norberg, M. M., Calhoun, V. D., Frost, R. O., . . . Pearlson, G. D. (2012). Neural mechanisms of decision making in hoarding disorder. *Archives of general psychiatry, 69*(8), 832-841.
Tolin, D. F., Wootton, B. M., Levy, H. C., Hallion, L. S., Worden, B. L., Diefenbach, G. J., . . . Stevens, M. C. (2019). Efficacy and mediators of a group cognitive–behavioral therapy for hoarding disorder: A randomized trial. *Journal of consulting and clinical psychology, 87*(7), 590.
Weaver, R., & Frederick, S. (2012). A reference price theory of the endowment effect. *Journal of Marketing Research, 49*(5), 696-707.
Welsted, A. C. (2014). *Compulsive hoarding and the theory of value: an economic model of excessive accumulation.* University of British Columbia.
Yap, K., & Grisham, J. R. (2019). Unpacking the construct of emotional attachment to objects and its association with hoarding symptoms. *Journal of behavioral addictions*, 1-10.

Supplementary Materials

Supplementary Materials 1. Distribution of hoarding severity by the diagnostic groups.

Self-reported severity of hoarding symptoms was broadly distributed among participants in both studies. Figures below illustrate both high within-diagnosis variability as well as significant overlap of distributions of SI-R scores across diagnostic groups (more so in Study 1). These suggest that analyses of the effects of discrete HD diagnosis on the EE are not redundant with analyses of the effects of self-reported hoarding severity on the EE.

Figure SM1.1. Distribution of hoarding severity by the diagnostic groups in Study 1.

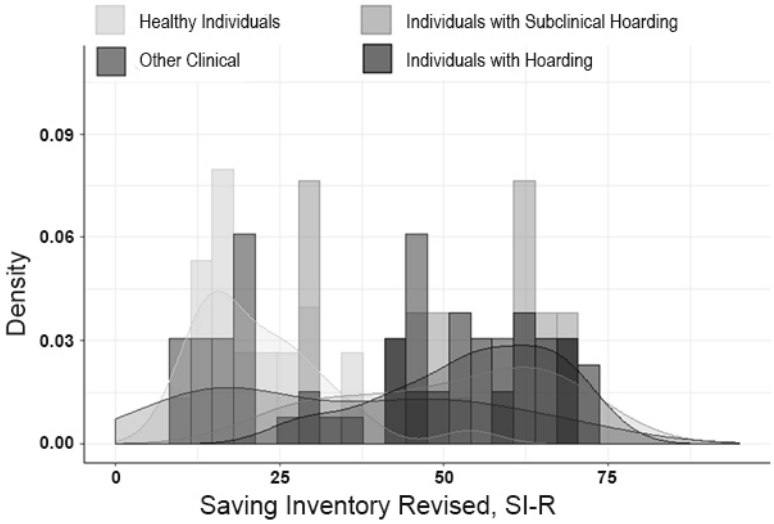
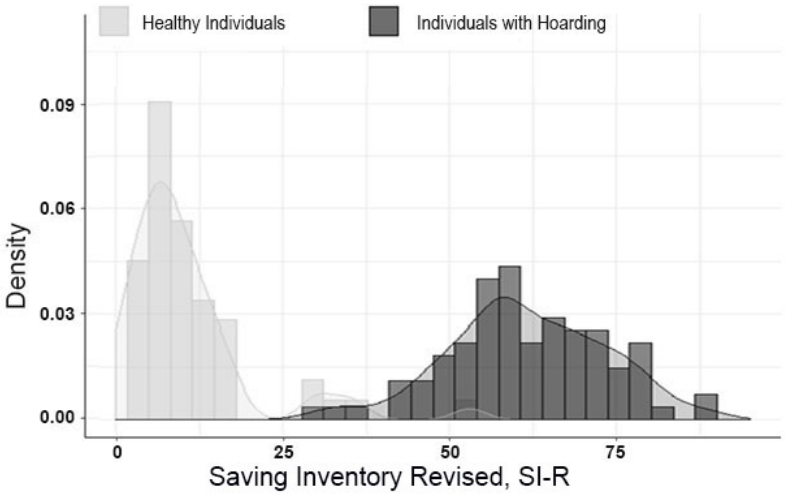


Figure SM1.2. Distribution of hoarding severity by the diagnostic groups in Study 2.


Healthy Individuals
Individuals with Hoarding
Density
0.09
0.06
0.03
0.00
0
25
50
75
Saving Inventory Revised, SI-R

Supplementary Materials 2. The Endowment Effect and Hoarding Disorder diagnosis in Study 1 (Healthy Control n = 23, Hoarding Disorder n = 43).

Table SM2. Value of Mug/Chocolate by Ownership Condition and Diagnostic Group

	df	Sum Sq	*F*	*p*
Mug				
Ownership	1	5588.34	24.43	<.01
HD vs. HC	1	179.78	0.57	.46
Ownership x [HD vs. HC]	1	176.28	0.54	.47
Chocolate				
Ownership	1	8171.88	25.22	<.01
HD vs. HC	1	2276.62	2.73	.07
Ownership x [HD vs. HC]	1	340.68	0.38	.68

Note: Aligned Rank Transformation for Nonparametric Factorial Analysis was used, 'aligned.rank.transform' routine in R with Type I Sum of Squares.

Supplementary Materials 3. The endowment effect and HD symptoms in Study 1.

Table SM3. The Association of Mug/Chocolate Value with Owner Condition, Saving Inventory Total Score (SI-R), and Owner x SI-R Interaction at the Selected Quantile Levels of Mug/Chocolate Values among Study 1 Participants (N = 81).

A: Mug

	Intercept	**Owner**	**SI-R**	**Owner x SI-R**
quantile	β [95% CI]	β [95% CI]	β [95% CI]	β [95% CI]
30th	**0.50 [0.50, 1.61]**	1.11 [-1.39, 2.58]	0.00 [-0.02, 0.00]	0.03 [-0.004, 0.08]
40th	**1.67 [0.21, 1.77]**	0.54 [-1.92, 3.56]	-0.017 [-0.02, 0.23]	0.07 [-0.06, 0.11]
50th, median	**1.73 [1.22, 2.58]**	1.27 [-1.41, 1.87]	**-0.02 [-0.03, -0.01]**	**0.07 [0.05, 0.13]**
60th	**2.53 [1.60, 2.84]**	-0.003 [-1.45, 2.02]	-0.03 [-0.03, 0.02]	**0.13 [0.06, 0.14]**
70th	**2.00 [1.28, 3.92]**	1.08 [-0.61, 8.03]	< 0.001 [-0.05, 0.07]	**0.10 [0.03, 0.14]**

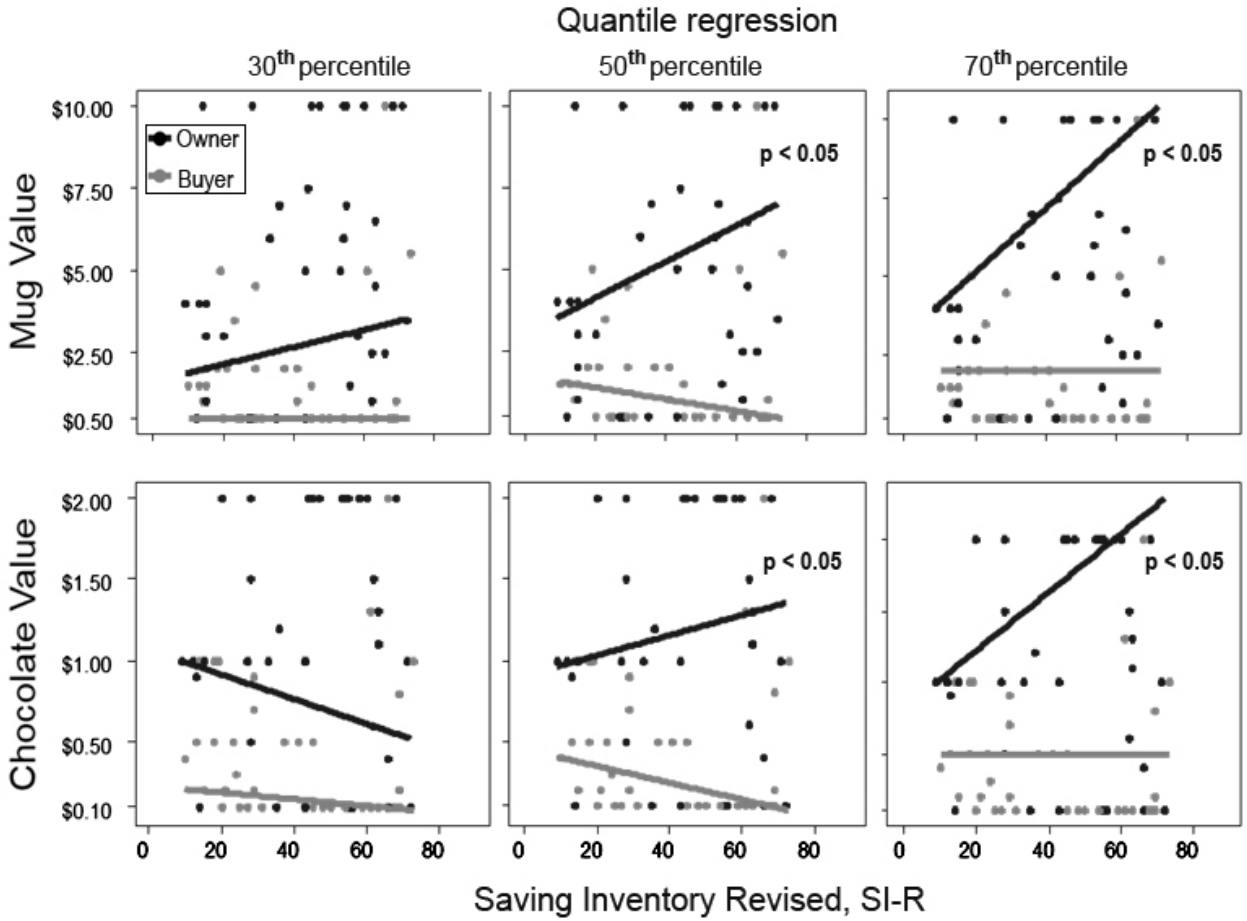
B: Chocolate

	Intercept	**Owner**	**SI-R**	**Owner x SI-R**
quantile	β [95% CI]	β [95% CI]	β [95% CI]	β [95% CI]

30th	**0.23 [0.11, 0.43]**	**0.84 [0.04, 1.02]**	-0.002 [-0.004, >10^{308}]	-0.005 [<-10^{10}, -0.01]
40th	0.28 [-2.20, 0.58]	**0.72 [0.39, 0.76]**	**-0.003 [-0.01, -0.002]**	**0.003 [0.002, 0.01]**
50th, median	**0.45 [0.26, 0.72]**	**0.45 [0.16, 0.62]**	**-0.005, [-0.01, -0.002]**	**0.01 [0.01, 0.02]**
60th	**0.61 [0.39, 1.14]**	0.23 [-0.35, 0.37]	-0.006 [-0.01, 0.01]	**0.02 [0.004, 0.04]**
70th	**0.50 [0.35, 1.24]**	0.32 [-0.50, 7.25]	< 0.001 [-0.02, 0.01]	**0.02 [0.004, 0.04]**

Note: lower and higher quantiles (≤ 0.20 and ≥ 0.80) had unreliable 95% CI and are not reported here; in **bold** are effects significant at p = 0.05 level; the model specification test described in Hsiao et al., (2007).

Figure SM3. Positive relation between endowment effect and SI-R in Study 1.



Note: Quantile regression - results for the 30th, 50th (median), and 70th percentiles of mug/chocolate values. Mug values (top) and chocolate values (bottom) show greater differences between owners and buyers (i.e., greater endowment effect) with increases in hoarding severity (Saving Inventory – Revised total score, SI-R). Results indicate that the difference in values between owners and buyers increases as SI-R increases (*p*-values indicate significance of this effect).

Supplementary Materials 4. Positive, Negative and Zero Endowment Effect for Each Item in Study 2.

Consistent with prior studies (e.g., Jefferson & Taplin, 2011), the EE was negative for some participants (between 24% and 40% across items). On average, normalized EEs were negative for two items (bookshelf: -0.11 ± 0.05, drill: -0.02 ± 0.05) and positive for the remaining items (from 0.04 ± 0.05 for the clock to 0.18 ± 0.05 for the casserole dish). Most EEs were not normally distributed in the sample (Shapiro-Wilk test p-values < 0.05, except for EEs for the bookshelf, drill, and clock in HC).

Table SM4. Frequencies by item

	Low Cost Items			Medium Cost Items		High Cost Items		
	Casserole Dish	Coffeemaker	Clock	Bookshelf	Drill	iPod	TV	Table
Negative	35 (25%)	37 (26%)	45 (32%)	57 (40%)	55 (39%)	35 (25%)	42 (30%)	43 (30%)
Zero	48 (34%)	50 (35%)	45 (32%)	41 (29%)	37 (26%)	39 (28%)	38 (27%)	39 (28%)
Positive	58 (41%)	54 (38%)	51 (36%)	43 (30%)	49 (35%)	67 (48%)	61 (43%)	59 (42%)

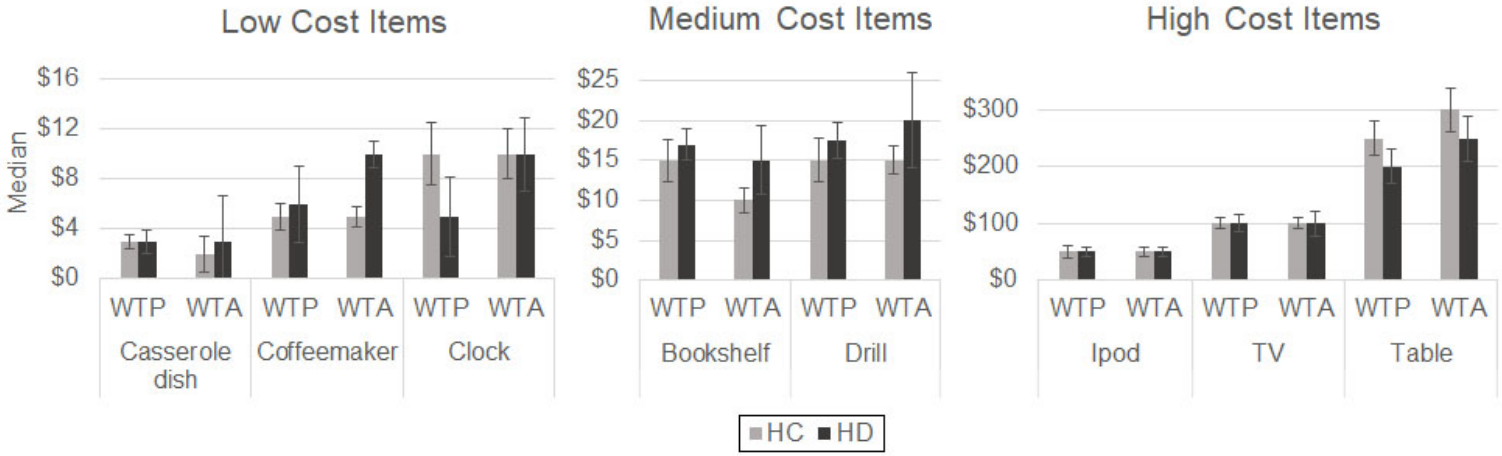
Supplementary Materials 5. The Endowment Effect and HD diagnosis, Study 2.

Table SM5. HD Diagnosis and the EE for low cost, medium cost, and high cost items, week 0: HC = 56, HD = 84.

	ANOVA type				Permutation
Dependent Variables	Test Statistic	df1	df2	p-value	Test p-value
Low cost items: Casserole, Coffeemaker, Clock	1.63	2.13	284.49	.20	.19
Medium cost items: Bookshelf, Drill	0.94	1.54	205.58	.37	.36
High Cost Items: I-pod, TV, Table	2.35	2.03	271.08	.10	.07

Note: Multivariate nonparametric ANOVA type test with 1000 permutations was used, 'nonpartest' routine in R

Figure SM5. HD and WTP/WTA for Low Cost, Medium Cost, and High Cost Items.



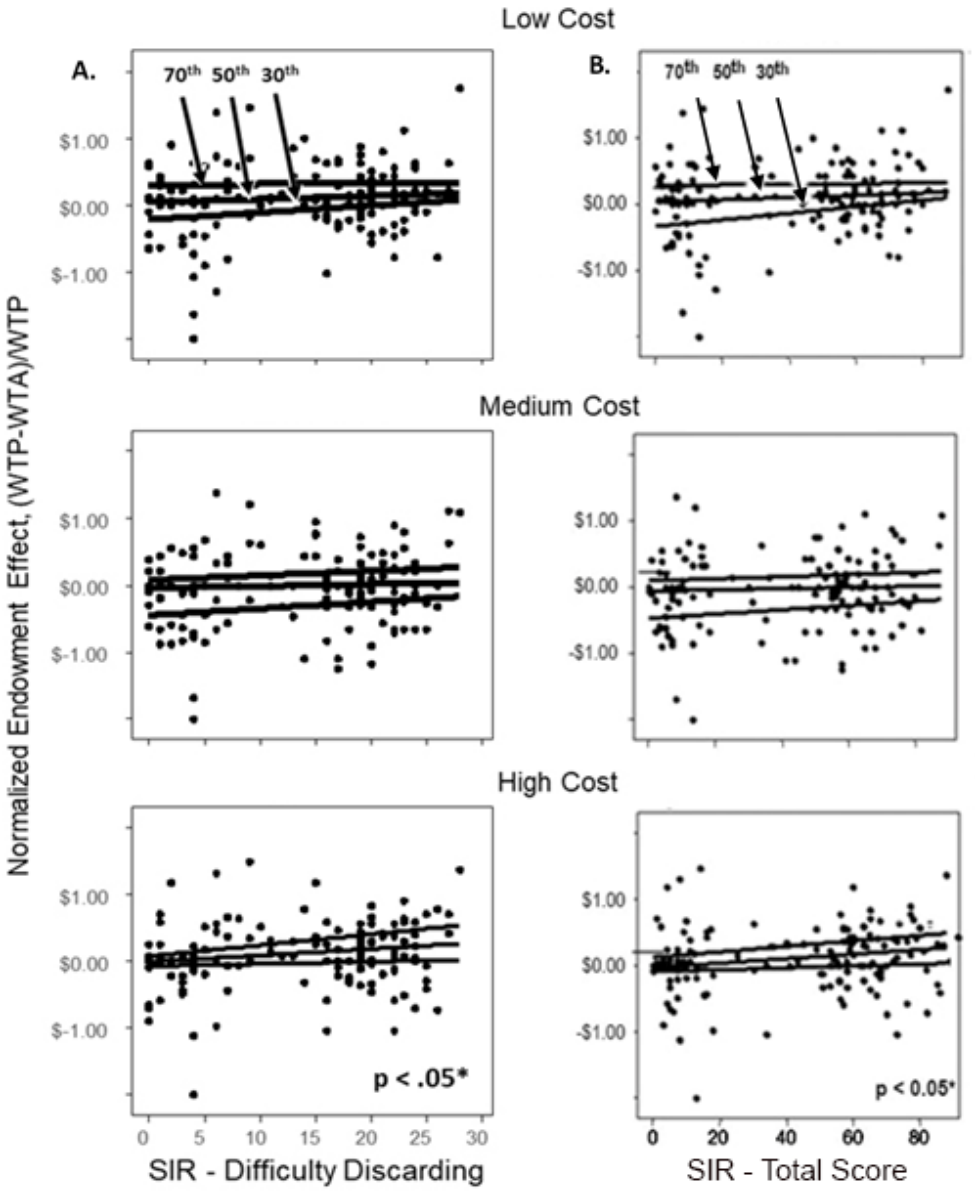
Supplementary Materials 6. The Endowment Effect and hoarding symptoms, Study 2.

Table SM6. The Association of Endowment Effect with Saving Inventory Total Score (SI-R) at Selected Quantile Levels of Endowment Effect Values among Study 2 Participants (N = 143).

	Low cost items		Medium cost Items		High Cost items	
	Intercept	Difficulty Discarding	Intercept	Difficulty Discarding	Intercept	Difficulty Discarding
quantile	β [95% CI]	β [95% CI]	β [95% CI]	β [95% CI]	β [95% CI]	β [95% CI]
30th	-0.33 [-0.55, 0.06]	0.01 [-0.002, 0.01]	**-0.47 [-0.67, -0.19]**	0.003 [-0.001, 0.01]	**-0.09 [-0.24, -0.01]**	0.001 [-0.001, 0.004]
40th	-0.002 [-0.30, 0.06]	0.0002 [-0.001, 0.01]	**-0.19 [-0.48, -0.03]**	0.001 [-0.002, 0.01]	-0.03 [-0.14, 0.004]	0.001 [-0.001, 0.004]
50th, median	0.04 [-0.02, 0.11]	0.002 [-0.001, 0.003]	-0.06 [-0.20, 0.28]	0.001 [-0.01, 0.004]	**-0.02 [-0.06, 0.05]**	**0.003 [0.0004, 0.01]**
60th	**0.10 [0.04, 0.23]**	0.001 [-0.001, 0.003]	-0.01 [-0.11, 0.17]	0.002 [-0.001, 0.004]	**0.04 [-0.03, 0.08]**	**0.004 [0.003, 0.01]**
70th	**0.29 [0.08, 0.53]**	0.0004 [-0.002, 0.01]	0.09 [-0.04, 0.38]	0.002 [-0.01, 0.01]	**0.13 [0.03, 0.28]**	**0.004 [0.002, 0.01]**

Note: lower and higher quantiles (≤0.20 & ≥ 0.80) had unreliable 95% confidence intervals and are not reported here; in **bold** are effects significant at p = 0.05 level; the model specification test described in Hsiao et al., (2007).

Figure SM6. Positive relation between the endowment effect and Saving Inventory and Difficulties Discarding subscale (A) Total Score (SI-R, B) in Study 2 revealed by quantile regressions.



Note: Quantile regression - results for the 30th, 50th (median), and 70th percentiles of low/medium/high cost items. * - normalized EE for high cost items (bottom panel) positively correlated with hoarding severity (Saving Inventory Revised total, SI-R) for 50^{th} and 70^{th} percentiles with $p < 0.05$. Nonparametric regression with bootstrapping – normalized EE for high cost items (bottom panel) positively correlated SI-R at significance $p = 0.057$. Results from both statistical approaches suggest that EE increases as SI-R increases.