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Through the mind's eye: mapping associations between hoarding tendencies and voluntary and involuntary mental imagery

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Abstract

Background: Preliminary evidence suggests that mental imagery may be an important clinical feature in hoarding. Individuals who hoard use objects as receptacles for memories, and experience more frequent, intrusive and distressing images compared with the general community. However, the specific nature of these associations remains poorly understood.

Aims: We aimed to investigate whether hoarding traits were related to the ability to voluntarily generate imagery in different sensory modalities, and uniquely with the tendency to experience negative intrusive imagery. We also aimed to understand the mechanism by which mental imagery experiences may confer vulnerability to hoarding problems.

Method: Undergraduates ($n = 328$) completed questionnaires assessing hoarding, beliefs about objects, imagining ability across the senses, and negative intrusive imagery, as well as symptom measures of depression, obsessive-compulsive disorder and post-traumatic stress. We conducted Pearson's correlations, hierarchical regressions, and mediational analyses.

Results: Hoarding tendencies were associated with reduced visualising ability, but not with the capacity to deliberately generate imagery in other senses. Hoarding was also uniquely associated with the tendency to experience negative involuntary imagery when controlling for symptoms of depression, obsessive-compulsive disorder, and post-traumatic stress. Object-memory beliefs partially mediated the relationship between hoarding and reduced visualising ability. Object attachment partially mediated the relationship between hoarding and negative intrusive imagery.

Conclusions: Results suggest that visualisation difficulties may promote a reliance on objects to facilitate recall, and experiencing negative intrusive imagery may strengthen object attachment. Findings may inform imagery-based conceptualisations and treatments of hoarding problems, such as imagery training or modification interventions.

Keywords: depression; hoarding; intrusive imagery; memory; mental imagery; object attachment

Introduction

Hoarding disorder (HD) is a complex neuropsychiatric disorder characterised by excessive acquiring and difficulty discarding items, resulting in clutter that compromises living spaces (American Psychiatric Association, 2022). Those with HD report an extremely poor quality of life, involving loneliness, social conflict, and frequent medical illness (Ayers *et al.*, 2014; Mathes *et al.*, 2019; Nutley *et al.*, 2021). Although HD is highly co-morbid with other psychiatric conditions

(e.g. depression; Vieira *et al.*, 2022), hoarding confers detrimental impacts on functioning independently of co-morbid psychopathology (Tolin *et al.*, 2019), and is associated with higher levels of disability than chronic pain or diabetes (Nutley *et al.*, 2022). The condition impacts up to 2.5% of the population (Postlethwaite *et al.*, 2019), making it twice as common as obsessive-compulsive disorder (OCD) and arguably the most prevalent obsessive-compulsive and related disorder (American Psychiatric Association, 2022).

The most influential model of HD is Frost and Hartl's (1996) cognitive-behavioural conceptualisation, expanded by Steketee and Frost (2006). In this model, HD is formulated as a multifaceted problem deriving from information processing deficits, maladaptive beliefs about maintaining control and responsibility over possessions, problems with emotional attachment to objects, behavioural avoidance of decision-making, and distress when discarding. Distal factors such as genetics and early aversive experiences are also theorised to contribute to hoarding symptom aetiology (Frost and Steketee, 2007). Although there is reasonably strong evidence for the cognitive-behavioural hoarding model (e.g. Grisham and Barlow, 2005), it does not capture some prominent clinical features of the disorder (e.g. social impairments; see Chen *et al.*, 2023). Moreover, although this model has guided the development of cognitive-behavioural therapy (CBT) for HD (Bratiotis and Steketee, 2015), recent reviews suggest CBT for HD only grants significant symptom relief in approximately a third of cases (David *et al.*, 2022), and many refuse or discontinue therapy prematurely (Steketee *et al.*, 2010). It is therefore important to identify features of the disorder not adequately captured by current models that may serve as novel targets for intervention to improve outcomes (Grisham *et al.*, 2022).

Mental imagery in hoarding

Emerging evidence suggests that mental imagery may represent an important clinical feature of hoarding and one promising treatment target. Mental images are internally generated perceptual experiences occurring without direct sensory input (i.e. 'Seeing with the mind's eye, hearing with the mind's ear . . .', Kosslyn *et al.*, 2001, p. 635), such as memories, dreams and imagined episodic future events. Mental images can be either deliberately generated or involuntarily experienced (i.e. as a brief 'flash'), and may occur across sensory modalities (e.g. auditory experiences, haptic sensations), although visual images tend to be most vivid (Schifferstein, 2009). While imagery forms a normal part of mental life for most individuals, including healthy controls (Tallon *et al.*, 2020), abnormal imagery processes have been observed across transdiagnostic psychological disorders, including hoarding problems (Stewart *et al.*, 2020).

For example, individuals who hoard describe using objects as receptacles for memories (Cherrier and Ponnor, 2010; Yap and Grisham, 2019), experience interfering imagery (e.g. resurfacing memories) when attempting to discard (Stewart *et al.*, 2020), and cite preserving these images as important reasons behind saving their items (Cherrier and Ponnor, 2010). Preliminary evidence also suggests that individuals who hoard experience more frequent, intrusive and aversive images during daily life than community controls, and these images cause life-interference and evoke avoidance behaviour (Stewart *et al.*, 2020). Finally, interventions targeting imagery have shown promise in pre-clinical trials for this population, such as imaginal exposure to, and rescripting of, mental images featuring feared discarding scenarios (Fracalanza *et al.*, 2021; Fracalanza *et al.*, 2024; Sabel *et al.*, 2024). Imagery may therefore be an important clinical feature of HD, as well as a potential understudied intervention target.

Despite these intriguing findings, research on mental imagery in hoarding is nascent relative to other disorders. For example, a vast volume of research has sought to define patterns of intrusive flashbacks in post-traumatic stress disorder (PTSD), negative self-referential images in social anxiety, and obsessional intrusions in OCD, as well as explore their role in symptom maintenance (Holmes and Mathews, 2010). Yet comparatively little is known about imagery characteristics in hoarding populations. For example, it is unclear whether hoarding is associated with a reduced or

enhanced ability to deliberately generate vivid imagery, a mostly stable trait, determined at birth (Pounder *et al.*, 2022), which is known to vary in the population on a spectrum from aphantasia (i.e. complete inability to produce or use mental imagery) to hyperphantasia (i.e. the tendency to experience extremely vivid and multisensory mental images, comparable to ‘real seeing’, Zeman *et al.*, 2020). Previous researchers have suggested that individuals with HD may experience more vivid, multisensory and evocative images (e.g. ‘Proustian memories’, see Frost and Steketee (2022) for a discussion), indicating a possible tendency towards hyperphantasia, whereas others have proposed individuals who hoard may experience issues deliberating generating and retrieving imagery, particularly visual memories (Hartl *et al.*, 2004), suggesting a more aphantasic profile.

Although two previous studies found no differences between individuals with elevated HD traits and controls in patterns of deliberate imagining (Stewart *et al.*, 2020; Yap and Grisham, 2020), these investigations were limited by their use of small samples and an exclusive focus on visualising ability rather than imagining ability across the senses. Moreover, previous research has partially relied on the Spontaneous Use of Imagery Scale (SUIS; Reisberg *et al.*, 2003) to make conclusions about the ability to deliberately use and produce imagery in hoarding at the trait-level, which has been criticised for its psychometric properties and validity as a measure of voluntary imagery use (see Cavedon-Taylor, 2022). We therefore endeavoured to address these gaps by examining associations between hoarding and the ability to voluntarily generate imagery across sensory modalities using gold-standard measures of deliberate imagining in a large sample of participants.

Moreover, although individuals with HD report more frequent and distressing involuntary imagery in daily life compared with community controls (Stewart *et al.*, 2020), more research is needed to determine if this association is specific to hoarding or can be accounted for by common co-morbidities that have unwanted intrusive imagery as a clinical feature, such as depression, OCD and PTSD (Chia *et al.*, 2021; Frost *et al.*, 2011; Worden and Tolin, 2022). Critically, in the one investigation of intrusive imagery in HD to date (Stewart *et al.*, 2020), over 63% of the sample had a co-morbid mental health diagnosis, including 22% of participants meeting criteria for major depression. As such, it remains unclear how much these results are attributable to the presence of other psychopathologies. We therefore aimed to replicate associations between hoarding and the tendency to experience negative intrusive imagery, while controlling for symptoms of depression, OCD and PTSD.

Mechanisms of association

The mechanisms linking imagery processes to hoarding traits have also yet to be specified. It is plausible that the unusual relationship between objects and memory endorsed by many individuals with HD (i.e. using items to evoke autobiographical memories, and over-valuing the importance of remembering these images) may arise from individual differences in patterns of deliberate imagining. For example, greater routine use and vividness of imagery in daily life might explain why individuals with hoarding problems tend to link memories with their possessions and assign these images importance (Cherrier and Ponnor, 2010). Alternatively, perhaps difficulties deliberately generating and retrieving imagery among those who hoard promotes a reliance on objects as visual cues to facilitate autobiographical recall, and give rise to beliefs about the catastrophic consequences of forgetting (Hartl *et al.*, 2004).

Similarly, experiences with negative intrusive imagery may contribute to hoarding by increasing object attachment (i.e. the tendency to derive a strong sense of comfort, connection and security from items). We propose this because evidence suggests negative intrusive imagery is usually a sequelae of traumatic or stressful life events (Brewin *et al.*, 2010), and exposure to adversity has been linked to heightened object attachment in particular (Chou *et al.*, 2018). Indeed, one prominent theory of hoarding proposes that object attachment in HD is a

compensatory process to manage the psychological impact of negative life experiences, particularly within the interpersonal domain (Chia *et al.*, 2021; Yap and Grisham, 2021).

As secondary aims, we therefore endeavoured to determine some potential mechanisms of association between hoarding and voluntary and involuntary imagery and specified two potential path models: one predicting hoarding from patterns of deliberate imagining via object-memory beliefs (i.e. the tendency to associate memories with an object and overvalue the importance of remembering these images); and another predicting hoarding from experiences with negative intrusive imagery via object attachment (i.e. the tendency to use objects as sources of security and emotional comfort).

Summary

In sum, we aimed to preliminarily investigate the association between hoarding and the ability to voluntarily generate imagery in different senses, as well as the tendency to involuntarily experience negative intrusive imagery, while controlling for associated psychological symptoms. As secondary aims, we endeavoured to elucidate possible mechanisms of association. We hypothesised that hoarding traits may be associated with unique patterns of deliberate imagining across the senses (i.e. being less or more able to bring vivid images to mind), and that object-memory beliefs may mediate these associations. We also hypothesised that hoarding would be positively associated with negative intrusive imagery, and that object attachment may mediate this association. As in other disorders, a greater understanding of imagery in HD may lead to advancements in treatment via imagery-based conceptualisations and treatment techniques, such as strategies to modify problematic mental images (Arntz, 2012).

As taxometric research indicates HD symptoms are dimensional in the general population (Coles *et al.*, 2003; Timpano *et al.*, 2013), and findings using analogue samples demonstrate generalisability to clinically severe populations in other OCD-spectrum disorders (Abramowitz *et al.*, 2014), we decided to examine the association between hoarding and mental imagery using a non-clinical undergraduate sample. In fact, college may be a particularly critical time to conduct hoarding research, as young adulthood is the time of symptom emergence (Grisham *et al.*, 2006) and detecting and addressing the correlates of HD early in development may be the most efficient and cost-effective method for minimising life-time harm (Dozier *et al.*, 2024). If preliminary associations between mental imagery and hoarding in the present study appear encouraging, our findings may serve as the basis for future translational work and clinical replications.

Method

Participants

Participants were a large undergraduate convenience sample, recruited via the university's research participation system. An *a priori* power calculation using G*Power, version 3 (Faul *et al.*, 2007) revealed that to detect a small effect size with 95% power with significance set at 0.05, 270 participants needed to be recruited. To allow for attrition and data-cleaning, and to permit secondary mediation analysis, we initially recruited 404 participants. Participants were subsequently excluded if they did not complete the entire study ($n = 10$) or failed more than one of five attention and validity checks recommended by Agley *et al.* (2022) embedded throughout the survey ($n = 66$). The remaining final sample therefore included 328 participants.

Participants ranged from age 17 to 62, with a mean age of 19.92 years ($SD = 4.04$); 242 (73.8%) identified as female, 77 as male (23.5%), seven as non-binary (2.1%), and two (0.6%) participants preferred not to disclose their gender. Most participants identified their ethnicity as East Asian ($n = 133$, 40.5%), followed by White ($n = 87$, 26.5%), South Asian ($n = 43$, 13.1%), multi-racial ($n = 28$, 8.5%) or Middle Eastern ($n = 17$, 5.2%).

Materials

Hoarding measures

The *Saving Inventory-Revised* (SI-R; Frost *et al.*, 2004) is a 23-item self-report measure of hoarding symptoms. It includes subscales assessing the main facets of hoarding: excessive acquisition, difficulty discarding and clutter, but items can also be summed to yield a total hoarding symptom severity score. The questionnaire includes items such as ‘To what extent do you have difficulties throwing things away?’, where responses are made on a Likert scale from 0 (‘none/not at all/never’) to 4 (‘almost all/extreme/very often’). The SI-R has good psychometric properties, including excellent reliability (Kellman-McFarlane *et al.*, 2019). In the current study, the measure also had strong internal consistency ($\alpha = 0.93$).

The *Saving Cognitions Inventory* (SCI; Steketee *et al.*, 2003) is a 24-item self-report measure of the maladaptive beliefs theorised to underscore compulsive hoarding. The measure includes four subscales assessing excessive responsibility towards possessions, beliefs about maintaining control over items, emotional attachment to possessions and beliefs about objects and memory. However, in the present study, only the 5-item object-memory beliefs (SCI-M) and the 10-item emotional attachment to possessions (SCI-EA) subscales were selected for inclusion as theoretically proposed mediators linking voluntary and involuntary imagery processes with hoarding. The SCI-M subscale measures the tendency for individuals to associate memories with their items, and over-value the importance of remembering these images (example item: ‘I must remember something about this, and I can’t if I throw this away’), whereas the SCI-EA subscale measures the propensity for individuals to derive emotional comfort, identity and connection from their possessions (example item: ‘I love some of my belongings the way I love some people’). Respondents rate to what extent they held each belief over the past week when attempting to discard an item on a Likert scale, ranging from 1 (‘not at all’) to 7 (‘very much’). The SCI subscales have performed well in previous psychometric research (Dozier *et al.*, 2017). In the present study, the internal consistency was excellent for the SCI-EA ($\alpha = .93$) subscale, and good for the SCI-M subscale ($\alpha = .81$).

Imagery measures

The *Vividness of Visual Imagery Questionnaire* (VVIQ; Marks, 1973; McKelvie, 1995) is a 16-item self-report measure of visualising ability. Participants are asked to imagine four scenes and then rate the clarity of the imagery they generate on a Likert scale from 1 (‘no image at all’) to 5 (‘perfectly clear and vivid as real seeing’). The VVIQ has good psychometric properties (see McKelvie, 1995), correlates with objective measures of visual cortex activity (Cui *et al.*, 2007) and is widely used to assess trait imagining ability (Pearson *et al.*, 2013). In the present study, the questionnaire also had excellent internal consistency ($\alpha = .93$).

The *Plymouth Sensory Imagery Questionnaire* (Psi-Q; Andrade *et al.*, 2014) is a 35-item self-report questionnaire assessing multisensory imagining ability. The measure includes subscales assessing the ability to generate vivid imagery across seven different sensory modalities: vision, sound, smell, taste, touch, bodily sensation, and emotional tone/feeling. Participants are required to imagine different sensory stimuli (e.g. ‘Imagine the taste of black pepper’) and then rate the clarity of their imaginal experience on a 0 (‘no sense at all’) to 10 (‘as clear and as vivid as real life’) point Likert scale. The Psi-Q subscales have shown excellent internal consistency in previous research (Pérez-Fabello and Campos, 2020; Woelk *et al.*, 2024). In the present study, the internal consistency was good to excellent for the visual ($\alpha = .80$), sound ($\alpha = .87$), smell ($\alpha = .87$), taste ($\alpha = .89$), touch ($\alpha = .91$), bodily sensation ($\alpha = .85$) and emotional tone/feeling subscales ($\alpha = .84$).

The *Intrusive Imagery Questionnaire* (IIQ; McCarthy-Jones *et al.*, 2012) is a 10-item self-report measure assessing the tendency to experience unwanted intrusive imagery in daily life. Participants respond to items such as ‘When I have an argument with someone, I will keep seeing images from it in my mind’s eye for the next few days, even though I don’t want to’ on a 1

(‘disagree’) to 5 (‘strongly agree’) point Likert scale. The IIQ has shown high internal consistency in previous research (McCarthy-Jones *et al.*, 2012). In the present study, the IIQ also had excellent internal consistency ($\alpha = .92$).

Measures of associated psychological symptoms

The Depression Anxiety and Stress Scale-21 items (DASS-21; Lovibond and Lovibond, 1995) is a 21-item self-report measure of anxiety, depression and stress. In this study, only the 7-item depression subscale was used. Participants are asked to respond to items such as ‘I was unable to become enthusiastic about anything’ and rate their applicability over the past week on a 0 (‘did not apply to me at all’) to 3 (‘applied to me very much or most of the time’) point Likert scale. The DASS-21 has excellent psychometric properties, including high internal consistency depression subscale (Henry and Crawford, 2005). In the present study, the internal consistency of the depression subscale was also excellent ($\alpha = .90$).

The Impact of Events Scale-Revised (IES-R; Weiss, 2007) is a 22-item self-report measure of post-traumatic stress. It includes subscales spanning avoidance, hyperarousal and intrusion symptoms, but items can also be summed to yield a total PTSD symptom score. Participants are asked to think about a traumatic event from their past and rate the extent to which items such as ‘Any reminder [of the traumatic event] brought back feelings about it’ applied to them over the past week on a 1 (‘not at all’) to 5 (‘extremely’) point Likert scale. In the present study, the instructions of the IES-R were modified slightly, so that participants were asked to *self-select* a traumatic life event they had faced in the past to focus on when answering the questionnaire items, rather than responding with respect to a pre-determined index event (exact wording: ‘Please think of a highly stressful or traumatic event you have faced in the past. Then read each item and indicate how distressing each difficulty has been for you with respect to this event in the past SEVEN days’). Of note, the opening instructions of the IES-R have been modified in similar ways by previous researchers (e.g. Vanaken *et al.*, 2020), and these modifications are consistent with how other widely used PTSD measures are administered (e.g. the PTSD Checklist for DSM-5; Weathers, 2013). The IES-R has demonstrated good psychometric properties in previous research, including excellent internal consistency (Creamer *et al.*, 2003). The internal consistency for the scale in the present study was also excellent ($\alpha = .95$).

The Obsessive Compulsive Inventory-Revised (OCI-R; Foa *et al.*, 2002) is an 18-item self-report measure of obsessive-compulsive disorder (OCD) symptoms. The questionnaire includes subscales measuring six OCD symptom dimensions: washing, checking, counting, obsessing, ordering and hoarding. Items can also be summed to yield a total OCD-symptom severity score. Participants respond to items such as ‘I am upset about unpleasant thoughts that come into my mind against my will’ and rate the extent to which the statement applied to them over the past month on a 0 (‘not at all’) to 4 (‘extremely’) point Likert scale. The measure has demonstrated excellent validity and reliability in previous psychometric research (Chasson *et al.*, 2013). Consistent with previous use (e.g. Wootton *et al.*, 2015), the OCI-R total score without the hoarding subscale was used in the present study. The scale had excellent internal consistency ($\alpha = .90$).

Procedure

Participants signed up for the study through the university’s research participation system and were provided with a hyperlink to access the survey hosted on the Qualtrics platform (<http://www.qualtrics.com>). Participants initially provided informed consent and then completed the demographics items and other study measures. To minimise the impact of order-effects and fatigue, the presentation of the questionnaires was randomised across participants. Following completion, participants were shown the debriefing statement, given the first author’s contact

Table 1. Means, standard deviations, and zero order correlations for mental imagery measures with hoarding symptoms

| | Mean | SD | <i>r</i> (with SI-R total) | <i>p</i> -value |
|-------------------------|-------|-------|----------------------------|-----------------|
| SI-R total | 25.80 | 13.91 | | |
| SCI-EA | 26.78 | 12.78 | .59* | <.001 |
| SCI-M | 14.48 | 6.82 | .57* | <.001 |
| DASS-Dep | 5.58 | 4.82 | .40* | <.001 |
| OCI-R | 33.76 | 11.41 | .51* | <.001 |
| IES-R | 54.42 | 19.13 | .37* | <.001 |
| VVIQ | 55.91 | 12.18 | -.17* | .002 |
| Psi-Q - Visual | 30.26 | 7.03 | -.16* | .002 |
| Psi-Q - Sound | 36.54 | 9.98 | -.09 | .121 |
| Psi-Q - Smell | 27.90 | 11.96 | -.01 | .845 |
| Psi-Q - Taste | 31.43 | 12.13 | -.03 | .618 |
| Psi-Q - Touch | 36.24 | 10.98 | -.01 | .810 |
| Psi-Q - Body Sensations | 33.04 | 10.67 | -.10 | .071 |
| Psi-Q - Feeling | 33.14 | 10.98 | -.06 | .249 |
| IIQ | 30.19 | 9.43 | .39* | <.001 |

SI-R total, Savings Inventory-Revised total score; SCI-EA, Saving Cognitions Inventory-Emotional Attachment subscale; SCI-M, Savings Cognitions Inventory-Object-memory Beliefs subscale; OCI-R, Obsessive Compulsive Inventory-Revised; IES-R, Impact of Event Scale-Revised; VVIQ, Vividness of Visual Imagery Questionnaire; Psi-Q, Plymouth Sensory Imagery Questionnaire; IIQ, Intrusive Imagery Questionnaire. *Significant after a Benjamini-Hochberg correction for multiple comparisons.

details for follow-up questions, and provided with course credit remuneration. The study took approximately 30 minutes to complete.

Data analyses

Analyses were conducted using SPSS version 26.0 (IBM Corporation, 2019). For all self-report measures, the relationship between hoarding tendencies and mental imagery constructs were first analysed through zero-order correlations. A hierarchical regression model was then built to identify whether our mental imagery measures predicted hoarding, controlling for depression, OCD, and PTSD. Finally, to understand the mechanism by which experiences with mental imagery may influence hoarding, we tested two theoretically derived mediation models using PROCESS Macro version 3, model 4 with 5000 bootstrapped samples (Hayes, 2018). Given multiple comparisons, we controlled for family-wise error through the Benjamini-Hochberg procedure, where the false discovery rate was set at 5%.

Preliminary assumption testing was conducted prior to all analyses. Issues of multicollinearity were examined via correlations (i.e. above .7) and collinearity diagnostics (i.e. variation inflation factor >5; Yu *et al.*, 2015). Outliers, normality, linearity, homoscedasticity and independence of residuals were determined by visually inspecting the normal probability and scatter plots of the standardised residuals. No outliers, multicollinearity issues, or assumption violations were detected.

Results

Table 1 presents the correlations, means and standard deviations of the study variables. As expected, hoarding was significantly related to object-memory beliefs and emotional attachment to objects. Hoarding also significantly correlated with depression, OCD, and PTSD symptoms. In terms of the imagery measures, hoarding was significantly negatively related to visualising ability, both on the VVIQ and the visualising subscale of the Psi-Q. No significant associations were found between hoarding and the capacity to generate mental imagery in other sensory modalities on the other Psi-Q subscales (i.e. smell, sound, taste, etc, all $p > .05$). However, hoarding was

Table 2. Results of hierarchical regression examining predictors of hoarding

| Variable | R^2 | ΔR^2 | F | B | $SE B$ | β | p | r_{partial} |
|---------------|-------|--------------|-------|------|--------|---------|-------|----------------------|
| Step 1 | .30 | .30 | 46.02 | — | — | — | — | — |
| DASS-Dep | — | — | — | .45 | .17 | .16* | .007 | .15 |
| OCI-R | — | — | — | .48 | .07 | .39* | <.001 | .37 |
| IES-R | — | — | — | .07 | .04 | .10 | .089 | .09 |
| Step 2 | .33 | .03 | 31.25 | — | — | — | — | — |
| DASS-Dep | — | — | — | .39 | .17 | .13* | .020 | .13 |
| OCI-R | — | — | — | .42 | .07 | .34* | <.001 | .31 |
| IES-R | — | — | — | .03 | .04 | .05 | .442 | .04 |
| VVIQ | — | — | — | -.16 | .05 | -.14* | .003 | -.16 |
| IIQ | — | — | — | .22 | .09 | .15* | .015 | .14 |

See Table 1 for acronym definitions. *Significant after a Benjamini-Hochberg correction for multiple comparisons.

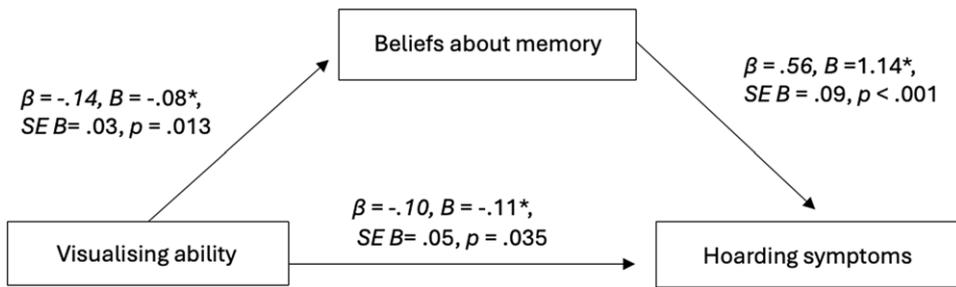


Figure 1. Estimates of effects in the first simple mediation model. *Significant after a Benjamini-Hochberg correction for multiple comparisons.

significantly positively associated with the tendency to experience negative intrusive imagery in daily life on the IIQ.

Table 2 presents the results of the hierarchical regression model that we built to determine if the imagery measures predicted hoarding over and above associated psychological symptoms. Depression, OCD and PTSD measures were entered in the first step of the model, and the indices of self-reported mental imagery that significantly correlated with hoarding were entered in the second step as predictors, noting that the VVIQ was included as the only measure of visualising ability (i.e. dropping the Psi-Q-Visual subscale) to increase the model’s power. Hoarding was entered as the dependent variable.

These analyses revealed that the imagery measures significantly predicted hoarding over and above depression, OCD and PTSD, $\Delta R^2 = .03$, $F_{5,322} = 31.27$, $p < .001$. Moreover, two individual predictors emerged. Visualising ability was a unique negative predictor, $\beta = -.16$, $t_{322} = -2.99$, $p = .003$, $r_{\text{partial}} = -.16$, while unwanted intrusive imagery was a unique positive predictor, $\beta = .22$, $t_{322} = 2.44$, $p = .015$, $r_{\text{partial}} = .14$ of hoarding.

Figure 1 represents the results of the first mediation model we built to test whether individual differences in imagining ability (i.e. being more or less able to use and produce imagery) give rise to object-memory beliefs (i.e. using items to evoke autobiographical memories, and overvaluing the importance of remembering these images), which then result in hoarding. In this model, hoarding was the dependent variable, visualising ability was the predictor variable, and our measure of object-memory beliefs was the theoretically proposed mediator. Results revealed that visualising ability shared a significant negative indirect association with hoarding through object-memory beliefs ($\beta = -.08$, $B = -.09$, $SE B = .04$, 95% CI [-0.16, -.02]). The full model accounted for 13.78% of the total variance in hoarding and was statistically significant, $F_{1,326} = 6.31$, $p = .0125$.

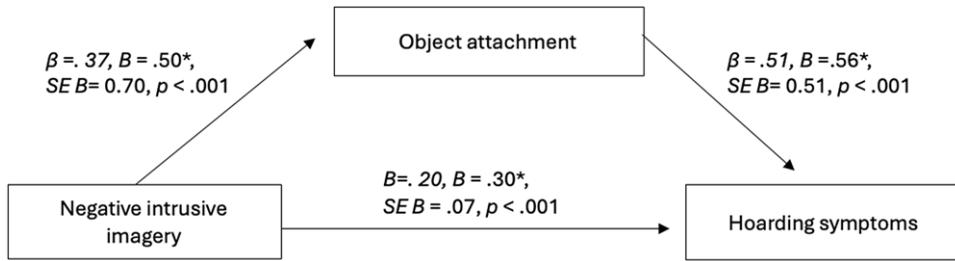


Figure 2. Estimates of effects in the second simple mediation model. *Significant after a Benjamini-Hochberg correction for multiple comparisons.

Figure 2 represents the results of the second mediation model we built to test whether experiences with negative intrusive imagery contribute to object attachment (i.e. using objects as sources of emotional comfort, security and connection), resulting in hoarding. In this model hoarding was the dependent variable, unwanted intrusive imagery was the predictor variable, and object attachment was the theoretically proposed mediator. Results revealed that negative intrusive imagery shared a significant positive indirect association with hoarding via object attachment ($\beta = .19$, $B = .28$, $SE B = .04$, 95% CI [0.20, 0.37]). The total model accounted for 37.06% of the total variance in hoarding, and was statistically significant, $F_{1,326} = 51.91$, $p < .001$.

Discussion

The primary aim of this study was to investigate preliminary links between hoarding and the ability to voluntarily generate and involuntarily experience mental imagery. Our findings indicated that individuals who had elevated scores on our hoarding symptom measure experienced a reliable visualising deficit but had an intact ability to deliberately generate vivid imagery in other sensory modalities. Intriguingly, we also found that these individuals tended to experience more negative intrusive imagery, even when controlling for symptoms of depression, OCD and PTSD. As secondary aims, we endeavoured to specify some potential pathways by which mental imagery processes may lead to hoarding behaviours. We found evidence to suggest visualising difficulties may promote hoarding by contributing to the formation of beliefs about the importance of recalling memories linked to hoarded objects, and experiences with negative intrusive imagery may be associated with hoarding by strengthening object attachment. Pending replication and extension beyond our analogue sample, these findings may have clinical implications, as well as significance for future research.

Imagining ability and hoarding symptoms

We found a negative relationship between hoarding and visualising ability, whereas no associations emerged between hoarding and the ability to deliberately generate imagery in other senses. Although the relationship was small ($r = -.17$), this visualising difficulty appeared robust, as it occurred across two different instruments (i.e. the VVIQ and the PsiQ-Visual), withstood a *post-hoc* correction, and remained as a unique predictor of hoarding after the inclusion of our control measures. These findings are inconsistent with previous research suggesting no differences in patterns of deliberate imagining between individuals with hoarding traits and community controls (Stewart *et al.*, 2020; Yap and Grisham, 2020). This discrepancy may be related to sample size and power-concerns, the populations involved (e.g. undergraduate *vs* MTurk), and the analytical method employed across studies (i.e. a more sensitive dimensional analysis *vs* between-group comparisons). The way imagining ability was assessed may also account for inconsistencies across studies, with previous research partially relying upon on the SUIIS (Reisberg *et al.*, 2003)

which has been criticised for its validity as a measure of voluntary imagery use, amongst other psychometric concerns (Cavedon-Taylor, 2022; Nelis *et al.*, 2014). To further clarify this association, future research from our laboratory will seek to investigate the distribution of hoarding traits amongst a large sample of individuals who have formally been identified as aphantasic and hyperphantasic and compare this with mid-range/normal imaginers.

We found that our beliefs measure about objects and memory, which assessed the tendency for individuals to link memories to their items and overvalue the importance of remembering these images, partially mediated the association between hoarding and visualising difficulties. This suggests trouble bringing visual images to mind voluntarily, such as memories of important past events, may give rise to specific beliefs and coping strategies about objects and memory, resulting in hoarding. For example, excessively acquiring to facilitate the recall of autobiographical events (Stewart *et al.*, 2020; Yap and Grisham, 2019), or retaining objects in sight out of fear of forgetting, thereby exacerbating clutter (Hartl *et al.*, 2004). Although low-memory confidence in hoarding is often considered to be an exaggerated and catastrophic misappraisal of true-memory functioning, and therefore a worthy target of cognitive challenging (Muroff *et al.*, 2014), our results indicate beliefs about the importance of recalling memories linked to objects in hoarding may be underscored by real problems in generating imagery, so emphasising remediation or coping approaches may be more appropriate. However, before translating this suggestion to clinical practice, future research should consider testing alternative, directional models of these associations. For example, it is plausible that reduced memory confidence in HD and associated coping strategies (such as reliance on objects as memory aids), may lead to reduced efforts to bring images voluntarily to mind, thereby impoverishing imagining ability overtime. Competing explanations for these findings should also be tested through further experimental work. For example, the lower vividness ratings endorsed by participants in our study with elevated scores on our hoarding symptom measure could reflect lower confidence in their visualisation abilities and/or unrealistic expectations about how vividly they should be able to imagine – especially given the Psi-Q and VVIQ have no anchor points. If this is the case, trying to train more vivid imagery could be unhelpful (for example, by reinforcing dysfunctional beliefs about the importance of remembering/visualising) rather than remediating an actual deficit.

Intrusive imagery and hoarding symptoms

We also found a positive and specific association between hoarding and the tendency to experience negative intrusive imagery that remained after controlling for symptoms of depression, OCD and PTSD. These findings replicate Stewart *et al.* (2020), and add to a growing body of evidence suggesting that negative intrusive imagery may be a distinct clinical feature of hoarding. Although we were unable to assess the exact phenomenology of these intrusions as the IIQ is a general intrusive imagery measure, our findings suggest that negative intrusive images in hoarding may be qualitatively distinct from those experienced in other co-morbid conditions, such as re-experiencing symptoms characteristic of PTSD (Birrer *et al.*, 2007) or disturbing obsessional imagery in OCD (Lipton *et al.*, 2010). Indeed, the content of problematic mental images tend to represent disorder-specific concerns (Hirsch and Holmes, 2007). Intrusive images in HD may therefore reflect hoarding-specific themes, such as memories of objects being discarded in the past against one's will, or images of causing environmental harm by discarding (Stewart *et al.*, 2020). However, future qualitative work will need to clarify the content and themes of negative intrusive imagery in HD compared with other clinical groups.

As hypothesised, we found that our measure of object attachment, which assessed the tendency for individuals to derive comfort, security and connection from their possessions, partially mediated the association between negative intrusive imagery and hoarding. These results arguably align with compensatory and stress-coping theories of HD (Timpano *et al.*, 2011; Yap and Grisham, 2021). That is, individuals experiencing distressing intrusive images as a by-product of

stressful life events may use objects to cope with these experiences, resulting in acquiring, saving and clutter problems. Alternatively, perhaps the idiosyncratic content of participant's negative intrusions pertained to concerns that naturally strengthened their object attachment (e.g. imagery of feared discarding scenarios), thereby promoting patterns of hoarding. Again, future research may consider testing alternative models of these associations. For example, heightened object attachment could plausibly increase negative intrusive images (e.g. about the welfare of items), thereby resulting in hoarding behaviour.

Clinical implications

Although our results require replication and extension in a clinical sample, they may contribute to a more nuanced model of HD that incorporates imagery targets. For example, difficulties visualising may form part of the broader profile of neuropsychological impairments conferring vulnerability to hoarding problems (e.g. attentional difficulties, executive impairments), specified in Frost and Hartl's (1996) model. Similarly, experiences with negative intrusive imagery may be the vehicle by which negative early experiences contribute to hoarding symptom development (Frost and Steketee, 2007). Future research should endeavour to further refine where experiences with imagery sit within the nomological network of variables considered to contribute to the aetiology and maintenance of hoarding problems.

The results of this study also hold potential implications for HD treatment. For example, our findings preliminarily suggest that approaches attempting to remediate and/or enhance visualisation ability might assist hoarding. Although visualising ability is generally considered to be congenitally determined and stable throughout the lifespan (Pounder *et al.*, 2022), there is evidence it can be improved through imagery/memory specificity training (Barry *et al.*, 2021), yielding positive effects on symptoms of psychopathology (e.g. depressive symptoms; Barry *et al.*, 2021). Moreover, our results tentatively suggest that therapies designed to reduce involuntary distressing imagery, such as imaginal exposure (Zoellner *et al.*, 2023) or imagery rescripting (Morina *et al.*, 2017) could theoretically be helpful for hoarding, with some pre-clinical evidence suggesting efficacy in this population at reducing difficulty discarding (Fracalanza *et al.*, 2021; Fracalanza *et al.*, 2024; Sabel *et al.*, 2024). Techniques designed to strengthen positive imagery to 'compete' with the retrieval of negative images could also be tested (Brewin, 2006). Given that gold-standard treatments for HD only result in clinically significant symptom change in approximately a third of cases (David *et al.*, 2022), future research should begin to pilot imagery remediation or modification therapies as adjunctive treatments for hoarding.

Limitations

Several limitations of our study are noteworthy. Firstly, we used a convenience sample of predominately Asian and White undergraduates, so future studies should examine these associations in a diverse clinical sample, with a greater age range. However, this method of recruitment gave us access to a large sample of participants, whereas previous research has been beset by power and sample-size concerns (Stewart *et al.*, 2020). Moreover, as hoarding traits are dimensional in the population (Timpano *et al.*, 2013), and first emerge in young adulthood (Grisham *et al.*, 2006), the use of analogue undergraduate samples to detect early correlates of HD are arguably highly relevant to advancing the field. As hoarding traits tend to worsen across the lifespan (Dozier *et al.*, 2016), early detection and remediation efforts could have a cascade of positive effects and markedly decrease hoarding's lifetime toll.

Another limitation was the reliance on self-report measures to assess imagery experiences. Although mental images can arguably only be assessed through introspection and/or self-report methods, and all our measures were psychometrically sound, experimental methods could be used to cross-validate the results (e.g. investigating whether intrusive imagery inductions give rise to

hoarding behaviours via the trauma-film paradigm; James *et al.*, 2016). Furthermore, relying on self-report measures prevented us from assessing the idiosyncratic features of participants' imagery potentially responsible for its relationship with hoarding traits.

Moreover, as the current research was correlational, it is unclear whether imagery experiences underlie the development of hoarding or vice versa, or if the relationship is bi-directional. The large amount of unexplained variance, and presence of residual direct associations in our models also suggests that several unmeasured third variables account for the development of HD traits and explain the nexus between hoarding and imagery processes. Finally, although our hypotheses were theoretically derived, we also did not seek pre-registration for our study and analytic plan. As we have made our data available to the research community, we encourage future researchers to test competing, hypothesis-driven models of association between hoarding and imagery, and/or extend our preliminary findings by employing alternative research designs. For example, longitudinal studies could be used to validate and improve upon our mediational models, such as determining whether visualising difficulties give rise to hoarding symptoms *over time*.

Concluding remarks

Overall, our results point to an intriguing relationship between mental imagery and hoarding. It appears that individuals who had elevated scores on our hoarding symptom measure simultaneously had difficulties bringing vivid visual images deliberately to mind, while also experiencing frequent distressing intrusive images. Although we used an analogue sample, our results preliminarily indicate abnormalities in mental imagery processes may be important vulnerability and/or maintaining factors in hoarding and suggest imagery could be a promising treatment target. Following replication and extension in a clinical sample, our findings may contribute to a more nuanced model of HD that incorporates imagery as a clinical feature, and could lead to the development and evaluation of imagery-based treatment strategies in this population, such as memory specificity training (Barry *et al.*, 2021) or imagery rescripting (Arntz, 2012).

Data availability statement. The data that support the findings of this study are openly available in the Open Science Framework at doi 10.17605/OSF.IO/W72TJ.

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