**Processes of Change in Online Acceptance and Commitment Therapy for Hoarding**

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**Abstract**

Initial research suggests that acceptance and commitment therapy (ACT) is efficacious in treating hoarding problems, but processes of change in ACT for hoarding are unclear. Thus, we investigated potential mediators and moderators in a randomized waitlist-controlled trial (n = 73) of web-based ACT for U.S. adults with clinically significant hoarding problems. Hoarding severity was significantly correlated with hoarding-related psychological inflexibility (*r* = .52, *p* < .01), mindful awareness (*r* = -0.40, *p* < .01), and beliefs that people with hoarding disorder are different from others (*r* = .31, *p* < .01). Effects of ACT were not significantly moderated by age, gender, or baseline hoarding-related psychological inflexibility. Longitudinal mediation analyses did not support mediation by hypothesized processes. However, the effect of condition on hoarding severity at follow-up was significantly mediated by hoarding-related psychological inflexibility at follow-up (*ab* = -0.41 [95% CI: -0.85, -0.01]), and change in hoarding-related psychological inflexibility (*r* = .73, *p* < .01) and mindful awareness (*r* = -.69, *p* < .01) was correlated with change in hoarding symptoms over time. Overall, our results suggest that psychological inflexibility, self-stigma, and mindful awareness are indeed related to hoarding symptoms, but we cannot conclude that they underly the effects of ACT for hoarding. Limitations include a predominantly White and female sample.

*Keywords: mediation; moderation; hoarding disorder; mHealth; psychological flexibility; mindfulness*

**A Process Investigation of an Acceptance and Commitment Therapy Self-Help Website for Hoarding**

Hoarding disorder (HD) is an obsessive-compulsive and related disorder involving persistent saving of items, ultimately resulting in excessively cluttered living areas that cause clinically significant functional impairment and/or distress (American Psychiatric Association, 2013). A recent meta-analysis of 11 studies (N = 53,578) found that two of every 100 people meet criteria for HD (Postlethwaite et al., 2019). It is well-established that individuals with symptoms of HD report significant disruptions in quality of life (Ong et al., 2015) and everyday functioning (Nutley et al., 2022). Individuals with HD also tend to meet criteria for several comorbid psychological conditions (Frost et al., 2015) and other health problems (Bates et al., 2021), which may complicate delivery of effective treatment.

Cognitive behavioral therapy (CBT) is the best-established treatment for HD, with several trials supporting large symptom reductions and medium improvements in impairment (Tolin et al., 2015). However, only 25-43% of CBT trial participants report clinically significant change, and improvements to treatment are therefore necessary (Tolin et al., 2015). Another treatment for HD with growing research support is acceptance and commitment therapy (ACT). ACT is focused on decreasing psychological inflexibility, a multifaceted process in which rigid responses to internal experiences and disconnection from personal values contribute to narrow and dysfunctional behavior patterns, by fostering psychological flexibility (the ability to consistently engage in meaningful action with flexible, present-focused attention and openness toward thoughts and emotions). In a recent multiple baseline of ACT for hoarding (N = 6), 5 of 6 participants reported improvements on discarding rate and general symptom measures (Ong, Krafft, Panoussi, et al., 2021). One recent trial of ACT for hoarding tested a self-help website with minimal supportive coaching. Treatment specifically targeted psychological inflexibility as it relates to hoarding symptoms and self-stigma, with results indicating the ACT website was efficacious (e.g., decreased hoarding severity and impairment, increased progress toward personal values; *citation masked for review*).

Evaluating how treatments work (i.e., treatment processes) and for whom they work best (i.e., treatment moderation effects) is essential to make treatments more potent or parsimonious. CBT putatively works through cognitive change and exposure; one study supports cognitive mediation in hoarding treatment (Levy et al., 2017), although component research contradicts the importance of cognitive restructuring (Frost et al., 2016). Mediators of change in ACT for hoarding have not previously been investigated; potential mediators that merit investigation in hoarding treatment are psychological inflexibility, mindfulness and self-stigma.

Psychological inflexibility is associated with HD severity and behaviors (Ong et al., 2018). It may be a particularly useful treatment target to examine as ACT is designed to improve it directly, and there is evidence that improvements in ACT are mediated by psychological inflexibility (Stockton et al., 2019). Low mindfulness (i.e., inattention) is one component of psychological inflexibility that may be particularly relevant to hoarding, given that hoarding is often comorbid with ADHD (Frost et al., 2015). Stigma has also been identified as an important process in hoarding; hoarding is highly stigmatized and self-stigma decreases treatment-seeking willingness (Chasson et al., 2018). It may be particularly painful to identify, address, and work on a hoarding problem when the afflicted individual believes that people with hoarding problems deserve disdain and blame. Notably, ACT can also effectively decrease stigma (Krafft et al., 2018). Thus, psychological inflexibility, mindfulness, and stigma merit investigation as potential mediators of change in ACT for hoarding.

It is also important to evaluate potential moderators of ACT for hoarding disorder. Past research suggests age moderates treatment efficacy of hoarding, with younger age associated with greater improvement in symptoms at post-treatment in one meta-analysis (Tolin et al., 2015). However, a more recent meta-analysis found that age did not moderate treatment effects (Rodgers et al., 2021). More research is therefore needed to clarify how age may impact treatment response, particularly because some research suggests that the prevalence of HD likely increases with age (Postlethwaite et al., 2019). Gender may also moderate outcomes; Tolin and colleagues (2015) found that gender had a moderating effect for HD symptoms and acquiring/discarding behaviors in CBT trials. This finding was supported in a more recent meta-analysis, which reported that studies with more female participants had greater effect sizes than those with fewer female participants (Rodgers et al., 2021). Lastly, because ACT targets psychological inflexibility, it may be important to examine baseline levels of psychological inflexibility as a moderator. It is possible that individuals who are already lower in psychological inflexibility may engage in and respond to treatment more effectively. Alternatively, individuals with high psychological inflexibility may benefit from treatment the most and report greater gains. There is some evidence that baseline psychological inflexibility moderates relative efficacy of ACT for other clinical concerns in some studies (Craske et al., 2014), while others do not find the same effect (Ong et al., 2020). Given the mixed findings, it is important to explore baseline psychological inflexibility as a moderator, particularly because it has not yet been examined as a moderator in treatment trials of HD.

In sum, mediators and moderators have received limited attention in research on the treatment of HD, with a dearth of such research on ACT for hoarding specifically. If psychological inflexibility and self-stigma contribute to hoarding problems, and ACT for hoarding works by targeting these processes (reduced psychological inflexibility, decreased self-stigma, increased mindful awareness), this would 1) clarify mediators of change that can be targeted to address hoarding, which may help improve treatment broadly, and 2) clarify whether ACT for hoarding works through hypothesized mechanisms. Therefore, the present secondary analysis aims to examine the moderators and mediators of ACT for hoarding from a waitlist-controlled trial evaluating an ACT self-help website for hoarding (*citation masked for review*). More specifically, we sought to examine if self-stigma, hoarding-related psychological inflexibility, and mindful awareness correlated with and mediated change in hoarding symptoms during ACT self-help for hoarding. We also evaluated whether the efficacy of ACT self-help for hoarding was moderated by age, gender, or baseline hoarding-related psychological inflexibility.

**Methods**

**Participants**

Participants were eligible for this study if they: 1) were 18 years of age or older, 2) lived in the USA, 3) were seeking help for clutter and/or hoarding, 4) were interested in testing a self-help website, and 5) met the clinical cutoff of 41 on the Saving Inventory-Revised (SI-R; Frost et al., 2004). A total of 122 individuals were screened for the study; 73 completed baseline assessment and enrolled in the study (see Figure 1 for a flow diagram). Analyses used an intent-to-treat approach, and all 73 individuals were retained in analyses (*n* = 38 in the intervention and *n* = 35 in waitlist). Participants were typically middle-aged (*M* = 47.67, SD = 4.32) and largely female (87.67%, with the remaining 12.33% male). Participants identified their race as: 76.71% White, 6.85% Asian, 5.48% bi/multiracial, 4.11% Black, and 6.85% other race; 6.85% of participants identified their ethnicity as Hispanic or Latino/a. Additional information on participant demographics is available in the outcome paper for the randomized controlled trial (RCT; *citation masked,* under review).

**Procedures**

The study from which current data were drawn is a randomized, waitlist-controlled trial. Procedures were approved by the IRB of the appropriate university, a land-grant university in the USA. The study was preregistered at ClinicalTrials.gov (*ID# removed for masked review*). Potential participants were initially screened online to determine whether they met eligibility criteria. If eligible, they reviewed an online informed consent form, and those who consented were automatically guided to a baseline survey, after which they were randomized with equal probability to intervention or waitlist. A posttreatment survey was administered 8 weeks after baseline, and a final follow-up survey was administered 12 weeks after baseline. Recruitment and data collection took place between February and November 2020.

***Intervention***

The ACT intervention consisted of completing 16 self-help website sessions. Participants were asked to complete two sessions per week over 8 weeks, and sessions were designed to take 15-20 minutes to complete. Participants continued having access to the website content after the 8-week period. Website content consisted of metaphors, examples, and interactive exercises, including some video and audio content. The website sessions respectively focused on 1) values identification and psychoeducation, 2) and 3) acceptance, 4) acceptance of shame/self-judgment, 5) and 6) defusion, 7) defusion from self-stigma, 8) self-as-context, 9) and 10) mindful awareness, 11) values, 12) values and committed action, 13) committed action, 14) generalization of acceptance, 15) generalization of committed action, and 16) relapse prevention. Participants in the treatment condition also received minimal supportive coaching provided by trained doctoral psychology students, consisting of an initial 10-15 minute phone call and weekly coaching emails. Coaching focused solely on facilitating adherence to the online intervention (e.g., troubleshooting barriers to adherence), and coaches on average spent approximately 52 minutes coaching each participant. More information on the intervention may be found in the RCT outcome paper (*citation masked,* under review) or by contacting *[masked for review]*.

**Measures**

***Saving Inventory-Revised (SI-R; Frost et al., 2004)***

 The SI-R is a 23-item measure designed to assess core symptoms of hoarding: difficulty discarding, excessive acquisition, and clutter. Higher scores indicate more severe hoarding symptoms. Example items include “How distressing do you find the task of throwing things away?” and “To what extent do you have so many things that your room(s) are cluttered?” The SI-R has the strongest psychometric qualities of any extant measure of hoarding symptoms (Ong, Krafft, Levin, et al., 2021). The SI-R is sensitive to treatment (e.g., Steketee et al., 2010) and has good internal consistency, temporal stability, and validity in clinical samples (Frost et al., 2004). Internal consistency for the SI-R total score was excellent (*α* = .93) in this sample.

***Clinical Global Impression – Improvement (CGI-I; Guy, 1976)***

The CGI-I is a single-item measure of overall clinical change (i.e., improvement or deterioration). A self-report version was used in the present study, and it is rated from 1 (very much improved) to 7 (very much worse). The CGI-I has been used previously to assess global change in online treatment for hoarding (Muroff et al., 2010).

***Self-Stigma of Hoarding Items (Chasson et al., 2018)***

 This study used seven items that have previously been used to assess self-stigma in hoarding (Chasson et al., 2018). They were developed to assess three theoretically distinct aspects of stigma: difference (i.e., people with hoarding disorder are dissimilar to other people), disdain (i.e., people with hoarding disorder are bad or disrespected compared to others), and blame (i.e., people with hoarding disorder are responsible for their condition). Higher scores indicate greater stigma. Difference and disdain are measured with three items, while blame is measured with a single item. These items were designed to measure public stigma, but have previously been used as a proxy for self-stigma (Chasson et al., 2018), as individuals with hoarding problems who endorse public stigma directed towards hoarding presumably experience high self-stigma. While this measure has not undergone formal psychometric evaluation, there is initial evidence of its validity (e.g., disdain correlates with the other two components, and blame is associated with decreased willingness to seek treatment; Chasson et al., 2018). In this sample, internal consistency was adequate for disdain (*α* = .70) and excellent for difference (*α* = .93).

***Acceptance and Action Questionnaire for Hoarding (AAQH; Krafft, Ong, et al., 2018)***

The AAQH is a 14-item measure of hoarding-related psychological inflexibility comprised of two subscales: Saving and Acquiring. Higher scores indicate greater inflexibility (e.g., nonacceptance of distress when discarding, inflexible attention to belongings, and cognitive fusion with beliefs about the need to keep or acquire items). Example items include “My thoughts or feelings make it hard for me to get rid of my things” and “I need to get rid of my urges to acquire new things.” There is initial evidence that this measure is valid and reliable within college students with elevated hoarding symptoms (Krafft et al., 2019). In the present study, internal consistency was excellent for the total score (*α* = .90) and good for both subscales (Saving *α* = .89, Acquisition *α* = .83).

***Five-Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006), Acting with Awareness Subscale***

The Acting with Awareness subscale of the FFMQ consists of eight items that assess the ability to focus one’s attention on the activity one is currently engaged in. Mindful, present-moment awareness is one facet of psychological flexibility that may be particularly relevant to hoarding, given that hoarding is defined by deficits in consistently making decisions about saving or discarding belongings, a process that requires thoughtful attention. Higher scores indicate greater mindful awareness. There is evidence that the subscale has convergent validity and internal consistency (Baer et al., 2006). Internal consistency was good (*α* = .89) in this study.

**Analysis Plan**

All analyses were conducted using R (R Core Team, 2018). The lmerTest package was used for analyses of overall change on process variables and moderation (Kuznetsova et al., 2017), while lavaan (Rosseel, 2012) was used for mediation tests. Treatment and waitlist groups were compared on demographics, outcome, and process variables to identify any covariates to correct failures in randomization. Study variables were inspected for adequate normality. Missingness was inspected and potential predictors of missingness were evaluated for significance. Zero-order correlations between process variables and hoarding severity were calculated to characterize relationships between stigma, psychological inflexibility, and hoarding symptoms at baseline.

 **Change in process measures over time.** Multilevel models with maximum likelihood estimation were used to investigate the overall impact of the intervention on process measures. Random intercepts (modeling participant-level variability in the dependent variable at baseline) were employed, and random slopes (modeling participant-level differences in trajectories in the dependent variable over time) were also used if likelihood ratio tests indicated they improved model fit. An unstructured variance-covariance matrix was used. Time-by-condition interactions were calculated and tested for significance, using *p*-values based on the Satterthwaite approximation. Standardized variables were used for all analyses. Standardization of dependent variables was performed using grand mean centering, and condition and time were dummy coded so that regression coefficients are standardized and can provide an estimate of effect size (Lorah, 2018). Specifically, time-by-condition coefficients indicate change in the treatment group, relative to the waitlist group, from baseline to follow-up, in terms of standard deviations. These coefficients are not precisely equivalent to Cohen’s *d*, because they account for the random effects and covariates included in these models, but they are similar in that they indicate the difference between groups over time, or the change within groups, in terms of standard deviations.

 **Moderation of treatment effect.** A series of moderation analyses were also conducted. Potential moderators of the impact of the intervention on hoarding severity were estimated and evaluated for significance using the same methodology described in the previous paragraph. The moderator term was calculated as Time x Condition x Moderator.

 **Mediation of treatment effect.** Longitudinal mediation models were then used to determine if improvement in the treatment condition was explained by hypothesized processes. Specifically, these models estimated the indirect effect of condition on the pre-specified primary outcome (hoarding severity) at follow-up, through each of the process variables at post-treatment (see Figure 2). A separate model was run for each process variable. These models provide estimates of the effect of condition on the mediator at post-treatment (*a* path), the effect of the mediator on hoarding severity at follow-up (*b* path), the effect of their interaction on hoarding severity at post-treatment (*ab* path, the indirect effect), the total effect of condition on hoarding severity at follow-up (*c* path), and the residual effect of condition on hoarding severity after the indirect effect is modeled (*c’* path). Models were estimated with the lavaan package (Rosseel, 2012) using full-information maximum likelihood (FIML) estimation. Percentile bootstrap confidence intervals for the indirect effect were obtained from the manymome package (Cheung & Cheung, 2022). Mediators and outcomes were both standardized, and time and condition were dummy coded, as described above.

 In addition to longitudinal mediation models, a series of post-hoc cross-sectional mediation models were also computed. These models repeated the above analyses, but with the mediator and hoarding severity both measured at follow-up, to assess whether the effect of the intervention on hoarding severity was significantly mediated by a particular process as measured at follow-up (see Figure 3). These post-hoc analyses were added given that most process measures changed significantly from posttreatment to follow-up.

 **Correlated change scores**. Finally, to further explore the relationship between changes in process variables and hoarding symptoms, change scores were computed for the primary outcome (SI-R score) and process variables (AAQH, FFMQ Acting with Awareness, Difference, Disdain, and Blame) from baseline to follow-up, and correlations between the change scores for the outcome and each of the process variables were calculated. These analyses were done combining across both treatment and waitlist groups, and use only complete cases given that change scores required data at baseline and follow-up to compute.

**Results**

**Preliminary Analyses**

 The two groups significantly differed on one outcome measure at baseline, the CGI-I, and baseline CGI-I score was thus included as a fixed covariate in subsequent analyses. Outcome and process variables adequately approximated normality. The following variables were evaluated as potential predictors of missingness on the primary outcome (hoarding severity) at posttreatment: baseline scores on all outcome and process variables (excluding subscales), baseline therapy and medication utilization, age, gender, and credibility and expectancy. None significantly predicted missingness (*p*s > .05). Random slopes significantly improved each model except the model with self-stigma of difference as an outcome (*p*s < .05) and were thus retained for all other models. The average number of sessions participants in the treatment condition had completed by posttreatment was 6.89 of the 16 sessions available (SD = 5.71). Of these 38 individuals, 9 did not complete any website sessions, 7 completed 2-4 sessions, 5 completed 5-7 sessions, 4 completed 8-10 sessions, 8 completed 12-13 sessions, and 5 completed all 16 sessions. Participants rarely did sessions out of order; thus, more participants were exposed to the earlier sessions (which focused primarily on acceptance, defusion, and self-as-context) compared to the later sessions (which focused primarily on mindful awareness, values, committed action, and skills generalization).

**Baseline Correlations**

 Zero-order correlations indicated a complex pattern of relationships between variables at baseline (see Table 2). Hoarding symptoms were significantly associated with self-stigma of difference (*r* = .31, *p* < .01), AAQH total (*r* = .52, *p* < .01), and FFMQ Acting with Awareness (*r* = -0.40, *p* < .01). Self-stigma of disdain and blame were not significantly related to hoarding severity. AAQH total was significantly correlated with self-stigma of difference (*r* = .26, *p* < .05), but not disdain or blame. FFMQ Acting with Awareness was negatively correlated with disdain (*r* = -.27, *p* < .05) and blame (*r* = -.28, *p* < .05).

 Correlates of hoarding severity at baseline were further explored to better characterize possible contributors to hoarding severity. Self-stigma of difference, AAQH total, and FFMQ Acting with Awareness were entered in a linear regression as predictors of hoarding severity. In this multiple regression, AAQH (*B* = 0.42, SE = -0.10, *p* < .0001) and FFMQ Acting with Awareness (*B* = -0.59, SE = 0.21, *p* < .01) were significant predictors of hoarding severity, while self-stigma of difference was not a significant predictor (*B* = 0.91, SE = 0.60, *p* = .13) at baseline.

**Change in Processes**

There was a significant time by condition interaction for each process variable except self-stigma of blame (see Table 3). In each case, the direction was consistent with hypotheses, such that the ACT condition improved significantly more than the waitlist condition from baseline to follow-up. The parameter estimates of these models can be interpreted as follows. Relative to waitlist, the ACT condition experienced a 0.50-SD decrease in self-stigma of difference, a 1.12-SD decrease in self-stigma of disdain, a nonsignificant 0.52-SD decrease in self-stigma of blame, a 0.79-SD decrease in AAQH total, and a 1.11-SD increase in FFMQ Acting with Awareness. Model residuals showed acceptable normality. Observed and predicted group means were plotted and indicated that change within the ACT condition was approximately linear for each outcome (i.e., equivalent slopes from baseline to posttreatment and posttreatment to follow-up).

 Linear contrasts were used to evaluate the timing of improvement within the ACT condition. The ACT group improved significantly on self-stigma of difference from baseline to posttreatment (*B =* 0.54, SE = 0.10, *p* < .0001) and posttreatment to follow-up (*B* = 0.27, SE = 0.05, *p* < .0001), on self-stigma of disdain from baseline to posttreatment (*B =* 0.69, SE = 0.15, *p* < .001) and posttreatment to follow-up (*B* = 0.34, SE = 0.08, *p* < .001), on self-stigma of blame from baseline to posttreatment (*B =* 0.46, SE = 0.17, *p* < .05) and posttreatment to follow-up (*B* = 0.23, SE = 0.09, *p* < .05), on AAQH Total from baseline to posttreatment (*B =* 0.87, SE = 0.12, *p* < .0001) and posttreatment to follow-up (*B* = 0.43, SE = 0.06, *p* < .0001), and on FFMQ Acting with Awareness from baseline to posttreatment (*B =* -0.83, SE = 0.13, *p* < .0001) and posttreatment to follow-up (*B* = -0.41, SE = 0.07, *p* < .0001). To summarize, the ACT condition experienced a statistically significant degree of improvement on each process from baseline to posttreatment ranging from an effect size of 0.46 to 0.87 SDs and again from posttreatment to follow-up with effect sizes from 0.23 to 0.43 SDs. On further examination, we found that nine participants (23.68%) of those assigned to treatment completed at least one website session between posttreatment and follow-up.

**Moderation**

 The three-way interactions between time, condition, and the three hypothesized moderators (age, gender, and baseline AAQH total) were nonsignificant (*p*s > .1; see Table 4). While power was limited to detect such an interaction, there is no indication that treatment efficacy differed based on age, gender, or initial psychological inflexibility. Residual inspection suggested adequate model fit.

**Mediation**

In each of the longitudinal mediation analyses, the bootstrapped confidence interval of the indirect effect included zero (see Table 5), providing no evidence that improvement in hoarding severity at follow-up was attributable to hypothesized processes at posttreatment. We conducted an exploratory series of longitudinal mediation models controlling for the impact of baseline SI-R score on the mediator and outcome, to assess whether the effect of treatment on hoarding symptoms was mediated by hypothesized processes after adjusting for individual differences at baseline; however, the indirect effect in each model was nonsignificant (i.e., 95% CIs contained 0).

 In the cross-sectional series of mediation analyses (see Table 6), the indirect effect was significant in the model evaluating AAQH total at follow-up (*ab* = -0.41, SE = 0.20, 95% CI = [-0.85, -0.01]) as a potential mediator of hoarding severity at follow-up. No other indirect effects were statistically significant.

**Correlations of Change Scores**

Across the full sample, change in SI-R total from baseline to follow-up was significantly associated with change in AAQH total (*r* = .73, *p* < .01) and FFMQ Acting with Awareness (*r* = -.69, *p* < .01) with a large effect size. Change in Difference (*r* = .33, *p* < .05) was significantly correlated with SI-R change with a moderate effect size, while change in Disdain (*r* = .15, *p* > .05) and Blame (*r* = .15, *p* > .05) were not significantly related.

**Discussion**

In the present study, we examined the role of hoarding-related psychological inflexibility and self-stigma in online ACT self-help for hoarding. Results from the randomized controlled trial from which current data were drawn indicated that the study intervention significantly improved hoarding symptom severity, functional impairment, well-being, and progress toward personal values (*citation masked*, under review). The objective of this follow-up paper was to clarify the relevance of processes of change to treatment response.

Findings indicated that hoarding severity was significantly and moderately correlated with self-stigma of difference (i.e., the internalized belief that people with hoarding disorder are different from other people), hoarding-related psychological inflexibility, and mindful awareness at baseline, providing convergent evidence for the relevance of these processes to the presentation of hoarding (Krafft et al., 2019; Ong et al., 2018). Self-stigma of difference was also significantly associated with hoarding-related psychological inflexibility, suggesting that these are related constructs. Consequently, targeting hoarding-related psychological inflexibility (e.g., teaching defusion from thoughts) may improve self-stigma of difference (e.g., client generalizes defusion to stigmatizing thoughts). At the same time, given that self-stigma of disdain and blame were not significantly correlated with hoarding severity and hoarding-related psychological inflexibility, it appears that the various facets of self-stigma are not uniformly associated with hoarding, consistent with survey research that has produced mixed findings on this relationship (Chasson et al., 2018).

With respect to effect of the ACT self-help intervention on process measures, we observed significant improvement over time in self-stigma of difference, self-stigma of disdain, hoarding-related psychological inflexibility, and mindful awareness—but not self-stigma of blame—suggesting that the ACT intervention was largely efficacious in targeting its hypothesized process of change (i.e., hoarding-related psychological inflexibility, mindfulness) and self-stigma as a potential barrier to treatment (Chasson et al., 2018). In addition, scores on these process measures further decreased from posttreatment to follow-up, indicating not just a positive effect at the end of the intervention but also maintenance of gains. This continued improvement may have been due to some participants continuing to use the website in the follow-up window. Together, these findings indicate that the ACT self-help intervention led to improvement in processes it was designed to target.

In addition, we tested whether these variables moderated and/or mediated treatment effects. There was no evidence showing that the effect of treatment on symptom severity depended on age, gender, or hoarding-related psychological inflexibility. In other words, the effect of treatment was relatively uniform along the dimension of these variables. However, it is possible that treatment response was moderated by an untested or unmeasured variable or that there was insufficient power to detect a moderation effect, given that the effect of treatment is likely to differ among individuals (Molenaar, 2004).

Finally, a more stringent test of the theoretical model underlying ACT would evaluate whether improvement in symptoms was explained by improvement in hoarding-related psychological inflexibility (Hayes et al., 2006; Stockton et al., 2019). Mediation findings did not support the processes of change posited by the ACT model; namely, hoarding-related psychological inflexibility and mindfulness did not explain symptom improvement. The null finding could be due to inadequate power. Another possible explanation is that due to limited adherence, participants received an inadequate “dosage” of the comprehensive ACT model; however, this appears less likely given that measures of psychological inflexibility and mindful awareness did change significantly after the intervention. Due to the limited sample size of this study, we did not attempt subgroup analyses; however, in the future it would be valuable to assess whether psychological inflexibility mediates the impact of ACT on hoarding in individuals with relatively severe symptoms.

Post hoc cross-sectional mediation analyses showed that hoarding-related psychological inflexibility measured at follow-up mediated symptom severity measured at follow-up. That is, the intervention was associated with decreased hoarding-related psychological inflexibility at follow-up, and hoarding-related psychological inflexibility at follow-up was associated with less symptom severity at follow-up. Nonetheless, given lack of evidence for a longitudinal mediation effect, our results do not support hoarding-related psychological inflexibility as a key process of change in ACT for hoarding. This stands in contrast to the large literature indicating that psychological inflexibility mediates the effects of ACT for a wide range of clinical presentations, including other obsessive-compulsive related disorders (Ong et al., 2020; Stockton et al., 2019). However, this was the first study to test hoarding-related psychological inflexibility as a mediator for an ACT intervention for hoarding disorder. Future ACT treatment studies for hoarding should still test this mediation given its centrality to ACT theory and ensure they are sufficiently powered to do so.

Although mediation was largely not supported, examination of change scores did demonstrate that changes in hoarding severity were correlated with changes in psychological inflexibility, mindful awareness, and the difference component of self-stigma over time. This provides additional support that psychological inflexibility, self-stigma, and mindful awareness are relevant to hoarding not just cross-sectionally but during the course of treatment, although the direction of this relationship is largely unclear. Future studies should clarify the temporal relationship between these processes and hoarding outcomes using a more precise framework (e.g., daily or weekly brief assessments).

Overall, the current study provides support for the efficacy of ACT self-help for targeted processes: hoarding-related psychological inflexibility, two of three aspects of self-stigma, and mindful awareness. This pattern of findings validates one part of the ACT model, that ACT decreases psychological inflexibility (Hayes et al., 2006). However, there was less support for another aspect of the ACT model, which states that improvement in outcomes is *due to* improvement in psychological inflexibility. Instead, we found evidence for cross-sectional mediation of symptom severity at follow-up and significant correlations between change scores but not for longitudinal mediation from posttreatment to follow-up.

**Limitations and Conclusion**

 The uneven findings related to self-stigma could be due to the unreliability of the self-stigma measure, given that the Blame subscale only contains one item, and all items were originally designed to measure public stigma (Chasson et al., 2018). Furthermore, the self-stigma measure has only been used in the context of hoarding in one previous study (Chasson et al., 2018), so there is limited evidence for its utility in this area. Similar to the AAQH, a self-stigma measure specifically designed for people who struggle with hoarding may be more useful than a general scale (Krafft et al., 2019). Second, the AAQH was adapted in part from the AAQ-II (Bond et al., 2011), which has been demonstrated share excessive overlap with measures of distress (Tyndall et al., 2019); while the AAQH has a much smaller relationship with distress than the AAQ-II (Krafft et al., 2019), additional research on the degree to which the AAQH measures a construct distinct from both distress and hoarding symptoms would increase confidence in our conclusions. Additionally, current analyses are exploratory given low power of the study to detect significant and clinically meaningful moderation and mediation effects. Thus, while current results shed light on how ACT self-help influences hoarding-related psychological inflexibility, they are limited in their ability to clarify *how* hoarding-related psychological inflexibility influences response to ACT for hoarding. Future studies should replicate present analyses with a bigger sample. Finally, most participants identified as female (87.7%) and White (76.7%), which is a longstanding issue in hoarding treatment studies (Tolin et al., 2015). The problem with such sample homogeneity is that generalization of findings to other groups is limited. For example, we cannot be certain a similar treatment will also lead to improvement in hoarding-related psychological inflexibility in a sample that largely identifies differently from female and White. Also, educational background was not assessed in this study, and it is possible that acceptability or efficacy of the self-help intervention would differ depending on educational variables such as reading level.

 Overall, this study provides a key initial test of the psychological inflexibility model applied to hoarding disorder through examining processes of change for an ACT-based intervention. These findings highlight the relationship of psychological inflexibility to hoarding symptoms and provide some preliminary data suggesting that reducing psychological inflexibility may lead to improvements in symptoms. It also suggests that ACT can effectively target self-stigma among individuals with hoarding and that some aspects of self-stigma may relate to hoarding severity. Future research is needed to continue to further clarify which processes of change are most relevant to the course of hoarding disorder, and how they can most effectively be engaged.

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**Table 1**

***Descriptive Statistics by Group and Timepoint***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Baseline | Group comparison at baseline | Posttreatment | Follow-up |
|  | ACT (n = 38)M(SD)/% | Waitlist (n = 35)M(SD)/% |  | ACT (n = 26)M(SD)/% | Waitlist (n = 26)M(SD)/% | ACT (n = 25)M(SD)/% | Waitlist (n = 29)M(SD)/% |
| SI-R Total | 66.25 (11.96) | 67.18 (14.84) | t(65.4) = -0.734, p = .47 | 54.46 (13.40) | 59.15 (12.18) | 46.72 (13.40) | 55.55 (14.86) |
| CGI-I | 4.31 (0.87) | 3.76 (0.90) | t(68.3) = -2.81, p = .006 | 2.69 (0.79) | 3.65 (1.38) | 2.76 (1.05) | 3.66 (1.01) |
| Difference | 6.62 (2.07) | 6.41 (2.19) | t(69.8) = -1.15, p = .25 | 5.85 (1.77) | 5.38 (2.04) | 5.44 (2.29) | 5.76 (2.04) |
| Disdain | 5.75 (2.27) | 5.73 (1.81) | t(70.9) = -1.91, p = .06 | 5.32 (1.59) | 5.51 (1.68) | 4.49 (1.91) | 5.70 (1.80) |
| Blame | 4.62 (2.39) | 5.76 (2.70) | t(68.6) = 0.03, p = .98 | 4.27 (1.85) | 4.81 (2.23) | 3.72 (1.67) | 5.34 (2.04) |
| AAQH Total | 75.25 (10.32) | 74.76 (11.97) | t(71) = -0.46, p = .64 | 63.54 (9.35) | 67.35 (10.77) | 57.80 (14.15) | 65.38 (13.93) |
| AAQH Saving | 40.69 (4.87) | 40.71 (6.25) | t(70.8) = -0.03, p = .98 | 35.12 (5.21) | 37.00 (5.08) | 32.52 (8.81) | 35.31 (7.76) |
| AAQH Acquisition | 34.56 (6.40) | 34.06 (7.62) | t(71) = -0.76, p = .45 | 28.42 (6.15) | 30.35 (7.20) | 25.28 (7.34) | 30.07 (7.77) |
| FFMQ Acting with Awareness | 20.00 (5.20) | 19.00 (3.87) | t(68.9) = 1.85, p = .07 | 22.92 (5.04) | 19.88 (4.56) | 25.28 (4.77) | 21.72 (5.95) |

**Table 2**

***Zero-Order Correlations at Baseline***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | M (SD) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 1. SI-R Total | 65.99 (12.24) |  |  |  |  |  |  |  |
| 2. Difference | 6.53 (2.05) | .31\*\* |  |  |  |  |  |  |
| 3. Disdain | 5.94 (1.93) | .21 | .50\*\* |  |  |  |  |  |
| 4. Blame | 5.53 (2.57) | .09 | .20 | .34\*\* |  |  |  |  |
| 5. AAQH Total | 73.99 (12.37) | .52\*\* | .26\* | .20 | .08 |  |  |  |
| 6. AAQH Saving | 40.14 (6.49) | .42\*\* | .22 | .15 | .03 | .88\*\* |  |  |
| 7. AAQH Acquisition | 33.85 (7.34) | .52\*\* | .23\* | .20 | .11 | .91\*\* | .60\*\* |  |
| 8. FFMQ Acting with Awareness | 19.51 (5.67) | -0.40\*\* | -.20 | -.27\* | -.28\* | -.22 | -.05 | -.33\* |

*Note*. \**p* < 0.05, \*\**p* < 0.01, \*\*\**p* < 0.001.

**Table 3**

*Time by Condition Effects on Process Variables*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Outcome | Time *β* | Condition *β* | Time\*Condition *β* | Baseline CGI-I *β* |
| Difference | -0.31\* | 0.10 | -0.50\* | 0.32\*\* |
| Disdain | 0.09 | 0.30 | -1.12\*\*\* | 0.27\*\* |
| Blame | -0.17 | -0.14 | -0.52 | 0.24\*\* |
| AAQH Total | -0.51\*\* | 0.13 | -0.79\*\* | -0.03 |
| FFMQ Acting with Awareness | 0.13 | -0.37 | 1.11\*\*\* | -0.10 |

*Note*. \**p* < 0.05, \*\**p* < 0.01, \*\*\**p* < 0.001.

**Table 4**

*Impact of Moderator Variables on SI-R Total*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Variable** | **B** | **SE** | ***t*** |
| *Time by condition by age* |
|  | Intercept | 0.15 | 0.46 | 0.33 |
|  | Time | -0.12 | 0.47 | -0.25 |
|  | Condition | -0.44 | 0.71 | -0.62 |
|  | Age | 0.01 | 0.01 | 0.75 |
|  | Baseline CGI | 0.14 | 0.10 | 1.47 |
|  | Time x Condition | -0.57 | 0.76 | 0.46 |
|  | Time x Age | -0.01 | 0.01 | -1.05 |
|  | Age x Condition | 0.01 | 0.01 | 0.63 |
|  | Time x Condition x Age | 0.00 | 0.02 | -0.17 |
| *Time by condition by gender* |
|  | Intercept | 0.36 | 0.53 | 0.69 |
|  | Time | -0.91 | 0.48 | -1.89 |
|  | Condition | 0.03 | 0.64 | 0.05 |
|  | Gender | 0.11 | 0.54 | 0.21 |
|  | Baseline CGI | 0.12 | 0.11 | 1.08 |
|  | Time x Condition | -0.63 | 0.63 | -1.00 |
|  | Time x Gender | 0.36 | 0.51 | 0.70 |
|  | Gender x Condition | 0.04 | 0.66 | 0.06 |
|  | Time x Condition x Gender | -0.11 | 0.67 | -0.17 |
| Time by condition by baseline AAQH total |
|  | Intercept | 0.50\*\*\* | 0.12 | 4.10 |
|  | Time | -0.55\*\*\* | 0.15 | -3.64 |
|  | Condition | 0.01 | 0.17 | 0.03 |
|  | Baseline AAQH | 0.61\*\*\* | 0.12 | 4.92 |
|  | Baseline CGI | 0.11 | 0.08 | 1.37 |
|  | Time x Condition | -0.788\*\*\* | 0.22 | -3.58 |
|  | Time x Baseline AAQH total | 0.08 | 0.16 | -2.05 |
|  | Baseline AAQH x Condition | -0.35\* | 0.17 | -2.05 |
|  | Time x Condition x Baseline AAQH | -0.02 | 0.22 | -0.09 |
|  |  |  |  |  |

*Note*. \**p* < 0.05, \*\**p* < 0.01, \*\*\**p* < 0.001.

**Table 5**

***Longitudinal Mediation Models with SI-R as Outcome***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mediator | a path | b path | c path | c’ path | Product of coefficients | Bootstrapped 95% CI | CGI-I → M | CGI-I → Y |
|  |  |  |  |  | Point estimate | SE | Lower | Upper |  |  |
| AAQH Total | -0.53\* | 0.53\*\*\* | -0.66\* | -0.38 | -0.28 | 0.16 | -0.71 | 0.02 | 0.22 | -0.06 |
| FFMQ Acting With Awareness | 0.59\* | -0.26 | -0.56 | -0.47 | -0.15 | 0.11 | -0.50 | 0.02 | 0.05 | 0.07 |
| Difference | -0.02 | 0.05 | -0.61\* | -0.61\* | 0.00 | 0.01 | -0.10 | 0.08 | 0.42\*\* | 0.01 |
| Disdain | -0.29 | 0.16 | -0.62\* | -0.58\* | -0.05 | 0.06 | -0.20 | 0.09 | 0.26 | 0.01 |
| Blame | -0.52 | -0.02 | -0.62\* | -0.63\* | 0.01 | 0.08 | -0.17 | 0.27 | 0.42\*\* | 0.06 |

*Notes*. \**p* < 0.05, \*\**p* < 0.01, \*\*\**p* < 0.001. CGI-I → M refers to the effect of baseline CGI-I on the mediator at posttreatment; CGI-I → Y refers to the effect of baseline CGI-I on the outcome (hoarding severity) at follow-up.

**Table 6**

***Cross-Sectional Mediation Models***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mediator | a path | b path | c path | c’ path | Product of coefficients | Bootstrapped 95% CI | CGI-I → M | CGI-I → Y |
|  |  |  |  |  | Point estimate | SE | Lower | Upper |  |  |
| AAQH Total | -0.56\* | 0.73\*\*\* | -0.62\* | -0.21 | -0.41 | 0.20 | -0.85 | -0.01 | 0.00 | 0.05 |
| FFMQ Acting With Awareness | 0.58\* | -0.30\* | -0.58 | -0.44 | -0.18 | 0.11 | -0.43 | 0.002 | 0.04 | 0.07 |
| Difference | -0.42 | 0.19 | -0.62\* | -0.53\* | -0.08 | 0.08 | -0.35 | 0.06 | 0.33\* | -0.02 |
| Disdain | -0.83\*\*\* | 0.21 | -0.63\* | -0.45 | -0.17 | 0.13 | -0.50 | 0.09 | 0.26\* | 0.00 |
| Blame | -0.85\*\*\* | 0.11 | -0.62\* | -0.52 | -0.10 | 0.12 | -0.43 | 0.15 | 0.18 | 0.04 |

*Notes*. \**p* < 0.05, \*\**p* < 0.01, \*\*\**p* < 0.001. CGI-I → M refers to the effect of baseline CGI-I on the mediator at follow-up; CGI-I → Y refers to the effect of baseline CGI-I on the outcome (hoarding severity at follow-up).

**Figure 1**

*Participant Flow Diagram*



**Figure 2**

*Path Diagram for Longitudinal Mediation*



**Figure 3**

*Path Diagram for Cross-Sectional Mediation*

