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An online experimental test of the compensatory process in hoarding disorder: reducing loneliness and its effects on object attachment

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Abstract

Attachment theory suggests that strong object attachment in hoarding disorder (HD) may be due to an attempt at compensating for unmet relatedness needs. We tested this compensatory process with an online experiment and hypothesized that reducing loneliness among participants with high hoarding symptoms would result in lower object attachment, and that change in loneliness would mediate the impact of an online loneliness intervention on object attachment. A pretest-posttest control group design was used. Participants were 298 MTurk workers pre-screened for high hoarding symptoms recruited via cloudresearch.com. At Time 1, participants completed measures of hoarding severity, loneliness, and four aspects of object attachment: overall object attachment to possessions, insecure object attachment, attachment to an old cherished item, and attachment to a novel item. We randomly assigned participants to either a loneliness intervention ($n = 142$) or an active control (a health education program; $n = 156$). All participants completed follow-up questionnaires after two weeks. We conducted ANCOVAs to assess for group differences at Time 2 whilst controlling for Time 1 variables. Results showed small but significant improvements in loneliness, thwarted belongingness, and object attachment for the novel item for participants who received the loneliness intervention relative to control participants. Mediational analyses revealed that the change in loneliness mediated the effect of the intervention on insecure object attachment. Consistent with attachment theory, these results indicate that reducing loneliness might lead to lower object attachment in hoarding disorder. Trials with clinical participants using more intensive loneliness interventions are warranted.

Keywords Hoarding disorder · Compulsive hoarding · Object attachment · Loneliness · Thwarted belongingness · Insecure object attachment

Hoarding disorder (HD) is a psychological disorder characterized by persistent and excessive saving tendencies due to distress associated with discarding possessions. Many people with HD also feel compelled to acquire things even though there is no need or space for these items. The disproportionate saving and acquiring behaviors contribute to the accumulation of possessions, which ultimately result in excessively cluttered living spaces that preclude the use of rooms for their intended purpose. HD has an estimated population prevalence of 2.5% (Postlethwaite et al., 2019) and is associated with significant impairment or distress (American Psychiatric Association, 2022). In addition to being associated with high levels of loneliness and depression (Frost et al., 2011; Yap et al., 2020), HD is also linked with increased risks of injury, accidental death (Saxena et al., 2011) and poor quality of life (Ong et al., 2015).

A prominent characteristic of HD is the presence of a strong emotional attachment to objects (or object

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attachment). Defined as an "affect-laden possession-specific bond between a person and an object or objects" (Kellett & Holden, 2014, p. 2), object attachment is strongly associated with hoarding symptoms (Timpano & Port, 2021) and is one of the central reasons why discarding causes high levels of distress. Several researchers have suggested that problems with object attachment in HD may originate in negative early childhood experiences (Kehoe & Egan, 2019; Kyrios et al., 2018; Timpano & Port, 2021). This etiological explanation is consistent with attachment theory (Mathes et al., 2020; Yap & Grisham, 2021).

Attachment theory and the compensatory process

Attachment theory posits that the quality of attachment to caregivers in childhood provides the basis for internal working models of the self, others, and relationships, which result in attachment styles that influence emotion regulation and social interactions into adulthood (Bowlby, 1988; Mikulincer & Shaver, 2019). When attachment figures are not reliable or supportive, individuals develop insecure attachment styles and an expectation that significant others will not be available or responsive. Thus, instead of seeking social support to alleviate distress, they seek comfort and security from other sources including inanimate objects, even when these objects do not fully satisfy relatedness needs (Mathes et al., 2020). Attachment theory therefore suggests that object attachment is an attempt to compensate for unmet relatedness needs when significant others are perceived to be unreliable or unavailable (Keefer et al., 2014).

Consistent with attachment theory, research has shown that individuals with HD have insecure attachment styles (Chia et al., 2021), have more experiences of interpersonal and childhood trauma (Fontenelle et al., 2021; Mathes et al., 2018), and report a lack of family warmth in childhood (Kyrios et al., 2018). Past research has also shown evidence consistent with the compensatory process in HD (i.e., the process where inanimate objects are used to compensate for unmet relatedness needs). For example, recent research showed that people with HD report higher levels of unmet relatedness compared to controls – including higher levels of thwarted belongingness (i.e., a perception that one is socially disconnected and lacks meaningful and reciprocal relationships; Edwards et al., 2023), higher levels of loneliness (Yap et al., 2023), and more interpersonal difficulties (Chen et al., 2021; Grisham et al., 2018). Several studies have also shown that hoarding is positively correlated with loneliness (Burgess et al., 2018; Yap et al., 2020; Yap et al., 2023), and that object attachment mediates the relationship between these interpersonal difficulties and hoarding symptoms (Kehoe & Egan, 2019; Yap et al., 2020).

Although these studies provide supportive evidence of a compensatory process, causal conclusions cannot be made because of the cross-sectional and observational nature of these studies. Unmet relatedness needs as indicated by higher levels of loneliness may lead to strong object attachment in HD, but hoarding also results in social impairment and loneliness (Timpano et al., 2020). Experimental studies are therefore needed to show that unmet relatedness needs are a cause of higher object attachment.

Experiments on the compensatory process

Several experimental studies in non-hoarding samples have demonstrated that manipulating unmet relatedness needs in participants affects object attachment (Bartz et al., 2016; Keefer et al., 2012). For example, Keefer et al. (2012) randomly assigned participants to one of four writing tasks where they wrote a personal experience where (1) a close other was reliable, (2) a close other was unreliable, (3) a stranger was reliable, or (4) a stranger was unreliable. They found that participants primed to think about unreliable close others had significantly higher object attachment than those in the other conditions.

Although experimental studies in non-hoarding samples have demonstrated that unmet relatedness needs lead to higher object attachment, research with high hoarding participants are needed to conclude that this compensatory process occurs in HD. However, unlike studies in non-hoarding samples, experimental studies in analogue HD samples (i.e., individuals with high hoarding symptoms who have not been diagnosed with HD) that have tested the compensatory process have shown mixed results. Kwok et al. (2018) and Mathes and Schmidt (2020) used the cyberball paradigm (Williams & Jarvis, 2006) to manipulate social exclusion in participants and reasoned that people in the social exclusion condition would experience feelings of social disconnection and turn to objects for comfort.

Kwok et al. (2018) hypothesized that social exclusion would result in higher ratings of object attachment, anthropomorphism, sentimental, and instrumental value for five novel items presented in the lab, relative to those assigned to an inclusion or overinclusion condition. They however failed to find significant group differences in object attachment, anthropomorphism, and instrumental value between the social exclusion, inclusion, and overinclusion conditions. They did find that, compared to participants in the inclusion and overinclusion groups, participants in the social exclusion condition reported that objects had higher sentimental value.

Instead of novel items, Mathes and Schmidt (2020) asked participants to describe, on index cards, ten personal belongings that they valued and would have difficulty discarding. Participants rated object attachment to these items before and after playing cyberball. Upon completing cyberball, they were also asked to make decisions about whether to keep or leave behind items in a fire. Results were mixed; the researchers did not find a significant difference between social exclusion and inclusion conditions in object attachment or the number of items saved. However, consistent with the compensatory process, they found that feelings of rejection after cyberball were positively associated with object attachment in the whole sample, and that object attachment mediated the association between rejection and the number of items saved.

Kwok et al. suggested that cyberball may not be an appropriate paradigm to examine the compensatory process because it only affects acute feelings of social exclusion by strangers rather than chronic loneliness in close relationships and therefore may have had negligible effects on object attachment. Furthermore, given that people with HD already experience high levels of loneliness (Yap et al., 2023), inducing social exclusion in the lab may not substantially increase the experience of unmet relatedness needs. The priming of attachment security to close relationships (Keefer et al., 2012; Norberg et al., 2020) may also be ineffective for people with HD because of the lack of close relationships in their lives.

We therefore propose that a test of the compensatory process in HD needs to involve an experiment designed for people with HD who have high levels of unmet relatedness needs. Instead of manipulating unmet relatedness needs by asking participants to recall close relationships or by simulating social exclusion, the experiment should manipulate unmet relatedness needs with an experimental condition that involves an intervention to reduce loneliness.

Different aspects of object attachment

Another consideration that may impact on experimental results is the way object attachment is assessed. Different measures emphasize different aspects of object attachment. For example, the Emotional Attachment Subscale of the Saving Cognitions Inventory (SCI-EA; Steketee et al., 2003) asks participants about their cognitions associated with discarding and includes items referring to anthropomorphism or objects as extensions of the self. On the other hand, the Inanimate Object Attachment Security Subscale from the Reciprocal Attachment Questionnaire – Adjusted (IOAS) (Keefer et al., 2012; Nedelisky & Steele, 2009) measures how insecure participants feel about their relationship to objects in general. Unlike the SCI-EA and IOAS, the Object Attachment Questionnaire (OAQ) measures attachment to a specific object (Grisham et al., 2009; Norberg et al., 2020).

Although all facets of object attachment are associated with hoarding disorder (Grisham et al., 2009; Yap & Grisham, 2019), the effect of loneliness on each of these facets may differ. People with insecure object attachment experience a strong need to be close to their possessions and cling tightly to them for fear of loss. With a sense of self that is enmeshed with their possessions, they feel anxious and vulnerable when separated from their belongings (Nedelisky & Steele, 2009; David & Norberg, 2022). It may be that reducing loneliness could lead to less reliance on objects for a sense of self. We might therefore see a greater impact of loneliness interventions on insecure object attachment given that insecure object attachment significantly decreased following the priming of attachment security to close relationships (Keefer et al., 2012) and has been shown to have the strongest association with HD (David & Norberg, 2022; Yap & Grisham, 2019).

In addition, object attachment to a specific item that is new may be more responsive to change than object attachment to an old cherished possession given that our emotional bond to possessions increases over time (Grisham et al., 2009). Using different measures in one study will help identify which facets of object attachment are influenced by loneliness.

Aims and hypotheses

The current study aims to further examine the hypothesised compensatory process in HD, which suggests that a decrease in loneliness would lead to a decrease in object attachment. We therefore conducted an experimental test of the model and randomly assigned individuals pre-screened for high levels of hoarding symptoms into either a loneliness intervention (the Building Stronger Connections program; BSC) or an active control (the Health Education Program; HEP). We hypothesized significantly greater reductions in loneliness, thwarted belongingness, object attachment, and hoarding severity in the experimental group relative to controls. We also hypothesized that change in loneliness would be associated with change in object attachment in the whole sample, and that reductions in loneliness would mediate the effects of the intervention on object attachment.

Methods

Participants

Participants were 298 individuals who were invited because they had scored above the cut-off score of > 9 on the Hoarding Rating Scale (Nutley et al., 2020) at a pre-screen. All participants were recruited via Cloudresearch.com (Litman & Robinson, 2020), a participant-sourcing platform that assists researchers with the recruitment of Mechanical Turk (MTurk) workers for online studies. MTurk workers are independent contractors with Amazon Mechanical Turk (www.MTurk.com) who complete computerized tasks for payment.

Previous studies have shown that MTurk workers produce reliable and valid data for clinical research (Arditte et al., 2016; Chandler & Shapiro, 2016) and that online experiments with MTurk participants have similar results to experiments conducted in the lab (Amir et al., 2012; Coppock, 2019). Consistent with past HD research using MTurk samples (Raines et al., 2016; Yap et al., 2020), we chose to recruit MTurk participants for our study because it allowed us to screen a large number of individuals for high levels of hoarding symptoms and therefore recruit the required number of participants for the experiment. An MTurk sample is also more demographically diverse than university samples and may therefore be more representative of hoarding patients in the community as it will include more men, older adults, and people who are unpartnered (Woody et al., 2020).

All participants were from the United States, were aged between 18 and 84 years, and were mostly white and women. There were no differences between randomly assigned groups on demographic variables (Table 1). Notably, there were no differences between groups in demographic factors associated with loneliness including age, gender, education, and employment (Moens et al., 2021; Switsers et al., 2022). The average hoarding severity score for the whole sample on the Saving Inventory – Revised (Frost et al., 2004) was high ($M = 36.32$, $SD = 15.38$) and just below the recommended clinical cut-off of ≥ 39 (Kellman-McFarlane et al., 2019). There were 121 participants who scored above the cut-off score indicating clinical levels of hoarding. These high hoarding scores are consistent with the HRS pre-screening and previous research showing that

Table 1 Participant demographics

		BSC ($n = 142$)	HEP ($n = 156$)	Total sample ($n = 298$)	t-test and Pearson $\chi 2$
Mean Age (*SD*)		41.42 (12.17)	40.21 (12.10)	40.78 (12.13)	$t(296) = 0.86$, $p = .39$
Gender	Man	40.8%	34.6%	37.6%	$\chi 2(2) = 2.53$, $p = .28$
	Woman	58.5%	62.8%	60.7%	
	Nonbinary	0.7%	2.6%	1.7%	
Ethnic background	White	77.5%	72.4%	74.8%	$\chi 2(4) = 3.11$, $p = .54$
	Black	5.6%	10.3%	8.1%	
	Asian	8.5%	10.3%	9.4%	
	Hispanic	4.2%	4.5%	4.4%	
	Other	4.2%	2.6%	3.4%	
Annual Family Income	≤$39,999	38.7%	34.0%	36.2%	$\chi^2(2) = 1.47$, $p = .48$
	$40,000 – $79,999	39.4%	38.5%	38.9%	
	≥$80,000	21.8%	27.6%	24.8%	
Marital Status	Married/de facto	43.7%	40.4%	41.9%	$\chi^2(2) = 2.66$, $p = .27$
	Widowed/separated /divorced	9.2%	15.4%	12.4%	
	Never married	47.2%	44.2%	45.6%	
Education	High School or lower	12.7%	11.5%	12.1%	$\chi^2(4) = 0.54$, $p = .97$
	Some College	19.0%	17.9%	18.5%	
	2 year degree	12.7%	11.5%	12.1%	
	4 year degree	39.4%	43.6%	41.6%	
	Professional degree or doctorate	16.2%	15.4%	15.8%	
Employment	Employed full-time	59.2%	60.3%	59.7%	$\chi^2(5) = 2.16$, $p = .83$
	Employed part-time	16.9%	16.7%	16.8%	
	Unemployed	14.1%	10.9%	12.4%	
	Retired	3.5%	3.2%	3.4%	
	Disabled	3.5%	3.2%	3.4%	
	Other (please specify)	2.8%	5.8%	4.4%	

Note. BSC = Building Stronger Connections Program designed to reduce loneliness, HEP = Health Education Program which is the active control condition

Note: Only one participant indicated that there were a student and we therefore merged that category with the unemployed category. All participants who selected "Other" specified that they were self-employed

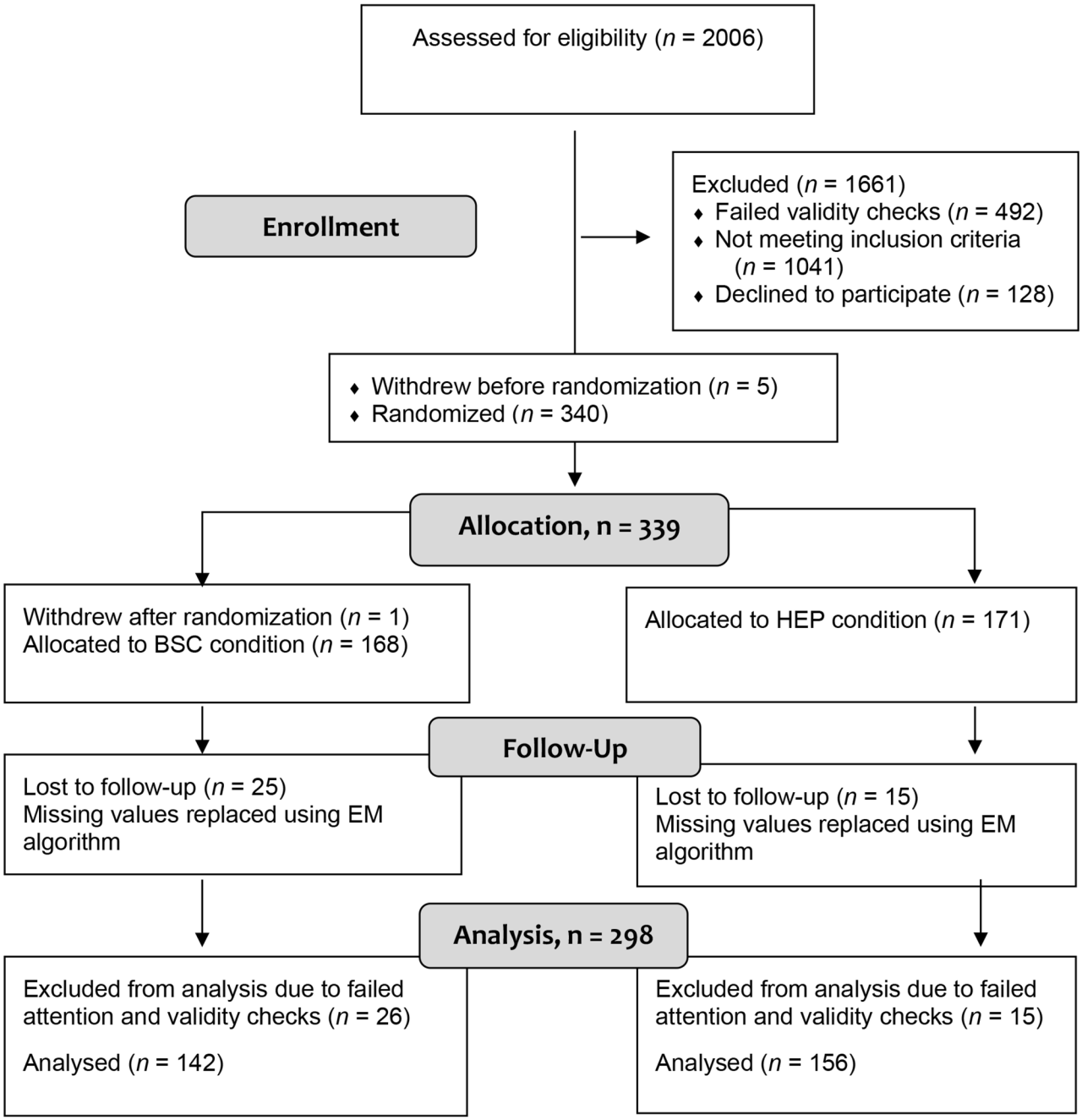

Fig. 1 CONSORT Flow diagram of participation. *Note*: BSC = Building Stronger Connections Program designed to reduce loneliness, HEP = Health Education Program which is the active control condition

MTurk workers tend to have high levels of hoarding symptoms (Arditte et al., 2016).

Measures

The following questionnaires were administered. at Time 1 (T1). The same questionnaires were readministered at Time 2 (T2; two-week follow-up).

Hoarding

The Saving Inventory-Revised (SI-R; Frost et al., 2004) is a 23-item self-report questionnaire comprising items that measure compulsive acquisition, difficulties discarding, and clutter. The total SI-R score is an indicator of hoarding disorder severity. Participants respond to questions on a 5-point rating scale ranging from 0 (Never) to 4 (Very often/almost all/extreme). Items 2 and 4 are reversed scored. Items are summed for a total score in which higher scores indicate higher levels of hoarding severity. The measure has very good psychometric properties (Kellman-McFarlane et al., 2019) and excellent internal consistency in the current sample (Cronbach's alpha = 0.94).

Object attachment

Unique facets of object attachment were assessed using three measures: the Emotional Attachment subscale from the Saving Cognitions Inventory (SCI-EA; Steketee et al., 2003), the Inanimate Object Attachment Security Subscale from the Reciprocal Attachment Questionnaire – Adjusted (IOAS; Nedelisky & Steele, 2009), and Object Attachment Questionnaire (OAQ; Grisham et al., 2009).

Overall object attachment The SCI-EA is a self-report measure of overall object attachment to personal possessions. It has 10-items that asks how frequently participants experienced cognitions related to object attachment when deciding whether to throw something away over the past week. Participants respond to statements on a 7-point rating scale ranging from 1 (not at all) to 7 (very much). The items are summed for a total score in which higher scores reflect higher levels of object attachment. The SCI-EA subscale has very good psychometric properties (Steketee et al., 2003) and excellent internal consistency in the current sample (Cronbach's alpha = 0.94).

Insecure object attachment The IOAS is a 17-item self-report measure of insecure object attachment. Questionnaire items tap the extent to which individuals fear the loss of their belongings, have a need to be close to possessions, and feel vulnerable if things were lost or unavailable. Participants respond on a 5-point Likert scale from 1 (disagree) to 5 (agree). Items are summed and higher scores indicate higher insecure object attachment. The has good psychometric properties (Nedelisky & Steele, 2009) and excellent internal consistency in the current sample (Cronbach's alpha = 0.93).

Object attachment to specific items (Cherished and Novel) The OAQ is a 13-item self-report measure of object attachment to a specific object. Participants were asked to rate on a 7-point Likert scale from 1 (Not at all) to 7 (Very much) about how they felt towards this object. Items are summed for a total score with higher scores indicating higher levels of object attachment. To assess object attachment to a specific cherished possession, we ask participants to identify a personal possession of low monetary value that they were emotionally attached to and was difficult to discard. We asked them to rate their attachment to this item using the OAQ (OAQ-old). To assess object attachment to a specific novel item, we also showed participants a picture of a smiley face keychain and asked them to imagine that they were given this keychain and to rate their attachment using the OAQ again (OAQ-new) (See Supplementary Materials). The OAQ has been used to assess object attachment to specific items and has good psychometric properties (Grisham et al., 2009). In the current study, the OAQ has excellent internal consistency for the old item (OAQ-old; Cronbach's alpha = 0.93) and for the novel item (OAQ-new; Cronbach's alpha = 0.95).

Loneliness

Two measures of loneliness were used: the UCLA Loneliness Scale – 3 (UCLA-LS3; Russell, 1996) and the thwarted belongingness subscale from the Interpersonal Needs Questionnaire (INQ-TB; Van Orden et al., 2012). The UCLA-LS3 is a self-report measure and has 20 items describing how people sometimes feel and participants are asked how often they feel that way on a 4-point scale from 1 (never) to 4 (always). Nine items are reverse scored. Items are summed for a total score with higher scores indicating higher levels of loneliness. The UCLA-LS3 has excellent psychometric properties (Russell, 1996) and its internal consistency in the current study is excellent (Cronbach's alpha = 0.96).

The INQ-TB measures thwarted belongingness which is defined as "a psychologically painful mental state that results when the fundamental need for connectedness…is unmet" (van Orden et al., 2012, p. 2). This self-report measure has nine items and participants indicate how true each item is for them on a 7-point Likert scale from 1 (Not at all) to 7 (Very true for me). Six items are reverse scored. The

sum of items form a total score with higher scores indicating higher levels of thwarted belongingness. The INQ-TB has very strong psychometric properties (van Orden et al., 2012) and its internal consistency in the current sample is excellent (Cronbach's alpha = 0.94).

Potential confounding variables

Two potential confounding variables that are associated with loneliness were also measured: depression and social anxiety (Oren-Yagoda et al., 2022; Wolska & Creaven, 2022). Depression was measured using the 7-item depression subscale of the Depression Anxiety and Stress Scales-21 (DASS-Dep; Lovibond & Lovibond, 1995). Participants are asked on a 4-point scale how much each statement applied to them over the past week from 0 (Never) to 3 (Almost always). The DASS-Dep has excellent psychometric properties (Lovibond & Lovibond, 1995) and excellent internal consistency reliability in the current sample (Cronbach's alpha = 0.94). Social anxiety was measured using the 3-item Mini-Social Phobia Inventory (Mini-SPIN; Connor et al., 2001). Participants are asked to rate how much each statement applied to them over the past week on a 5-point scale from 0 (Not at all) to 4 (Extremely). The measure has very good psychometric properties (Connor et al., 2001) and good internal consistency in the current sample (Cronbach's alpha = 0.84).

Table 2 Summary of the building stronger connections intervention

Video	Content
1	• Overview of the intervention: Facts, Myths, and Strategies • Defining social isolation • The human need for connection • Negative effects of social isolation • Social isolation fuels itself
2	**Myth #1**: if you are around a lot of people, you won't feel isolated. • Challenging the myth: You don't need a lot of people. You need high-quality social interactions to meet your need to belong, not necessarily high quantity. • High-quality social interactions are person-to-person, frequent, and involve mutual support. • Social media cannot fulfill your need to connect. • Being smart about social media use – using it to stay connected, not as a substitute for getting together or talking on the phone. **Activity** • Review a list of activities that may be of interest and list additional activities that could help you stay connected. • Set a goal and make a plan to engage in one activity.
3	**Myth #2**: You should wait for people to reach out to you. • Challenging the myth: What if everyone waited for others to reach out? • Taking opposite action • It's better late than never to reconnect with family and friends. • Strategies: Consider different methods for connecting, connect with people from your past or seek out a new neutral person, start things off simple, and don't stop at one person. **Activity** • Think of some people who you can connect with in the coming week. List their names. • Select someone who you would like to contact over the next week and make a plan to contact them.
4	**Myth #3**: Isolation lasts forever • Challenging the myth: Feelings of isolation can change from day to day • Willingness to connect • Reaching out experiments: Take the first step and try things out. **Review of myths**

Procedure

The study was approved by [deidentified] human research and ethics committee. The study protocol was preregistered prior to data collection on 26th January 2022 on the Open Science Framework (OSF) registries (anonymized link: https://osf.io/jxbhq/?view_only=e0fd37251e7b425cb52563241ca824d6).

In line with recommended cut-offs for the HRS (Nutley et al., 2020), participants were pre-screened from an initial sample of 2006 MTurk workers using an HRS cut-off score of > 9. The cut-off was chosen in place of the preregistered pre-screening method as it provided both high sensitivity (0.90) and specificity (0.96) and a less conservative approach to identifying people with probable HD (Nutley et al., 2020).

All study material was presented online using the Qualtrics platform. A total of 473 individuals were invited to participate in the study; 128 declined to participate. Five commenced the study but withdrew without completing baseline measures at T1. The remaining 340 participants gave consent and completed baseline measures: SI-R, SCI-EA, IOAS, UCLA-LS3, INQ-TB, DASS-Dep, and Mini-SPIN. They were then randomly assigned to either the loneliness intervention (Building Stronger Connections; BSC; $n = 169$) or active control condition (Health Education Program; HEP; $n = 171$) at T1 (Fig. 1).

The BSC and HSC interventions used psychoeducation material from previous intervention studies (Short et al., 2019). Each intervention comprised four short videos that were approximately 30 min in total. The videos in the BSC intervention presented facts and myths about loneliness. Participants were also introduced to strategies and activities to work on for the next two weeks to reduce loneliness (see Table 2). The HEP intervention presented information about diet, sleep, and exercise, with strategies and activities to work on over the two-week period. After each video, we checked whether participants had paid attention by asking

them a multiple-choice question about the video (see Supplementary Materials for links to the BSC and HEP interventions). Participants rated from 1 (none at all) to 5 (a great deal) the extent to which they were able to work on these activities/tasks over the past two to three weeks. Immediately after watching the videos, participants completed the OAQ-old and OAQ-new.

To address concerns about the quality of MTurk data, we used several measures to ensure the validity of the self-report responses. We restricted the study to workers with at least 98% approval ratings for previously completed work and applied CloudResearch's default data quality exclusions to restrict the study to only CloudResearch approved participants, which has been shown to significantly improve data quality (Hauser et al., 2022). At the start of the study, we used CAPTCHA to ensure that participants were not bots. We used two attention checks and asked participants to confirm at the end of T1 that they had responded to the best of their ability to all questions (see Supplementary Materials). Participants who failed any of these attention checks were excluded from the study. We also asked four multple choice questions that were related to the content of the videos to check if participants had paid attention to the videos. Participants who failed any of these questions were also excluded from the study.

After two weeks, participants were invited back for a follow-up assessment where they completed all questionnaires again (T2). Forty participants were lost to follow-up. Missing values analysis for T2 data showed that Little's MCAR test was not significant indicating missingness at random, χ^2 (df=2)=2.24, p=.33. Missing values for participants lost to follow-up were thus replaced using the EM algorithm (Dong & Peng, 2013). Of the 339 participants, 41 participants failed the attention and validity checks, leaving a total of 298 participants: 142 in the BSC condition and 156 in the HEP condition (see Fig. 1). Participants were reimbursed via CloudResearch for a total of US$16 for participating in the study. The payment comprised US$1 at the pre-screen, US$10 at T1, and US$5 at T2.

Data analysis

All analyses were conducted on SPSS v28. Differences between groups at T1 in hoarding and object attachment were examined using between subjects Analyses of Variance (ANOVA). Analyses of Covariance (ANCOVA) were then conducted to test for differences between BSC and HEP on each outcome variable adjusting for T1 scores. Intervention (BSC = 1, HEP = 0) was the independent variable, T1 scores were entered as covariates and T2 scores were the dependent variables. Potential confounding variables (age, gender, depression, and social anxiety) were assessed prior to random assignment to be included as covariates if there were significant group differences. At pre-registration, we also proposed mixed design (2×2) ANOVAs to assess OAQ-new and OAQ-old but results were similar to ANCOVAs and were therefore not reported. We have however included these results in the supplementary materials.

To examine whether change in loneliness was associated with change in object attachment, we used residual change scores between T1 and T2 and conducted Pearson's correlations to examine if there were significant associations between change in loneliness (UCLA-LS3 and INQ-TB) and change in the four aspects of object attachment (SCI-EA, IOAS, OAQ-old, and OAQ-new). Residual change scores are calculated by subtracting predicted T2 scores from actual T2 scores. The predicted T2 scores are estimated by regressing the T2 scores on T1 scores (Kisbu-Sakarya et al., 2012).

We used the SPSS PROCESS macro (Hayes, 2022) to examine whether UCLA-LS3 loneliness mediated the effects of treatment on the different aspects of object attachment. Consistent with an ANCOVA method, UCLA-LS3 and object attachment at T1 were entered as covariates. Intervention was entered as the predictor variable, UCLA-LS3 at T2 as the mediator and object attachment at T2 as the dependent variable.

Results

Preliminary analyses

There were no significant differences between groups on all variables at T1, including depression, social anxiety, age, and gender. As such, these variables were not included as covariates in the analyses. There were also no significant differences between groups at T1 on UCLA-LS3, INQ-TB, SI-R, and measures of object attachment. Mean UCLA-LS3 scores at T1 for both groups were higher than the recommended cut-off score of >43 (Cacioppo & Patrick, 2008) indicating high levels of loneliness in the sample (Table 2).

Two-hundred and seventy participants responded to the question about how much they worked on the suggested activities. Only 17% reported not engaging at all in the activities. The mean rating was 2.39 (SD = 0.09) and 2.54 (SD = 0.08) for the BSC amd HSC group repectively. There was no significant difference between groups, t(df = 268) = 1.23, p = .22.

Effects on loneliness and object attachment

Two ANCOVAs were conducted with T2 scores on the UCLA-LS3 and INQ-TB as dependent variables and T1 scores as covariates. Results showed that compared to the HEP condition, there was significantly lower loneliness

Table 3 Means (and standard deviations in parentheses) for all variables across time points and differences between experimental (BSC; $n = 142$) and Control (HEP: $n = 156$) groups

	Time 1 (T1)		Statistic 1		Time 2 (T2)		Statistic 2		
	BSC	HEP	t (296)	p	BSC	HEP	F (1, 295)	p	ηp^2
UCLA-LS3	51.74 (14.09)	52.18 (14.19)	-0.27	0.79	49.54 (12.23)	51.91 (13.88)	6.50	0.01	0.02
INQ-TB	33.87 (13.50)	33.77 (14.08)	0.06	0.95	32.23 (12.97)	34.57 (14.16)	6.61	0.01	0.02
IOAS	38.35 (15.07)	39.97 (14.06)	-0.96	0.34	40.03 (13.42)	41.05 (13.87)	0.03	0.87	0.00
SCI-EA	30.70 (14.88)	31.17 (14.07)	-0.28	0.78	30.30 (12.73)	30.82 (14.39)	0.03	0.84	0.00
OAQ-old	58.01 (19.13)	55.89 (17.08)	1.01	0.31	57.17 (16.32)	54.68 (16.34)	0.76	0.38	0.00
OAQ-new	34.61 (16.56)	33.58 (18.16)	0.51	0.61	32.12 (15.79)	34.23 (16.92)	4.40	0.04	0.02
SPIN	6.13 (3.38)	6.29 (3.36)	-0.41	0.68	6.23 (3.31)	6.48 (3.11)	0.30	0.58	0.00
DASS-Dep	7.63 (5.68)	7.37 (5.83)	0.38	0.70	7.21 (5.06)	6.87 (5.85)	0.16	0.69	0.00
SI-R	36.73 (15.63)	35.94 (15.20)	0.44	0.66	37.42 (14.56)	35.45 (14.45)	1.98	0.16	0.01

Note: Statistic 1 = t test for differences between groups at T1, Statistic 2 = F test (ANCOVA) for differences between groups at T2 controlling for T1, all p values are two-tailed. BSC = Building Stronger Connections Intervention; HEP = Health Education Program active control. UCLA-LS3 = UCLA Loneliness Scale Version 3; INQ-TB = Thwarted Belongingness, IOAS = Insecure Object Attachment Scale, SCI-EA = Saving Cognitions Inventory Emotional Attachment subscale, OAQ-old = object attachment for cherished possession. OAQ-new = Object attachment for new keychain, SPIN = Mini-Social Phobia Inventory, DASS-Dep = Depression subscale from the Depression Anxiety Stress Scales; SI-R = Saving Inventory – Revised Total

Table 4 Pearson's Correlations between Residual Change Scores with Two-Tailed p Values in Parentheses ($n = 298$)

	UCLA-LS3	INQ-TB	IOAS	SCI-EA	OAQ-old	OAQ-new	SI-R
UCLA-LS3	-						
INQ-TB	0.69**	-					
	(< 0.001)						
IOAS	0.24**	0.25**	-				
	(< 0.001)	(< 0.001)					
SCI-EA	0.07	0.13*	0.44**	-			
	(0.24)	(0.03)	(< 0.001)				
OAQ-old	0.02	0.15*	0.18**	0.35**	-		
	(0.75)	(0.01)	(0.002)	(< 0.001)			
OAQ-new	< 0.01	− 0.002	0.21**	0.29**	0.11	-	
	(0.96)	(0.97)	(< 0.001)	(< 0.001)	(0.07)		
SI-R	0.16**	0.19**	0.38**	0.41**	0.17**	0.14*	-
	(0.005)	(0.001)	(< 0.001)	(< 0.001)	(0.003)	(0.018)	

** $p < .01$, * $p < .05$

Note: All variables are residual change scores, UCLA-LS3 = UCLA Loneliness Scale Version 3; INQ-TB = Thwarted Belongingness, IOAS = Insecure Object Attachment Scale, SCI-EA = Saving Cognitions Inventory Emotional Attachment subscale, OAQ-old = object attachment for cherished possession. OAQ-new = Object attachment for new keychain, SI-R = Saving Inventory – Revised Total score

and thwarted belonginess in the BSC condition at T2 (see Table 3).

Five ANCOVAs were conducted to examine if there were differences between groups on SI-R and the four measures of object attachment at T2 after controlling T1. Results showed significantly lower OAQ-new in the BSC condition at T2 after controlling for T1 compared to HEP. There were however no significant differences in SI-R (hoarding severity), IOAS (insecure object attachment), SCI-EA (overall object attachment), and OAQ-old (object attachment for the cherished possession) (see Table 3).

Mediation analyses

Residual change scores were calculated for loneliness, thwarted belongingness, the four measures of object attachment, and hoarding severity, and Pearson's correlations were calculated between these residual change scores (Table 4). Although the ANCOVAs showed differences between groups on loneliness and OAQ-new, there were no significant correlations in the residual change scores between OAQ-new and measures of loneliness (UCLA-LS3 and INQ-TB). However, there were significant correlations between residual change scores for loneliness and both IOAS (insecure object attachment) and SI-R (hoarding severity).

Given that ANCOVA results showed significant group effects on OAQ-new and loneliness, we tested whether change in UCLA-LS3 mediated the effects of the BSC condition on OAQ-new. Indirect effects were examined using the SPSS PROCESS macro (Hayes, 2022). Intervention (BSC = 1, HSC = 0) was entered as the predictor variable, UCLA-LS3 at T2 as the mediator and OAQ-new at T2 as the dependent variable. UCLA-LS3 and OAQ-new at T1 were entered as covariates. Paths from intervention to the mediator (path a), and from mediator to outcome (path b) were calculated using 5000 bootstrap samples to arrive at 95% confidence intervals for the indirect effects (indirect ab path). Total effects (path c) and direct effects (path c') were also calculated. Results showed no significant indirect effects (see Fig. 2).

Since we found significant correlations between residual change scores for UCLA-LS3 and IOAS, there may be mediated effects in the absence of significant intervention effects on IOAS. O'Rourke and MacKinnon (2018) noted that when a mediated effect and total effect are equal, the power to detect the mediated effect is much larger than the power to detect the intervention effect, especially in a situation where the effects are small and the sample size is large. This meant that significant mediation is possible even when there is no significant total effect. We therefore tested whether change in UCLA-LS3 mediated the effects of the intervention on IOAS. Indirect effects were examined using the SPSS PROCESS macro with 5000 bootstrap samples (Hayes, 2022). Intervention was entered as the predictor variable, UCLA-LS3 at T2 as the mediator and IOAS at T2 as the dependent variable. UCLA-LS3 and IOAS at T1 were entered as covariates. Results showed significant indirect effects of IOAS change (see Fig. 2).

Discussion

The current study aimed to test a model of compensatory processes in hoarding. We found partial support for our hypotheses. As hypothesized, the loneliness intervention significantly reduced loneliness, thwarted belongingness, and object attachment to a new keychain compared to the active control. These findings are consistent with the compensatory model and with non-clinical experimental research that showed that social disconnection resulted in increased object attachment (Keefer et al., 2012; Bartz, 2016). Importantly, by using an experimental design which randomly assigned participants to a loneliness intervention or an active control, we addressed limitations

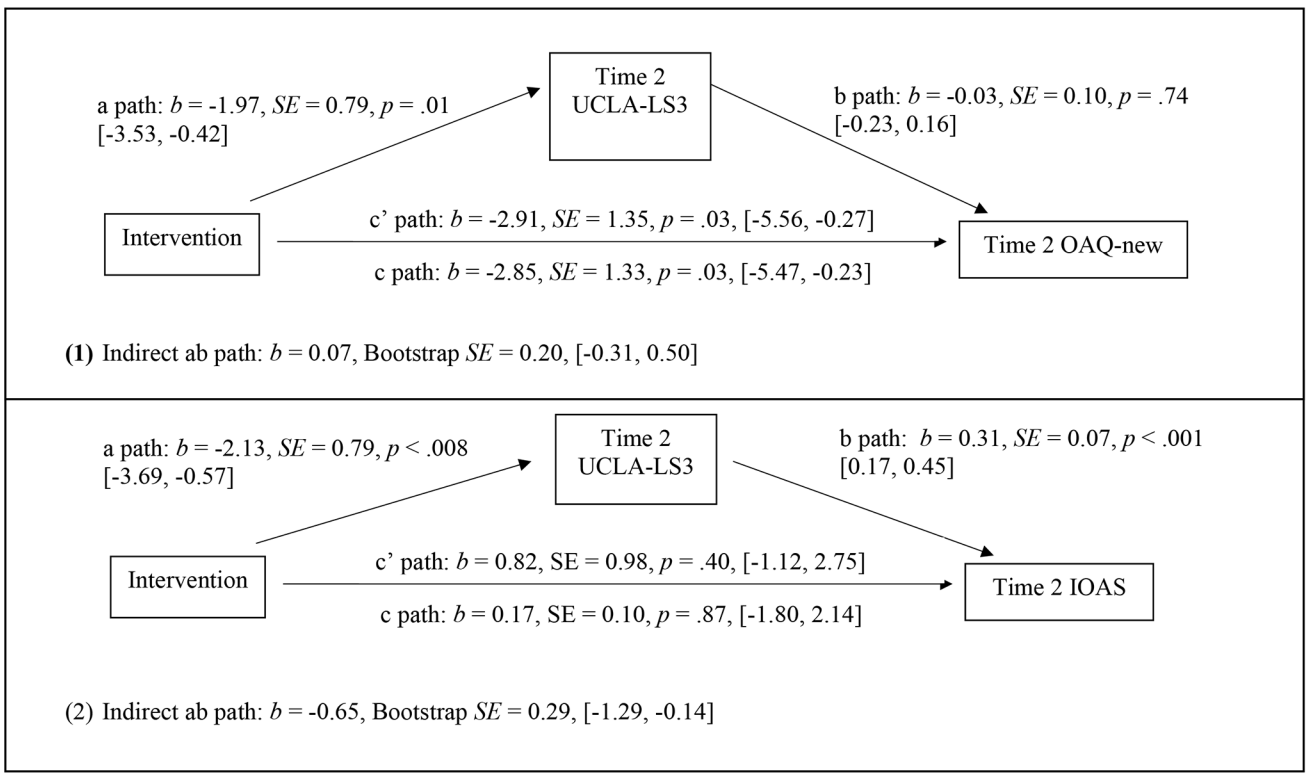

Fig. 2 Mediation analyses examining (1) whether loneliness mediated the effects of the intervention on object attachment for a new keychain and (2) whether loneliness mediated the effects of the intervention on insecure object attachment. Note: All path estimates are unstandardized coefficients. 95% confidence intervals are in square brackets. UCLA-LS3 = UCLA Loneliness Scale Version 3, OAQ-new = object attachment questionnaire for new keychain. IOAS = Insecure Object Attachment Scale. UCLA-LS3 and OAQ-new at Time 1 were entered as covariates in model 1 and UCLA-LS3 and IOAS at Time 1 were entered as covariates in model 2

of previous studies (e.g., Mathes & Schmidt, 2020) and we showed that a reduction in loneliness can result in reductions to object attachment.

However, the effects were small and there were no significant group differences on other measures of object attachment or hoarding severity. The lack of intervention effects on other facets of object attachment and hoarding severity could be due to the small effects of the intervention on loneliness relative to controls. There was a relatively short follow-up period between T1 and T2, and participants may not have had enough opportunities to make major improvements to social connectedness. Unlike the attachment to a new object, the other measures of object attachment (i.e., emotional attachment to possessions in general, attachment to a cherished item, and insecure object attachment) all referred to personal possessions with a longer period of ownership and attachment. Changes to these facets of object attachment may require larger reductions in loneliness.

Nevertheless, as predicted, change in loneliness and thwarted belongingness were associated with change in insecure object attachment and hoarding severity, although this was not the case with attachment to the new keychain. Similarly, when indirect effects were examined, we found that change in loneliness mediated the effect of the intervention on insecure object attachment but not on attachment to the new keychain. These findings from the mediational analyses were surprising given the significant intervention effect on attachment to the new keychain but not on insecure object attachment. One explanation is that the active control condition which targeted health-related behaviors such as exercise, may have led to improvements in social connectedness (Pels & Kleinert, 2016). This interpretation is consistent with our findings that although the effects of BSC on loneliness and object attachment relative to controls were weak, there was a moderately large association between change in loneliness and change in insecure object attachment in the whole sample.

The findings of the mediational analyses are consistent with research showing that loneliness is associated with hoarding severity and that object attachment mediates the relationship between loneliness and hoarding (Yap et al., 2020). It is also consistent with recent research showing the importance of insecure object attachment in understanding hoarding behaviors (David & Norberg, 2022). The formation of close emotional bonds to personal possessions occurs in people without HD (Csikszentmihalyi & Rochberg-Halton, 1981; Yap & Grisham, 2020) and most people can identify belongings that have sentimental value and are linked with personal meaning and memories. Their attachment to these possessions may be strong but they do not cling to these objects, nor do they feel excessive amounts of anxiety about losing them. By contrast, people with HD tend to report insecure emotional attachments to their possessions (Yap & Grisham, 2019, 2020). This insecure object attachment explains why turning to objects for comfort and security in people with HD does not satisfy their relatedness needs. Even though they may experience some comfort from their possessions, their strong need to be close to their belongings is accompanied by feelings of anxiety and a fear of loss - not just of the possession but also of control, identity, and memories (Kings et al., 2020, 2021).

Our study is an experiment that shows that targeting loneliness has a causal impact on object attachment. It therefore indicates that reducing loneliness might lead to a lowering of the need to rely on possessions for comfort and safety. However, we are not suggesting that our BSC intervention, which was less than an hour and only had a two-week follow-up, was sufficient for the treatment of HD. Future studies involving more potent online interventions with longer follow-up and online guidance by a therapist, so that participants are supported to problem solve obstacles and engage in planned activities, might have larger mitigating effects on loneliness, object attachment, and HD, as indicated by recent research showing promising results for interventions targeting social difficulties in hoarding disorder (Chen et al., 2023a; Grisham et al., 2022).

Limitations and future directions

Several limitations need to be acknowledged. Although participants were screened for high levels of hoarding and many met the clinical cut-off based on the SI-R, HD was not formally diagnosed. Further research in a clinical sample is required for generalisation of our findings to the clinical HD population.

Although the IOAS has good internal consistency and concurrent validity (Nedelisky & Steele, 2009; Yap & Grisham, 2019), the measure has not been subjected to rigorous psychometric evaluation. Recently, David and Norberg (2022) developed and evaluated the Object Attachment Security Measure (OASM) and showed that it could distinguish secure and insecure object attachment reliably. Future research should use the OASM.

The use of an online sample in which we relied solely on self-report questionnaires is also a limitation. A lab study where actual objects are used to assess object attachment may have yielded different results. For example, when we asked participants about the novel object, we asked them to imagine that they were given a keychain rather than giving them a real keychain as was done in previous research (Grisham et al., 2009). Future research with real keychains and using an experience sampling method (where real-time ratings of loneliness and object attachment to a real keychain are collected) could provide further insights into the compensatory process.

Our study is also limited because the BSC intervention was modified and therefore not a fully-fledged loneliness intervention. Previous studies using the BSC program and other evidence-based online loneliness interventions show larger effects on loneliness with longer intervention and follow-up periods (Choi et al., 2012; Short et al., 2019). We also did not prompt participants to engage with or complete activities over the two weeks. Although the majority of individuals reported engaging in the tasks, a substantial proportion did not. Futhermore, we did not assess changes in social interaction at follow-up. Future research examining the effects of a social-based intervention on insecure object attachment and hoarding behaviors is warranted.

While both groups had similar levels of depression and social anxiety at baseline, we did not ask about or control for other treatments that participants were engaging in during the two weeks which may have affected loneliness and object attachment.

We also recognize that we have restricted the testing of the compensatory process by focusing on loneliness. There are other factors that can result in unmet relatedness needs, such as insecure intepersonal attachment and interpersonal conflict. Perhaps improving these factors could also improve insecure object attachment. Further research to examine the role of other interpersonal factors is warranted.

Conclusions

Our study is the first to show that reducing loneliness leads to lower object attachment for a novel item in a high hoarding sample and that change in loneliness is associated with change in insecure object attachment. These findings are consistent with attachment theory and provide further evidence of the compensatory process. Although this study is a test of the compensatory process rather than an evaluation of an intervention for HD, we could also view this as a proof-of-concept pilot study given that the results showed that improving loneliness using a brief online intervention works in people with high hoarding symptoms. As there are many benefits to reducing loneliness such as improvements in quality of life, lower depression, and better physical health (Leigh-Hunt et al., 2017), addressing loneliness should be a priority in HD interventions. Therefore, in line with a process-based approach, we recommend that clinicians should assess loneliness in HD clients and tailor interventions to explore adaptive ways of meeting relatedness needs (Hayes et al., 2022).

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