



Hoarding Disorder: Executive Functioning and Treatment Acceptability

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A thesis submitted in partial fulfilment of the requirements for the degree of Doctorate in
Clinical Psychology

Clinical and Applied Psychology Unit
University of Sheffield

May 2025

Declaration

I, the author, confirm this thesis is my own work and that I am aware of the University of Sheffield guidance on unfair means (www.sheffield.ac.uk/new-students/unfairmeans). This thesis is submitted in partial fulfilment of the requirements for the degree of Doctorate in Clinical Psychology. This work has not been submitted for any other degree or to any other institution. No funding has been received for this thesis and there are no conflicts of interest to be declared.

Structure and Word Count

Part One: Literature review

Excluding tables and references: 7997

Including tables and references: 16920

Part Two: Empirical study

Excluding tables and references: 7990

Including tables and references: 10738

Total

Excluding tables and references: 15987

Including tables and references: 27658

Lay Summary

Hoarding disorder (HD) impacts negatively on many health, social and economic outcomes. Psychological models and interventions have been developed and tested for HD, but show variable effectiveness and acceptability. Understanding reasons for this variability is essential to improving treatment outcomes.

The first chapter systematically reviews evidence of acceptability for psychological interventions for HD. This was defined by calculating overall treatment refusal and dropout rates using proportional meta-analysis, and by synthesising information about user experiences of and attitudes towards psychological interventions for HD. 54 relevant studies were identified, of which 27 reported treatment refusal (i.e. people eligible for therapy who did not begin treatment). The overall treatment refusal rate was 13.43%. 48 studies were analysed for dropout rate, which was 14.93%. These rates were found to be similar to interventions for other mental health conditions, despite common assumptions that HD patients disengage more from therapy. Qualitative feedback was analysed using a theoretical framework of acceptability. User experiences were generally positive and therapies were experienced as helpful. However, people with HD anticipated interventions to be painful and coercive, struggled to engage with therapeutic tasks and required significant support to implement therapeutic skills themselves.

Executive function refers to mental processes of receiving, retaining and using information. Difficulties with these processes are a significant problem and barrier to accessing therapy for people with HD, but little research has examined the interaction of cluttered environments (a key feature of HD) with these difficulties. A virtual reality (VR) home was developed to replicate hoarded conditions, and healthy participants completed attention tasks in cluttered and uncluttered VR environments. Participants had slower

reactions and missed more responses in cluttered environments. They experienced the VR homes as immersive and realistic, and reported greater distress in the cluttered home. This study indicates that clutter may maintain executive function problems and distress levels in HD.

Acknowledgements

I would first like to thank the many people who have helped this project come to fruition. To Steve, your creativity, drive and optimism have been instrumental in getting me to this point. To Mel, thank you for your patience, reassurance and belief in me even when this process has felt overwhelming. Thanks to Jonny for the legwork that went into developing this idea in the first place, and to Daniela for your competence and enthusiasm in answering my million questions. To Russell and Penny at XRTherapeutics, this could not have happened without your generosity and skill. Szymon – thank you for your perseverance even when your time was limited and I was off having a baby! To the team at Sheffield Mind, and to your wonderful support group who gave their time to think about this project with me, I am so grateful and inspired by the work you are doing and the passion you are doing it with.

Thanks also go to the many many people who have reminded me, throughout, that there is more to life than the pages you are about to read. To my girls on the course, what a privilege to train with you, and to watch you become fully-fledged psychologists. To my maternity leave companions, I have been honoured to share the journey of new motherhood (and relentless carer's leave) with you. To my mitra study group, thank you for seeing me, for holding me, for letting me turn up and be myself in the many, many emotional states I have experienced over the last four years. Rabs, Daisy, Rosa – your friendship has been so restful and nourishing and needed throughout, and always will be.

To my dad, siblings, niblings and loved ones who have cheered me on from afar and been so proud of me – thank you.

And finally. To Guillaume, Eva, Audrey. I learn so much from you each and every day. What a privilege to be loved by you, grow with you, and share the joy, adventure and wholeheartedness of the life we are building together, of which this is just a small chapter.

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Part One: Literature Review

Acceptability of Psychological Interventions for Hoarding Disorder: A Systematic Review and Meta-Analysis

Abstract

Objectives. Hoarding disorder (HD) incurs significant disability and disease burden, but psychological interventions for HD have difficulty engaging and retaining adult patients in treatment. This systematic review and meta-analysis synthesized evidence around acceptability in HD intervention literature, extracted key themes and conducted a proportional meta-analysis of treatment refusal and dropout rates.

Methods. PubMed, PsycInfo, SCOPUS and ProQuest were searched in April 2025 for quantitative and qualitative research exploring psychological interventions for adult HD patients. Sekhon et al.'s (2017) acceptability framework was used to narratively synthesize study findings. Pooled treatment refusal and dropout rates were synthesised using proportional meta-analysis and benchmarked against other diagnoses.

Results. Fifty-four studies were included (n=2027). The treatment refusal rate (k=27) was 13.43% (95% CI[8.10-19.67]) and treatment dropout rate (k=48) was 14.93% (95% CI[10.73-19.58]). Participants reported high anxiety about interventions, but actual experiences were positive with few adverse effects. Interventions were less acceptable on domains of self-efficacy and perceived effectiveness (e.g. adherence, maintenance of gains). Significant flexibility and effort was required to reduce ongoing intervention burden. Treatment refusal and dropout for HD benchmarks as equivalent to other disorders.

Conclusion. HD treatments have refusal and dropout rates similar to interventions for other conditions. Many barriers prevent HD populations from accessing interventions, with some groups underrepresented in both treatments and research. Universal definitions of treatment refusal and dropout and further research into lived experiences of treatment are required.

Practitioner Points

- Psychological interventions for HD have similar treatment refusal and dropout rates to those for other disorders.
- People with HD perceive interventions negatively and have difficulty accessing treatment due to the impact of the condition, but actual experiences of treatment are positive and helpful.
- Significant adaptation and scaffolding are required to engage people with HD in treatment, encourage adherence and maintain skills and progress.

Introduction

Hoarding Disorder

Hoarding disorder (HD) is characterised by persistent difficulties and distress associated with discarding items and accumulation of clutter that impairs quality of life and functioning (American Psychiatric Association, 2013; Ong et al., 2015). HD affects 1.5-6% of the population (Postlethwaite et al., 2019) and is associated with high levels of disability and disease burden (Nutley et al., 2022). Subjective distress in HD is high, with elevated suicide risk (Gil-Hernandez et al., 2025), loneliness (Yap et al., 2023) and physical and psychiatric comorbidities (Bates et al., 2021). Cluttered homes increase risk of physical harm due to fire, falls, toxicity and squalor (Brakoulias & Milecevic, 2015). People with HD may experience homelessness (Rodriguez et al., 2012), unemployment and poverty (Tolin et al., 2008), and the burden is felt by caregivers, families (Büscher et al., 2014) and neighbours/wider communities (Frost et al., 2000).

Previously a feature of obsessive and compulsive disorder (OCD), HD is now considered a distinct condition due to phenomenological differences in symptom clusters, illness course and treatment response (Mataix-Cols et al., 2010). Understanding of the aetiology of HD has been shaped by a dominant cognitive-behavioural model (Frost & Hartl, 1996) which suggests that information-processing deficits interact with unhelpful beliefs about the value of possessions and behavioural avoidance to produce symptoms of excessive saving and acquiring. More recent evidence has widened this evidence base. HD shows strong familial heritability (Dozier & Ayers, 2017; Steketee & Frost, 2006), with inherited vulnerability being compounded by early life events, such as trauma exposure and attachment difficulties (Chia et al., 2021). HD is also associated with a range of neurocognitive deficits

(Woody et al., 2014) and mood difficulties (Kyrios et al., 2018), which contribute to the development of symptoms and impede treatment engagement and recovery. Despite its significant impact, HD can present with poor insight, low motivation for change and reduced help-seeking (Worden et al., 2014), even in the context of family or public service pressure (Frost et al., 2010),

Treatment for HD

Cognitive behavioural therapy (CBT) using exposure and response prevention (ERP), the frontline evidence-based intervention for OCD (McKay et al., 2015), has historically been used to treat HD. HD symptoms were shown to respond poorly (Bloch et al., 2014), thus prompting the development of an HD-specific CBT protocol, placing greater emphasis on motivational interviewing and skills training (Steketee & Frost, 2006). CBT-HD can be delivered in either group or individual formats and uses domiciliary visits to assess risk and hoarding severity and to practise sorting and discarding (Steketee & Frost, 2006; Muroff et al., 2014). A low-intensity version of CBT-HD has been developed, using Tolin, Frost and Steketee's (2013) workbook *Buried in Treasures: Help for Compulsive Acquiring, Saving and Hoarding* (BIT). BIT consists of structured workshops (either clinician- or peer-facilitated) offering psychoeducation, skill building, cognitive restructuring and the encouragement of discarding practice (Frost et al., 2011).

Cognitive Rehabilitation and Exposure/Sorting Therapy (CREST; Ayers et al., 2014) combines aspects of compensatory cognitive training with traditional exposure techniques to reduce functional impairments and treatment barriers in HD populations. There is an increasing body of research indicating that these treatments, alongside other modalities with smaller evidence bases (e.g. Acceptance and Commitment Therapy [ACT], Compassion-Focused Therapy [CFT]; O'Brien & Laws, 2025), can alleviate some of the distress and clutter associated with HD. However, these interventions appear limited in their ability to

produce clinically significant change, with many patients exhibiting symptomatology above clinical thresholds even after treatment and high levels of relapse at follow-up (Thompson et al, 2017; Williams & Viscusi, 2016). HD has therefore garnered a reputation as a “hard to treat” condition (Frost et al., 2010), with many unresolved barriers to current therapeutic offers being fully accessible, acceptable and effective.

Treatment Acceptability

Patient acceptance of an intervention is a prerequisite of efficacy - those who attend and complete treatment, and engage meaningfully with the model used, will obtain most benefit (Glenn et al., 2013; Mira et al., 2019). Acceptability is therefore a key consideration in the evidence base for any intervention (Sekhon et al., 2017), but definitions have varied. Acceptability is commonly operationalised as: patient behaviours indicating willingness to engage in intervention-related tasks (attendance, treatment refusal, treatment completion, dropout; Simmonds-Buckley et al., 2022); beliefs and attitudes towards treatment (Sidani et al., 2010); and actual experience of interventions (Wilks et al., 2020).

Sekhon’s (2017) theoretical framework of healthcare intervention acceptability provides a synthesis of these aspects and an overall definition of acceptability as “*a multi-faceted construct that reflects the extent to which people delivering or receiving a healthcare intervention consider it to be appropriate, based on anticipated or experiential cognitive and emotional responses to the intervention*”. Seven domains underpin this construct: affective attitude (participants’ emotional responses to intervention); burden (effort required for an individual to participate and barriers preventing participation); ethicality (experience of side effects and congruence of intervention with participants’ values); intervention coherence (participants’ understanding of intervention content and purpose); opportunity cost (loss of benefits due to participation); perceived efficacy (participants’ beliefs about the likelihood of

achieving goals); and self-efficacy (participants' confidence in their skills and ability to undertake intervention).

The Current Review

These domains of acceptability are of clear significance to HD intervention efficacy research, where high levels of dropout and difficulties with motivation and engagement are consistently reported (Ayers et al., 2018). Despite this, no systematic and multifaceted overview of treatment acceptability has been undertaken to date, and therefore it is still unclear how HD interventions are experienced by participants. All existing reviews of HD treatments focus on intervention efficacy. Although O'Brien and Laws (2025) reported dropout rates in their HD outcome meta-analysis, no overall estimate was provided and the use of mean rates limits the accuracy and specificity of these findings. No assessment of treatment refusal rates in HD interventions has been previously undertaken. Treatment refusal occurs when a patient is assessed as eligible for an intervention and then fails to attend treatment (Simmonds-Buckley et al., 2022). Additionally, O'Brien and Laws (2025) did not complete a narrative synthesis of acceptability. Reasons for treatment refusal, dropout and possible poor acceptability therefore remain unknown, and tying the rate of and reasons for HD patients' refusal and dropout of treatment is the focus of this review.

Proportional meta-analysis for synthesising HD treatment refusal and dropout rates using the Barker et al. (2021) methodological guidelines carries several benefits. The first is in producing single-summary estimates of refusal and dropout rates with accurate variance estimation, reflecting unitary proxies by which we can evaluate overall HD intervention acceptability. It also allows calculation of significant covariates of HD treatment refusal and dropout, which is helpful in developing interventions that are both efficacious and acceptable to patients.

The primary aims of this review were therefore to: 1) undertake a systematic review of concepts and data pertaining to acceptability in the HD intervention literature using Sekhon et al.'s (2017) framework; 2) conduct proportional meta-analysis of treatment refusal for all relevant interventions; 3) conduct proportional meta-analysis of treatment dropout for all relevant interventions; 4) complete moderator analyses to better understand patterns of treatment refusal or dropout and 5) to benchmark treatment refusal and dropout for HD interventions against those used for other mental health diagnoses. In conclusion, the current review wanted to reliably estimate treatment refusal and dropout and then contextualize acceptability results with a narrative synthesis of study findings.

Methods

The protocol for this review was pre-registered on the PROSPERO International Prospective Register for Systematic Reviews (CRD42023471339), and PRISMA guidelines were followed when completing and reporting the review (Page et al., 2021; Appendix A).

Data Sources

Searches were completed in the following databases on 7th October 2024: PubMed, PsycInfo, Scopus and ProQuest. Searches were repeated on 1st April 2025, alongside a new search of the first five pages of Google Scholar, to identify new studies and extant grey literature. Search terms can be found in Appendix B. Relevant meta-analyses and reference lists were scrutinised, and key authors contacted for unpublished data.

Study Selection

Studies reporting use of psychological interventions for HD in adult participants were included – full criteria based on a PICO framework (Richardson et al., 1995) can be found in Table 1. All study designs were considered, except single case evidence. Studies referring to OCD without specifying a hoarding-specific subtype, or to hoarding behaviours attributable

to other conditions (e.g. dementia, Diogenes' syndrome, schizophrenia), were excluded. Studies offering non-psychological interventions (e.g. case management, professional decluttering, pharmacotherapy), or combining psychological therapy with other treatments in such a way that its unique effect was indistinguishable, were excluded. Self-help interventions without clinician input were included if they assessed dropout, adherence or any other acceptability outcome. A second rater reviewed 20% of studies identified for screening and full-text review. Disagreements were resolved through discussion or, at screening stage, by progressing all studies suggested by either reviewer to full-text review.

Data Extraction and Outcome Definitions

A bespoke Microsoft Excel data extraction form (Appendix C) was developed to ensure full capture of relevant data. This was piloted prior to use for data extraction. Study data extracted were 1) authors and publication date, 2) sample characteristics (mean age, sex as percentage of male participants, ethnicity as percentage of White/Caucasian participants), 3) sample sizes (N assessed for eligibility; N eligible for treatment; N beginning treatment), 4) HD assessment tools, and 5) intervention characteristics (modality, length, delivery format).

Treatment refusal was extracted as the number of participants assessed as eligible for treatment (i.e. not excluded by study criteria) who then declined participation or attended zero sessions. Treatment dropout was extracted according to authors' own definition or as number of participants not completing treatment. Additional acceptability outcomes extracted were: adverse effects; client feedback scores; and qualitative data pertaining to Sekhon et al.'s (2017) domains of acceptability.

Table 1*PICO framework for inclusion and exclusion criteria*

	Inclusion criteria	Exclusion
Population	Adults (age 18+) Diagnosis or clinically significant symptoms of HD. Diagnosis of OCD with hoarding as primary presentation.	Children and young people (<18 years) Patients with OCD without hoarding / hoarding not specified. Subclinical hoarding symptoms. Hoarding in the context of organic or other psychiatric conditions.
Intervention	Any psychological intervention targeting symptoms of HD.	Single-session experiments. Pharmacological interventions. Social or multimodal interventions where psychological component not reported separately.
Control/Comparison	Any: treatment as usual, alternative intervention, waiting list. Control condition not necessary for inclusion.	None specified.
Outcome	Treatment refusal. Dropout from treatment. Adverse effects/events. Patient feedback. Client satisfaction questionnaires. Other reported and qualitative information relating to domains of acceptability (Sekhon et al. 2017).	Effectiveness outcomes only.

Data Synthesis

Data were narratively synthesized using Sekhon et al.'s (2017) framework as topic headings. Quantitative synthesis of means and percentages was used to understand overall sample demographics. Proportional meta-analyses using random effects models were undertaken to determine pooled treatment refusal and dropout rates. Effect sizes were extracted as single proportions for treatment refusal (N who did not attend treatment following assessment or enrolment / N offered treatment or assessed as eligible i.e. not

excluded according to study criteria) and treatment dropout (N who dropped out of treatment / N starting treatment) for each eligible intervention.

Quality Assessment and Risk of Bias

Included studies were assessed for risk of bias using JBI Critical Appraisal Tools (Joanna Briggs Institute, 2017) for randomised controlled trials (RCT), quasi-experimental studies, cross-sectional studies, case series and qualitative studies. Items rated as “Yes” on relevant indicators of quality scored 1, and items rated as “No” or “Unclear” scored 0. Studies achieving 50% or below of eligible items were rated ‘poor’, those scoring 50-70% as ‘moderate’ and those scoring above 70% as being of ‘good’ quality (Shu et al., 2024; George et al. 2014).

Data Analysis

Random-effects proportional meta-analysis of treatment refusal and dropout rates was conducted using the metafor package for R (Version 4.3.3; Viechtbauer, 2010). Freeman-Tukey double arcsine transformations were applied to raw proportions to ensure correct estimation of variances, which can be constrained (and therefore underestimated) for extreme proportions (i.e., close to zero/one). Following analysis, estimates were backtransformed to provide pooled rates alongside 95% confidence intervals. Both Cochran’s Q and I^2 statistics were used to assess inter-study variability, increasing the likelihood of detecting true, rather than incidental, heterogeneity (Higgins et al., 2003). Further analysis was undertaken to determine sources of heterogeneity where I^2 was above Cochrane’s 75% threshold (Deeks et al., 2019). Statistical significance was indicated where $p < 0.05$. The relevance of tests for publication bias in proportional meta-analysis is questionable (Borenstein, 2019), as treatment refusal and dropout do not carry significance values traditionally affecting publication. Nevertheless, the potential impact of higher treatment refusal and dropout on

reporting was explored using funnel plots, rank correlation tests for asymmetry, Egger's regression test (Egger et al., 1997) and failsafe N statistics.

The impact of outlying studies on treatment refusal and dropout was examined using minimum and maximum rates from 'leave-one-out' analyses. Where sufficient studies allowed (Fu et al., 2011), moderator analyses were used to explore the impact of treatment characteristics on refusal and dropout rates. Categorical moderators were: therapy type, delivery (in-person/online), format (individual/group), domiciliary visits (yes/no) and setting (research/clinical). Continuous moderators were: number of sessions; and study quality score.

Benchmarking

Pooled treatment refusal and dropout rates for HD interventions were benchmarked against rates in other affective and non-psychotic disorders to determine the relative acceptability of psychological interventions for HD. Electronic databases were searched for comparable meta-analyses reporting pooled disorder-specific refusal and dropout rates (proportions with 95% confidence intervals) – these provided comparison benchmarks. Where multiple meta-analyses existed for the same disorder, the most recent was selected as assumed to incorporate the largest body of evidence. 10 reviews were identified. These were meta-analyses of treatments for OCD (Leeurwerik et al., 2019), generalised anxiety disorder (Gersh et al., 2017), post-traumatic stress disorder (Varker et al., 2021), pathological health anxiety (Shi et al., 2016), major depressive disorder (Cooper & Conklin 2015), eating disorders (Linardon et al., 2018) and borderline personality disorder (Iliakis et al., 2021). Three meta-analyses examined multiple disorders (Fernandez et al., 2015; Swift & Greenberg, 2014; Swift et al., 2017). Drop-out and refusal rates were compared by assessing overlap of the 95% confidence intervals for estimated rates.

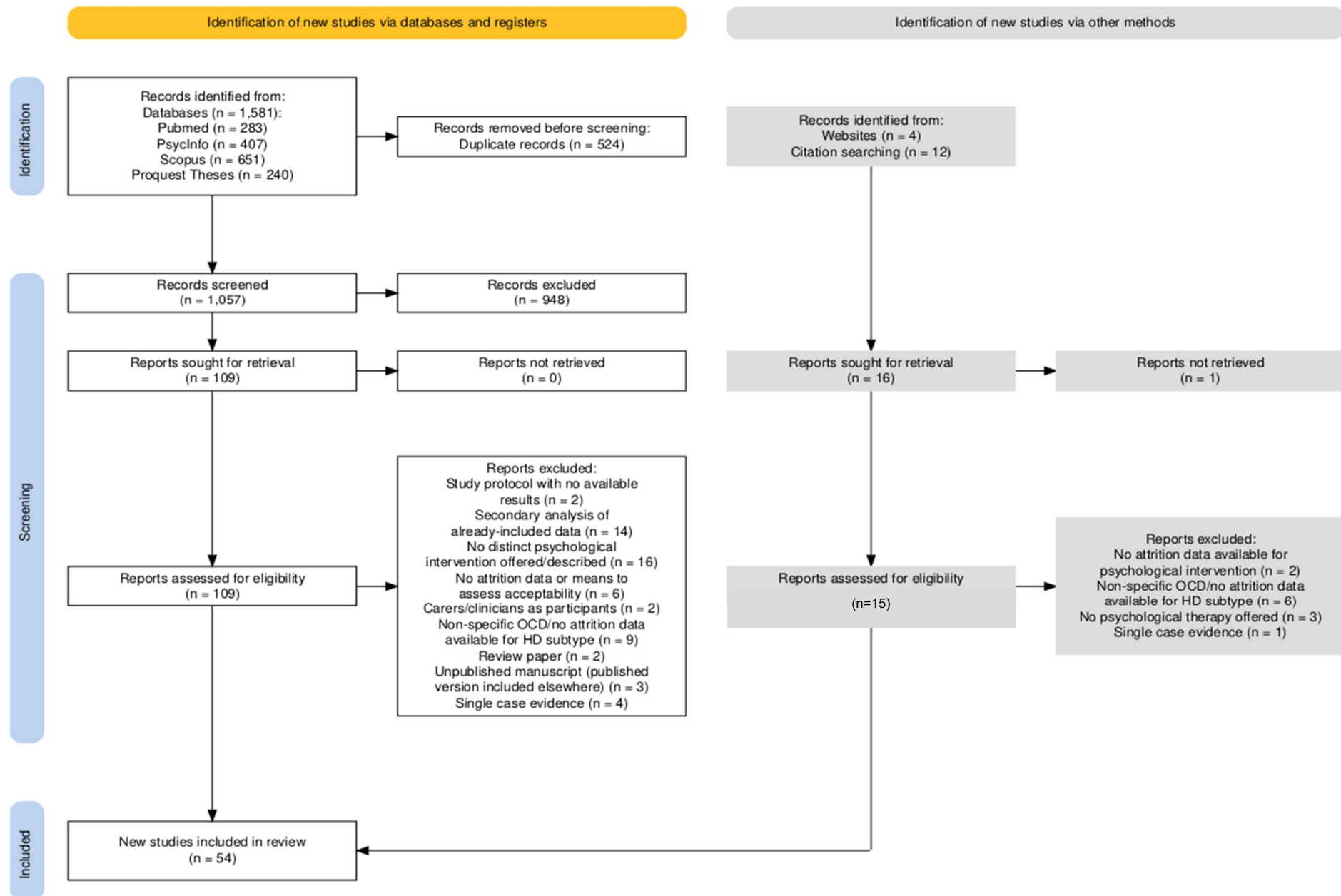
Results

A PRISMA diagram of study selection can be found in Figure 1. A total of 1073 titles were screened, and 125 full texts reviewed. The kappa score for inter-rater reliability at the screening stage was 0.72, indicating good agreement. At full-text review, principal reasons for study exclusion were: lack of discrete psychological intervention reported; secondary analysis of data; OCD populations without data specific to hoarding subtype. Inter-rater reliability was substantial for full text review ($K=0.68$). Differences of opinion ($k=4$) were resolved through discussion - two studies were excluded as secondary analysis, one additional author was contacted for dropout data, and one study was included as offering qualitative (although not intervention-specific) data around acceptability. Eleven authors were contacted for treatment refusal or dropout data (either unpublished data or data unreported in published studies). Five authors responded, one reporting that data had not yet been fully collected and four unable to provide further clarifying data. Forwards and backwards reference searches on included studies identified no further research.

Study Characteristics

Fifty-four studies were included in this systematic review (see Table 2), consisting of 33 non-randomised (pre-post) intervention studies, 15 RCTs, three qualitative studies, two cross-sectional studies and one case series. Most studies ($k=39$) were conducted in USA, six in Australia, four in the UK, three in Canada and individual studies in China and Sweden. Most studies used research-specific settings and designs ($k=40$), while 14 studies were conducted in clinical practice.

Figure 1. PRISMA flowchart for study selection



Participant Characteristics

Included studies report data from $n=2027$ participants. $N=1766$ began interventions in $k=48$ treatment studies. Sample sizes ranged from 5-203, with a mean intervention sample size of 29.93 ($SD=28.37$). Demographic data were only available for treatment completers in $k=16$ studies. Using reported data, 22.58% of participants were male, with studies ranging from 0-72% male participants. Three studies had all-female samples. Mean age of participants was 54.45 ($SD=14.57$), with study-specific mean ages ranging from 19.71 ($SD=1.49$) to 73.66 ($SD=6.54$). 83% of participants for whom ethnicity data were available were White/Caucasian.

Treatment Characteristics

Fifty-nine separate treatments were reported in $k=48$ intervention studies. Twenty-seven of these were CBT interventions (two using CBT-ERP; all others using CBT-HD), 11 were BIT and six were CREST. Other therapies included exposure therapy ($k=5$, including written imaginal exposure), ACT ($k=3$), and single studies of CFT, motivational interviewing (MI), rational emotional behaviour therapy, social cognition interaction training, inference-based therapy, cognitive remediation and relaxation training. Domiciliary visits were not included in $k=34$ interventions, whilst 24 entailed work in the home (ranging from two assessment sessions to full 41-session interventions). One study did not confirm whether domiciliary visits were used. Group HD interventions were delivered in $k=34$ studies, 18 interventions were delivered 1:1 and seven combined group and individual components. Most interventions ($k=46$) were delivered face-to-face, nine were delivered remotely (via video-call, email, website or independent self-help) and four combined formats or allowed participants to choose. Treatments ranged in length from 3-41 sessions ($M=17.91$, $SD=6.59$).

Table 2
Study characteristics

Study authors (Year)	Study design	Country (Treatment setting)	HD diagnostic / severity measures	Intervention	No of. Sessions (Format)	No. of home visits	Treatment refusal (n)	Sample N starting treatment	Mean age (SD)	Sex (% male)	Ethnicity (% white)	Attrition n (proportion)	Definition of attrition	Quality assessment
Abramowitz et al. (2003)	Pre-post	USA (Private outpatient clinic)	Y-BOCS, Diagnostic interview	CBT - EXRP	15 (1:1, F2F)	0	NR	16	37.55 (16.6)	48.3	93	4 (0.25)	Did not complete treatment	57.14 (Moderate)
Ayers et al. (2011)	Pre-post	USA (Research outpatient clinic)	UHSS, SI-R	CBT for HD	26 (1:1, F2F)	6-7	3	12	73.66 (6.54)	41.67	83.33	0 (0)	Did not complete treatment	83.33 (Good)
Ayers et al. (2012) ^a	Qualitative	USA (Research outpatient clinic)	HRS	CBT for HD	26 (1:1, F2F)	9	NR	12	73.66 (6.54)	41.67	83.33	NR	NR	50 (Poor)
Ayers et al. (2014)	Pre-post	USA (Research outpatient clinic)	UHSS, SI-R	CREST	24 (1:1, F2F)	3-6	NR	11	66 (7)	18.18	90.91	0 (0)	Did not complete treatment	83.33 (Good)
Ayers et al. (2018a)	Pre-post	USA (Research outpatient clinic)	UHSS, SI-R	CREST	26 (Group, F2F)	4	16	25	55.48 (2.22)	28	76	3 (0.12)	Did not complete treatment / lost to post-treatment assessment	88.89 (Good)
				Exposure Therapy	26 (Group, F2F)	4		35	61.06 (1.47)	25.71	80	9 (0.26)		
Ayers et al. (2018b)	RCT	USA (Research outpatient clinic)	UHSS, SI-R	CREST	26 (1:1, F2F)	NR	4	31	69.35 (6.49)	22.58	83.87	6 (0.19)	Did not complete treatment / removed from study	69.23 (Moderate)
Chan (2008)	Pre-post	USA (Research outpatient clinic)	SI-R	CBT	16-20 (Group, F2F)	0	NR	25	52.8 (7.64)	16	36	14 (0.56)	No drop-out definition. Used loss to posttreatment	33.33 (Poor)
Chandler et al. (2019)	Pre-post	UK (Complex anxiety disorders service)	DSM-V, CIRS, SI-R	CBT	12 (Group, F2F)	2	1	23	57.8 (11.3)	25	NR	3 (0.13)	Did not complete treatment	60 (Moderate)
Chen et al. (2023)	Pre-post	Australia (Telehealth service)	DIAMOND	SCIT	12 (Group, online)	0	0	12	59.87 (12.63)	16.67	NR	0 (0)	Did not complete treatment	55.55 (Moderate)

Study authors (Year)	Study design	Country (Treatment setting)	HD diagnostic / severity measures	Intervention	No of. Sessions (Format)	No. of home visits	Treatment refusal (n)	Sample N starting treatment	Mean age (SD)	Sex (% male)	Ethnicity (% white)	Attrition n (proportion)	Definition of attrition	Quality assessment
Chou et al. (2020)	Pre-post	USA (Research outpatient clinic)	SI-R, SIHD	CFT	16 (Group, F2F)	0	0	18	62.72 (10.14)	38.89	NR	5 (0.28)	Missed three consecutive sessions	81.81 (Good)
				CBT	15 (Group, online)	0	5	14	64 (11.92)	10.53	NR	7 (0.50)		
Davidson et al. (2021) ^a	Qualitative	USA (Research outpatient clinic)	SI-R, CIRS	CREST	26 (1:1, F2F)	NR	NR	21	69.7 (6.5)	19	86	NR	No drop-out definition	60 (Moderate)
DiMauro et al. (2014)	RCT	USA (Outpatient clinic)	HRS-I, MINI	Cognitive remediation	24 (1:1, online)	0	28	10	58 (15.81)	23	NR	0 (0)	Did not complete treatment	78.57 (Good)
				Relaxation training	24 (1:1, online)	0		7	62.29 (5.74)	23	NR	0 (0)		
Dozier & Nix (2025)	Pre-post	USA (University research centre)	SIHD, CIRS, SI-R	Motivational Interviewing	6 (1:1, F2F)	6	1	14	64 (10.3)	13	73	5 (0.36)	Withdrawal / lost to posttest	70 (Moderate)
Fang et al. (2023) ^b	RCT	China (University counselling service)	SI-R	ACT	8 (Group, F2F)	0	NR	48	19.71 (1.56)	48.88	NR	3 (0.06)	Withdrawal / lost to posttest	46.15 (Poor)
				REBT	8 (Group, F2F)	0		48	19.72 (1.49)	48.94	NR	1 (0.02)		
Fitzpatrick et al. (2018) ^b	Pre-post	Australia (University research centre)	SIHD, MINI, SI-R	CBT (HOPE+)	20 (1:1/group, F2F/online)	0	NR	16	55.20 (10.5)	10	NR	6 (0.38)	Lost to posttreatment assessment (following online component)	55.55 (Moderate)
Fracalanza et al. (2021)	Case series	USA (University research centre)	SCID-V-RV, SI-R, CIRS	Written Imaginal Exposure	3 (Group, F2F)	0	NR	8	60.5 (8.3)	0	87.5	0 (0)	Did not complete intervention	80 (Good)
Fracalanza et al. (2024)	RCT	USA (Research laboratory)	SCID-V-RV, SI-R, CIRS	Written Imaginal Exposure	3 (1:1, online)	0	5	17	56.94 (10.74)	18	47	0 (0)	Completed all study tasks as assigned	57.14 (Moderate)

Study authors (Year)	Study design	Country (Treatment setting)	HD diagnostic / severity measures	Intervention	No of. Sessions (Format)	No. of home visits	Treatment refusal (n)	Sample N starting treatment	Mean age (SD)	Sex (% male)	Ethnicity (% white)	Attrition n (proportion)	Definition of attrition	Quality assessment
Muroff & Steketee (2018) ^b	Pre-post	USA (University research centre)	ADIS-IV, HRS-I, SI-R	CBT for HD	26 (1:1, online)	0	NR	10	58.86 (5.91)	28.57	85.71	3 (0.30)	Did not complete intervention	70 (Moderate)
O'Connor et al. (2018) ^b	Pre-post	Canada (University research centre)	HRS, CIRS, SI-R	CBT for HD + personal reasoning/self-identity	20 (1:1/Group, F2F)	0	2	19	53.12 (8.9)	35.3	NR	3 (0.16)	Did not complete intervention	80 (Good)
Ong et al. (2021) ^b	Pre-post	USA (University research centre)	SI-R, HRS-I, DIAMOND, CIRS	ACT for HD	Up to 20, m=13.7 (1:1, F2F or online)	0	0	7	59.3 (15.4)	0	100	1 (0.14)	Did not complete intervention	55.55 (Moderate)
Pittman et al. (2021)	Pre-post	USA (Specialist community mental health team)	SIHD, CIRS, HRS	CREST	20-40 (1:1, F2F)	NR	NR	37	68.73 (7.46)	32.43	83.78	8 (0.22)	Withdrawal from treatment	50 (Poor)
Raila et al. (2023)	Pre-post	USA (University research centre)	SCID-V-RV, SI-R, CIRS	BIT VR decluttering	24 (1:1/Group, F2F/online)	0	3	10	63.5 (4.59)	40	90	1 (0.10)	Lost to post-treatment assessment	83.33 (Good)
Robertson et al. (2020)	Cross-sectional study	Australia (Online community sample)	HRS-SR	NR	NR	NR	NR	50	47.82 (12.92)	18	NR	NR	NR	55.55 (Moderate)
Rodriguez et al. (2016)	Cross-sectional study	USA (Online community sample)	SI-R, CIRS	NR	NR	NR	NR	203	48 (18)	20	76	NR	NR	75 (Good)
Rowa et al. (2020) ^b	Pre-post	Canada (Anxiety disorder outpatient clinic)	SI-R	CBT for HD	12 (Group, F2F)	0	NR	64	52.66 (10.24)	14.75	NR	3 (0.05)	Attending <8 of 12 sessions	44.44 (Poor)
Seaman et al. (2010) ^b	Pre-post	UK (Anxiety disorder outpatient clinic)	SCID-IV, OCI	CBT for OCD	12-18 (1:1, F2F)	0	NR	20	40.83 (11.21)	61.1	83.8	2 (0.10)	Withdrawal / did not complete intervention	55.55 (Moderate)

Study authors (Year)	Study design	Country (Treatment setting)	HD diagnostic / severity measures	Intervention	No of. Sessions (Format)	No. of home visits	Treatment refusal (n)	Sample N starting treatment	Mean age (SD)	Sex (% male)	Ethnicity (% white)	Attrition n (proportion)	Definition of attrition	Quality assessment
Steketee et al. (2000)	Pre-post	USA (Anxiety disorder outpatient clinic)	ADIS-IV, YBOCS	CBT for HD	29 (1:1/Group, F2F)	14	NR	7	50.43 (7.05)	71.43	NR	3 (0.43)	Did not complete intervention as per protocol (group + individual components)	33.33 (Poor)
Steketee et al. (2010)	RCT	USA (University outpatient clinic)	ADIS-IV, SI-R, HRS-I	CBT for HD	26 (1:1, F2F)	6-7	30	41	53.9 (8.03)	23.91	86.96	4 (0.10)	Discontinued treatment	61.54 (Moderate)
St-Pierre-Delorme & O'Connor (2016) ^b	RCT	Canada (University research centre)	SI-R, CIRS	Inference Based Therapy + VR decluttering	29 (1:1/Group, F2F)	0	NR	16	50.36 (9.55)	14.29	Not reported	2 (0.13)	Did not complete intervention	46.15 (Poor)
Strickland et al. (2016) ^b	RCT	USA (Research centre)	SI-R, UHSS	CREST	20 (Group, F2F)	3	NR	29	55.50 (10.64)	30.43	73.91	6 (0.21)	Discontinued treatment	76.92 (Good)
				Exposure Therapy	20 (Group, F2F)	3		37	60.11 (7.56)	19.23	80.77	11 (0.30)		
Tolin et al. (2007) ^b	Pre-post	USA (University research centre)	ADIS-IV, SI-R, CIRS	CBT for HD	26 (1:1, F2F)	6-7	NR	14	42.20 (14.96)	0	80	4 (0.29)	Discontinued treatment	66.66 (Moderate)
Tolin et al. (2012)	Pre-post	USA (Research centre)	HRS-I, SI-R	CBT for HD	16 (Group, F2F)	0	NR	6	52.83(6.71)	66.67	83.33	0 (0)	Did not complete intervention	90 (Good)
Tolin et al. (2019)	RCT	USA (Hospital outpatient clinic)	DIAMOND, SI-R, HRS-I	CBT for HD	16 (Group, F2F)	0	4	78	53.98 (9.25)	17.24	90.8	20 (0.26)	Non-completion of therapy / 5 instances of non-compliance	84.62 (Good)
Turner et al. (2010) ^b	Pre-post	USA (Community mental health centre)	CIRS, HRS	CBT for HD	28-41, m=35.3 (1:1, F2F)	35.3	2	9	72.3 (NR)	16.67	Not reported	3 (0.33)	Did not complete 26 sessions of intervention	66.66 (Moderate)

Study authors (Year)	Study design	Country (Treatment setting)	HD diagnostic / severity measures	Intervention	No of. Sessions (Format)	No. of home visits	Treatment refusal (n)	Sample N starting treatment	Mean age (SD)	Sex (% male)	Ethnicity (% white)	Attrition n (proportion)	Definition of attrition	Quality assessment
Weiss et al. (2020)	Pre-post	USA (Hospital outpatient clinic)	SI-R, CIRS	CBT for HD	15 (1:1, F2F)	NR	NR	29	67 (8)	31.03	Not reported	17 (0.59)	Did not complete intervention	55.55 (Moderate)
Wheaton et al. (2024)	RCT	USA (Research outpatient clinic)	SI-R, HRS-I, CIRS	BIT + In-Home Decluttering	16 (Group, F2F)	10	1	41	56.32 (10.52)	34.15	70.73	4 (0.10)	Withdrawal / lost to post-treatment assessment	70.58 (Good)
Wootton et al. (2021) ^a	RCT	USA (Hospital outpatient clinic)	DIAMOND, SI-R, HRS-I	CBT for HD	16 (Group, F2F)	0	NR	70	54.26 (8.52)	17	91	NR	NR	77.77 (Good)
Worden et al. (2017)	Pre-post	USA (Anxiety disorder outpatient clinic)	SIHD, CIRS, SI-R	CBT for HD + contingency management	16 (Group, F2F)	6	6	14	51.5(8.2)	35.71	92.9	4 (0.29)	Withdrawal from study	77.77 (Good)
Yap et al. (2022)	Pre-post	Australia (University research facility)	SIHD, SI-R	BIT	15 (Group, online)	0	3	10	59.78 (7.24)	10	Not reported	1 (0.10)	Withdrawal from treatment and study	28.57 (Poor)

Note. NR = not reported. Y-BOCS = Yale-Brown Obsessive Compulsive Scale. UHSS = UCLA Hoarding Severity Scale. SI-R = Savings Inventory-Revised. HRS = Hoarding Rating Scale (-I = Interview; -SR = self-report). CIRS = Clutter Image Rating Scale. DIAMOND = Diagnostic Interview for Anxiety, Mood, OCD and Related Neuropsychiatric Disorders. SIHD = Structured Interview for Hoarding Disorder. MINI = Mini-International Neuropsychiatric Interview. SCID-V = Structured Clinical Interview for DSM-5 (-RV = Research Version). ADIS-IV = Anxiety Disorders Interview Schedule for DSM-IV. CGI = Clinician's Global Impression. HSS = Hoarding Severity Scale. OCI = Obsessional Compulsive Inventory. F2F = face-to-face. VR = Virtual Reality.

^aThese studies constitute secondary analysis of data included elsewhere but also offer additional data related to acceptability. They have therefore been included for narrative but not quantitative synthesis. ^bDemographic data reported for these studies relates to completer sample only as drop-outs not described. ^cOnly partial sample (outpatients) included as some participants accounted for in Steketee et al. (2010)

Acceptability Characteristics

Twenty-seven studies reported sufficient information regarding patient flow to calculate treatment refusal. N=283 treatment refusers were identified from a total of n=1336 people assessed as eligible and offered/allocated to treatment. All intervention studies (k=48) reported dropout rates, and criteria for determining dropout were: non-completion of therapy (k=32), participant withdrawal (k=13), loss to post-treatment/follow-up assessment (k=10) and non-compliance or attendance below a specified threshold (k=5). Some studies applied multiple criteria, and three reported no definition of dropout. N=360 treatment dropouts were identified.

Quality Assessment

Overall, study quality was moderate (M=63.81, SD=16.49). Twenty-two studies were of ‘moderate’ quality, 21 were ‘good’ and 12 were ‘poor’ (Frost et al., 2011’s two studies were rated separately). Bias in included studies was attributable to: intervention delivery (variation in therapist/protocol adherence); sampling (self-selecting, female and older participants; underpowered sample sizes); measurement (self-report measures, no external assessment of clutter, different clinical thresholds).

Narrative Synthesis

Sekhon et al.’s (2017) framework has been applied to the findings of included studies (k=54).

Affective Attitude

Client Feedback Measures. Nine studies used psychometric tools to ascertain feedback about HD interventions. The most-used tool was the Client Satisfaction Questionnaire (k=5; CSQ-8; Atkisson & Zwick, 1982). Studies also utilised the Treatment Evaluation Inventory-Short Form (TEI-SF; Kelley et al., 1989), Treatment

Acceptability/Adherence Scale (TAAS; Milosevic et al., 2015), Working Alliance Inventory (WAI; Horvath & Greenberg, 1989), Credibility and Expectancy Questionnaire (CEQ; Devilly & Borkovec, 2000), and single-item satisfaction ratings. Overall findings (Table 3) suggest moderate-to-high levels of satisfaction. There were some exceptions (including some explicit dissatisfaction) and not all participants completed evaluation tools, which were only obtained from treatment completers.

Anticipatory Anxiety. Ayers et al. (2012) noted that prior to commencing individual CBT participants felt fearful of experiencing distress and being asked to do things against their will. Steketee et al. (2000) found participants reluctant to access CBT, often doing so only under pressure from family and friends. Robertson et al. (2020) found that 24% named the anticipated negative emotional impact of therapy as a barrier to seeking support and were particularly worried about being ‘forced’ to discard items. Aversion to behavioural tasks (i.e. discarding practice, decluttering) was highlighted elsewhere, experienced as ‘pressuring’ (McGrath et al., 2024), triggering negative emotional reactions (“frustrated...angry and overwhelmed”, “awful”, “frozen”; Linkovski et al., 2018) and directly contributing to dropout (Dozier & Nix, 2025). Participants found either/or goal-based ‘success’ or ‘failure’ unhelpful in the “ongoing struggle” with HD (Chou et al., 2020). Rodriguez et al., (2016) found that participants anticipated HD therapy as being “extremely emotionally painful” and worried about having no control over therapeutic processes or long-term effects.

Table 3*Satisfaction measure results*

Study	Intervention	Measure	Score [M(SD)]	Interpretation
Chen et al. (2023)	SCIT	CSQ-8	25.9 (NR)	Very satisfied
Chou et al. (2020)	CFT	Single-item quality assessment	100% scored ‘good’ or ‘excellent’	Very satisfied
	CBT		79% scored ‘good’ or ‘excellent’	Mostly satisfied
DiMauro et al. (2016)	Cognitive remediation	CSQ-8	20.56 (1.59)	Mostly satisfied
	Relaxation training	CSQ-8	21 (1.53)	Mostly satisfied
Dozier & Nix (2025)	MI	TAAS	85% scored ≥ 50	Consider the treatment to be acceptable (remaining participants neutral)
Fracalanza et al., 2021	Written imaginal exposure	Single-item acceptability assessment	100% rated ‘Yes’	Acceptable
Ivanov et al. (2018)	CBT + online support	CSQ-8	25.9 (5.4)	Very satisfied (one participant recorded as dissatisfied with treatment)
Krafft et al. (2023)	ACT online self-help	TEI-SF	25.46 (6.63)	Adequate (<27 cut-off of 27 for moderate acceptability; Patton et al., 2023)
		CEQ	Credibility = 6.62 (1.23) Expectancy = 61.09 (21.27)	Adequate
			4.80 (0.12)	Adequate acceptability

		Bespoke 7-item Likert scales		
Muroff & Steketee (2018)	CBT	WAI	>219 for all participants, mean item scores >6	High
O'Connor et al. (2018)	Group CBT	Single-item acceptability question	100% rated 'Yes' for all components	Acceptable
Turner et al. (2010)	Group CBT	CSQ-8	27.2 (Not reported)	High satisfaction
Raila et al. (2023)	BIT + VR decluttering	CEQ	Credibility = 18.33 (7.63) Expectancy = 15.56 (7.57)	Higher than neutral
		Single-item acceptability question	83% rated 'Yes'	Acceptable (although one participant found intervention 'unacceptable')
Worden et al. (2017)	CBT + Contingency management	CSQ-8	28.6 (5.63)	High satisfaction

Therapeutic Relationship. Actual experiences of HD interventions were generally positive and therapeutic relationships played a key role in this. Participants referred to therapists' kindness and compassion (Ayers et al., 2012; Ivanov et al., 2018; Linkovski et al., 2018; Chen et al., 2023), helpfulness in offering accountability, motivation and clarity (Raila et al., 2023; Muroff & Steketee, 2018; Davidson et al., 2021; Wheaton et al., 2024), as well as safety and boundaries (Chandler et al., 2019; Linkovski et al., 2018). One participant interviewed by McGrath (2024) explicitly attributed the therapeutic alliance as protective

against dropout: “I thought to myself I would pull out...during the ... third or fourth sessions.... But ... the coach, he guided us through”.

Treatment Preferences. Rodriguez et al. (2016) found that only individual CBT and self-help books were deemed explicitly acceptable psychological interventions, with online and facilitated support groups and group CBT eliciting neutral opinions. Female participants were more likely to endorse treatment options as ‘acceptable’ than males. Mathews et al. (2016; 2018) found that more participants favoured group CBT over BIT, although a majority (in the 2018 study) expressed no preference. Robertson et al. (2020) identified that HD patients preferred individual face-to-face treatments or low-intensity options with clinician support (e.g. website-based interventions, self-help workbooks), over group HD therapies.

Findings around the acceptability of group interventions were conflicting. Groups could offer strong mutual support (Frost et al., 2011; Chen et al., 2023), non-judgmental understanding and common experiences (Linkovski et al., 2018; Chandler et al., 2019), reduced shame (McGrath et al., 2024) and social isolation (Moulding et al., 2017; Steketee et al., 2000). Elsewhere, however, it was hypothesized that lower levels of personalisation and therapist attention (Gilliam et al., 2011) and concerns about confidentiality (Iqbal, 2015) contributed to treatment refusal and dropout in group HD interventions. Chou et al. (2020) reported some participants finding self-disclosure uncomfortable in group settings, and McGrath et al. (2024) noted that if participants did not feel represented or affectively aligned with others in HD treatment groups, they could easily feel excluded, stigmatised and that treatment was not ‘made for them’. Features of HD interventions making them more acceptable were: structure, positive relationships with others, respect for patient autonomy (Wheaton et al., 2024), accountability, and adaptation of treatments to individual needs (Rodriguez et al., 2016).

Ethicality (Adverse Effects)

Only k=16 studies reported a definition, or the presence or absence, of adverse effects, making it difficult to reliably ascertain safety and ethicality in the HD intervention literature. Adverse effects were recorded for eight interventions. Frost et al. (2011) reported that two BIT participants (11.76%) experienced “overwhelming distress” in the early weeks of intervention. Steketee et al. (2000) described strong negative affect and disengagement for two participants in response to intervention demands. Ayers et al. (2011) reported increased HD symptoms for two CBT patients (16.67%). Mathews et al. (2016) reported deterioration in HD severity scores for two CBT clients (4.9%) and one BIT client (5%). Linkovski et al. (2018) reported a temporary increase in excessive acquisition for one patient, which they attributed to a bereavement. One MI patient demonstrated reliable deterioration in HD symptoms (Norberg et al., 2021), increased symptoms of paranoia, and was referred to further psychiatric care (Dozier & Nix, 2025). One patient reported sickness using a VR headset to perform decluttering practice (Raila et al., 2023).

Burden

Barriers to Accessing Therapy. Robertson et al. (2020) identified many barriers preventing HD patients from accessing psychological interventions – an average of 4.6 barriers from a predetermined list. The most cited was cost of private mental healthcare. Participants also reported a preference for resolving problems without professional help and lack of knowledge about available services. In other studies, HD patients were deterred by scheduling or travel difficulties and lack of internet access (Davidson et al., 2021; Moulding et al., 2017; Rodriguez et al., 2016; McGrath et al., 2024), or long waiting lists and a lack of local appropriate services for HD (McGrath et al., 2024; Rodriguez et al., 2016).

While these barriers may be common in treatment for other conditions, studies suggested that interventions for HD are particularly burdensome and hard to engage with due to the well-evidenced additional impact of HD on patients: poor physical health and higher age (Pittman et al., 2021; Turner et al., 2010; Davidson et al., 2021), executive dysfunction contributing to forgetfulness and organisational difficulties (Turner et al., 2010; Strickland, 2016), lack of social support to complete therapeutic tasks (Turner et al., 2010; Weiss, 2020) and concurrent mental health challenges (Moulding et al., 2017). Psychological interventions for HD can add to in-home clutter (e.g. worksheets; Chandler et al., 2019) and some HD-specific tasks are difficult to perform in clinical settings (e.g. “lugging” belongings to sessions for sorting/discarding practice; Davidson et al., 2021). Domiciliary visits elicited fear of judgment, criticism or referral to statutory agencies for some (McGrath et al., 2024), particularly when symptoms (i.e. clutter) were worse, suggesting that HD patients are unable to access or accept support when most needed due to shame about the state of their home.

Reasons for Dropout. Many dropouts were attributable to sudden disruptive events indicative of instability in the lives of HD patients – job loss (Iqbal, 2015), housing crises (Muroff & Steketee, 2018), acute medical issues (Fitzpatrick et al., 2018; Grisham et al., 2022; O’Connor et al., 2021; Gilliam et al., 2011; Iqbal, 2015) or relationship breakdown (Tolin et al., 2007). Some studies (and a small number of participants) cited explicit dissatisfaction with aspects of treatment (Mathews et al., 2018; Gilliam et al., 2011; Tolin et al., 2007; Worden et al., 2017). More commonly, studies pointed to participants struggling to ‘keep up’ with therapeutic tasks (Worden et al., 2017; Iqbal, 2015; Tolin et al., 2007; Steketee et al., 2010), particularly in studies with stricter adherence or attendance policies (Mathews et al., 2016; Gilliam et al., 2011; Tolin et al., 2019). Most dropouts were unexplained. Several authors suspected that logistical justifications for dropout (cost, scheduling difficulties; Mathews et al., 2018; Fang et al., 2023; Gilliam et al., 2011) masked

continued ambivalence and fluctuating motivation about HD treatment (Iqbal, 2015; Steketee et al., 2010; Pittman et al., 2021; Tolin et al., 2007).

Self-Efficacy

Motivation and Confidence. Robertson et al. (2020) found that HD participants were unlikely to want or feel able to seek treatment in the future (rating intervention motivation 2.96 on a 0-10 scale). Turner et al. (2010) reported difficulty engaging or motivating HD patients in the face of widespread and pressing socioeconomic issues (e.g. housing, finances, legal issues), and that patients were sceptical about learning or trying new strategies. Some authors concluded that HD patients were primarily externally motivated and not necessarily accessing treatment from a personal desire for change (Frost et al., 2011; Steketee, 2000).

Treatment Adherence. Session attendance, where reported, varied widely and ranged from 13% (Yap et al., 2022; Krafft et al., 2023) to 100% (Chen et al., 2023; Muroff & Steketee, 2018). Good attendance was often attributable either to at-home treatments (Kellett et al., 2015) or significant additional therapist effort and support (Moulding et al., 2017; Muroff & Steketee, 2018; Tolin et al., 2007). Treatment flexibility and adaptation sometimes came at the expense of intervention flow and continuity (e.g. 26-week interventions taking an average of 49 weeks; Steketee et al., 2011). Many studies took additional measures to elicit and maintain engagement, including frequent contact attempts before sessions (Ayers et al., 2018a), requirement of upfront fees (Moulding et al., 2017), additional home visits (Chandler et al., 2019), adjusting session agendas to problem-solve engagement barriers (Ayers et al., 2018a; Turner et al., 2010), breaks between sessions (Mathews et al., 2016), catch-up sessions (Muroff & Steketee, 2018; Moulding et al., 2017; Ivanov, 2017) and ‘marathon’ sessions (Tolin et al., 2007). Few studies (Tolin et al., 2019; Mathews et al., 2016) had strict compliance and attendance policies. Sixty-five percent of ‘dropouts’ in Tolin et al.’s (2019) study were excluded due to non-compliance rather than voluntary withdrawal.

Homework Compliance. Most HD interventions set between-session work, which correlates with treatment outcomes (Ayers et al., 2011; Tolin et al., 2007). Studies consistently reported poor homework adherence, ranging from 10% or minimal completion (Ayers et al., 2011; Ivanov et al., 2018) to, at most, around 50% (Tolin et al., 2007; Mathews et al., 2018). Adaptations made to scaffold homework completion included participants recording updates on therapists' voicemail (Steketee et al., 2000), reducing homework quantity and complexity (Kellett et al., 2015 – in the context of mild learning disabilities) and reminder emails (Krafft et al., 2023). Poor compliance was evident even where session attendance and expressed motivation were both high (Mathews et al., 2018). Wootton et al. (2021) found that HD patients scored highly on measures of within-session engagement but achieved only moderate between-session compliance. This is consistent with observations that patients were able to understand and engage with within-session tasks when appropriately scaffolded but struggled to do so independently (Ayers et al., 2011; Ayers et al., 2012; Steketee et al., 2000). Some patients only adhered to treatment recommendations when observed (“binge decluttering”; Worden et al., 2017) and then undermined their own progress between sessions (e.g. acquiring more items; Linkovski et al., 2018). Difficulties with compliance were attributed to life disruptions or executive function deficits.

Building Self-Efficacy. Despite pervasive difficulty delivering HD interventions ‘as intended’, studies suggested that interventions could increase patient self-efficacy. Linkovski et al. (2018) reported that participants gained motivation by no longer perceiving themselves as “lazy”. Many felt a sense of accomplishment in surpassing expectations of their own distress tolerance and ability (Ayers et al., 2012). Participants found CBT tools easy to integrate and helpful for monitoring progress (Chou et al., 2020); in-home decluttering practice increased optimism by achieving rapid results (Linkovski et al., 2018); and virtual therapies increased accountability due to the therapist’s observation of progress in the home

(Muroff & Steketee, 2018). However, authors reported demoralisation and renewed ambivalence at treatment termination. Participants felt there had been insufficient support (Linkovski et al., 2018; Davidson et al., 2021) and that they would struggle to independently apply learned skills, make further progress or prevent HD relapse (Steketee, 2000).

Perceived Effectiveness

Patients' belief that interventions were helpful was found to be essential to seeking and accepting treatment (Rodriguez et al., 2016). However, a significant number (26%) of HD patients, when asked, did not believe that current treatments would work (Robertson et al., 2020). There were nevertheless examples of perceived effectiveness in individual interventions. Strategies that patients found effective and useful included direct exposure, goal setting, behavioural cues and behavioural scheduling (CBT; Ayers et al., 2012; Turner et al., 2010), calendars, to-do lists, problem-solving, discarding practice and relapse prevention (CREST; Davidson et al., 2021). Key outcomes and gains from treatment included increases in insight (Davidson et al., 2021; Fracalanza et al., 2021; Raila et al., 2023; Wheaton et al., 2024), distress tolerance (Davidson et al., 2021; St-Pierre Delorme & Connor, 2016), self-compassion (Chou et al., 2020; Wheaton et al., 2024) and discarding (Fracalanza et al., 2021; Raila et al., 2023). Overall, most participants explicitly asked about perceived helpfulness rated interventions as "quite a bit" or moderately effective (Chandler et al., 2019; Davidson et al., 2021; Fracalanza et al., 2021; Raila et al., 2023). Despite this perception of helpfulness, study participants gave lower assessments of actual symptom improvement (Chandler et al., 2019; Linkovski et al., 2018; St-Pierre Delorme & Connor, 2016), suggesting that intervention and participant goals may differ.

Intervention Coherence

Two intervention approaches received feedback as being coherent and relevant to HD patients. Concrete, behavioural interventions were experienced by many as more comprehensible and applicable than cognitive or emotional exercises due to targeting visible clutter (Ayers et al., 2012; Chou et al., 2020). Patients found cognitive restructuring and case formulations in CBT abstract, difficult to operationalise and remember (Ayers et al., 2012), and psychoeducation about theory-symptom links inaccessible (Chen et al., 2023). Conversely, other patients felt that interventions focusing on ‘deeper’, holistic aspects such as emotional or autobiographical underpinnings of HD or the relationship of HD with identity were ‘healthier’ and more sustainable (Chou et al., 2020; McGrath et al., 2024; O’Connor et al., 2018). Regardless of approach, several HD patients terminated treatments prematurely if they were not the ‘right fit’ (Mathews et al., 2018) and expressed a strong need for interventions to be ‘personalised’ to individual needs (Rodriguez et al., 2016).

Opportunity Cost

Fitzpatrick et al. (2018) reported that online treatments reduced opportunity cost by minimising patient travel and time off work, and financial cost was a barrier to accessing and continuing treatments (Robertson et al., 2020; Gilliam et al., 2011). Mathews et al. (2016) explored relative delivery costs of BIT and CBT groups (with BIT cheaper to deliver), although it is unclear how this translates to cost to patients.

Meta-Analysis Results

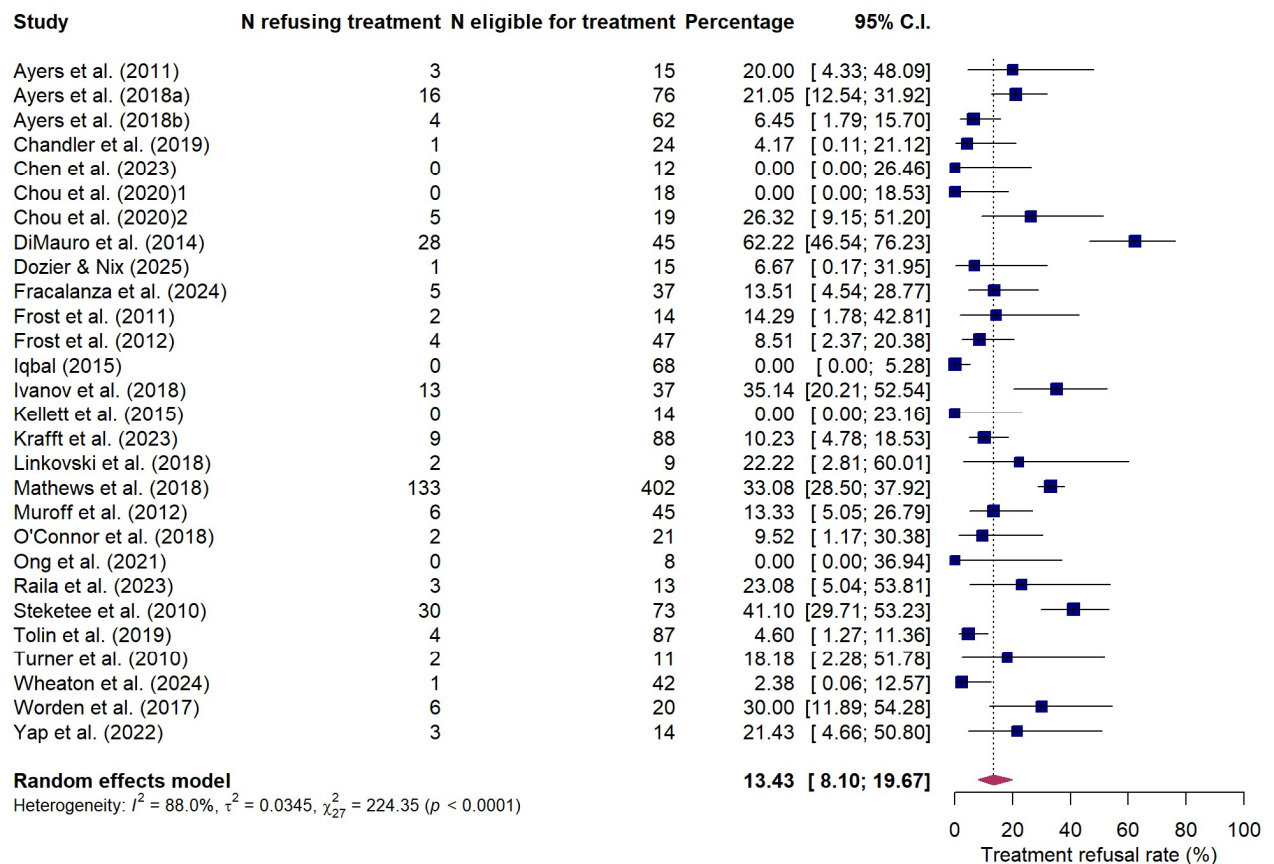
Treatment Refusal

A proportional random-effects meta-analysis was undertaken using n=1336 people assessed for eligibility in k=27 studies (see Figure 2). The pooled treatment refusal rate was 13.43% (95% CI[8.10-19.67]). Statistically significant heterogeneity was found across

studies ($Q(27)=224.35$, $p<0.0001$, $I^2=85.92\%$). Leave-one-out analysis gave minimum 11.94% and maximum 14.58% treatment refusal rates. Visual inspection of the funnel plot indicated possible asymmetry due to an outlying study (see Figure 3), but neither Kendall's tau ($\tau=0.043$, $p=0.752$) nor Egger's regression test ($z=-0.698$, $p=0.485$) were significant. The failsafe N statistic using Rosenthal's method and a target of $p=0.05$ was 7298, and 99 using the Orwin method and a 'negligible' treatment refusal rate of 10%.

Figure 2

Forest plot for treatment refusal



A mixed-effects model using therapy type (CBT; BIT; Other) as a moderator was non-significant ($R^2=0.00$, $p=0.366$). Other intervention characteristics were not explored as moderators since participants were not necessarily aware of these features at the point of treatment refusal.

Figure 3

Funnel plot for treatment refusal rates

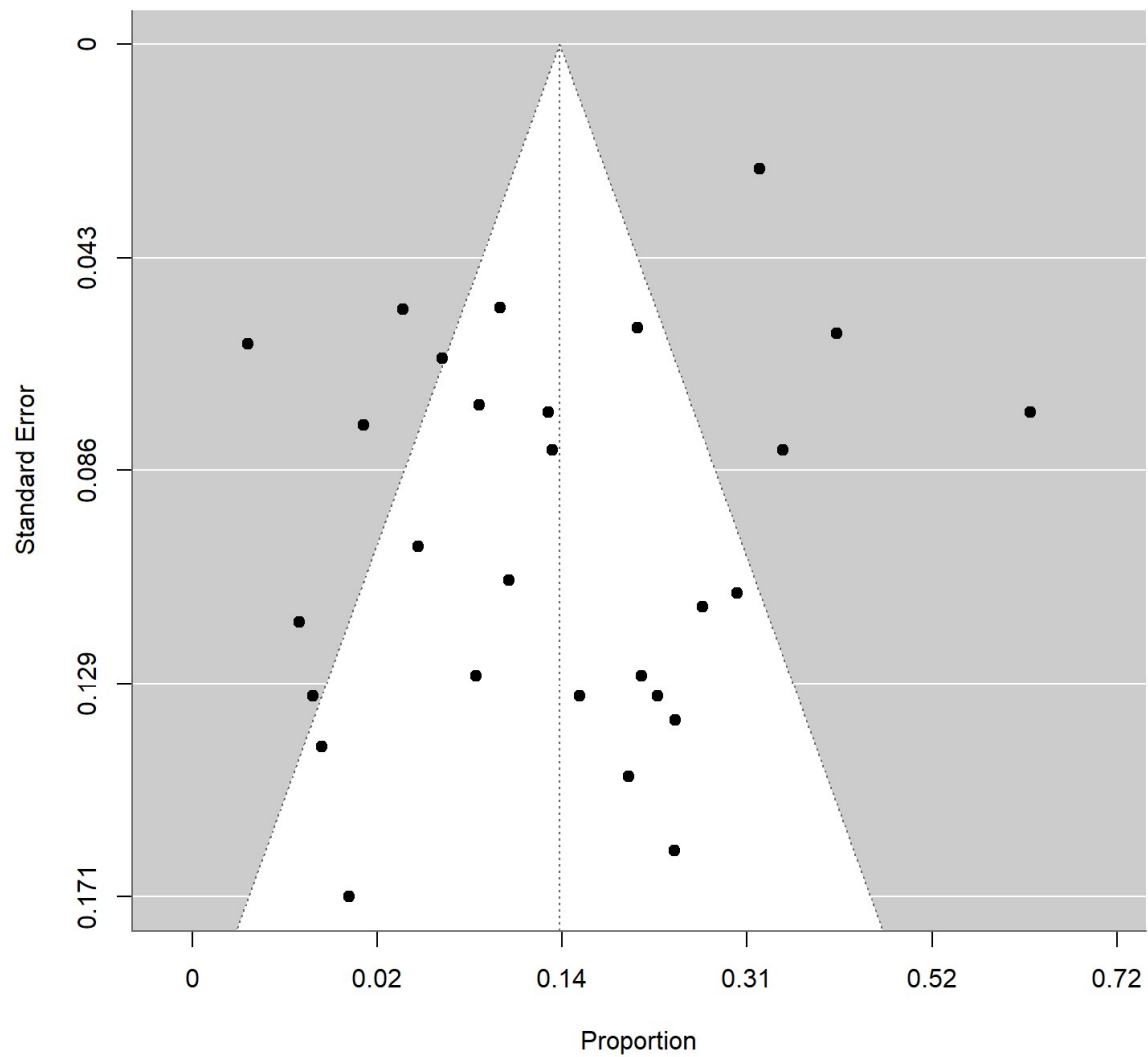
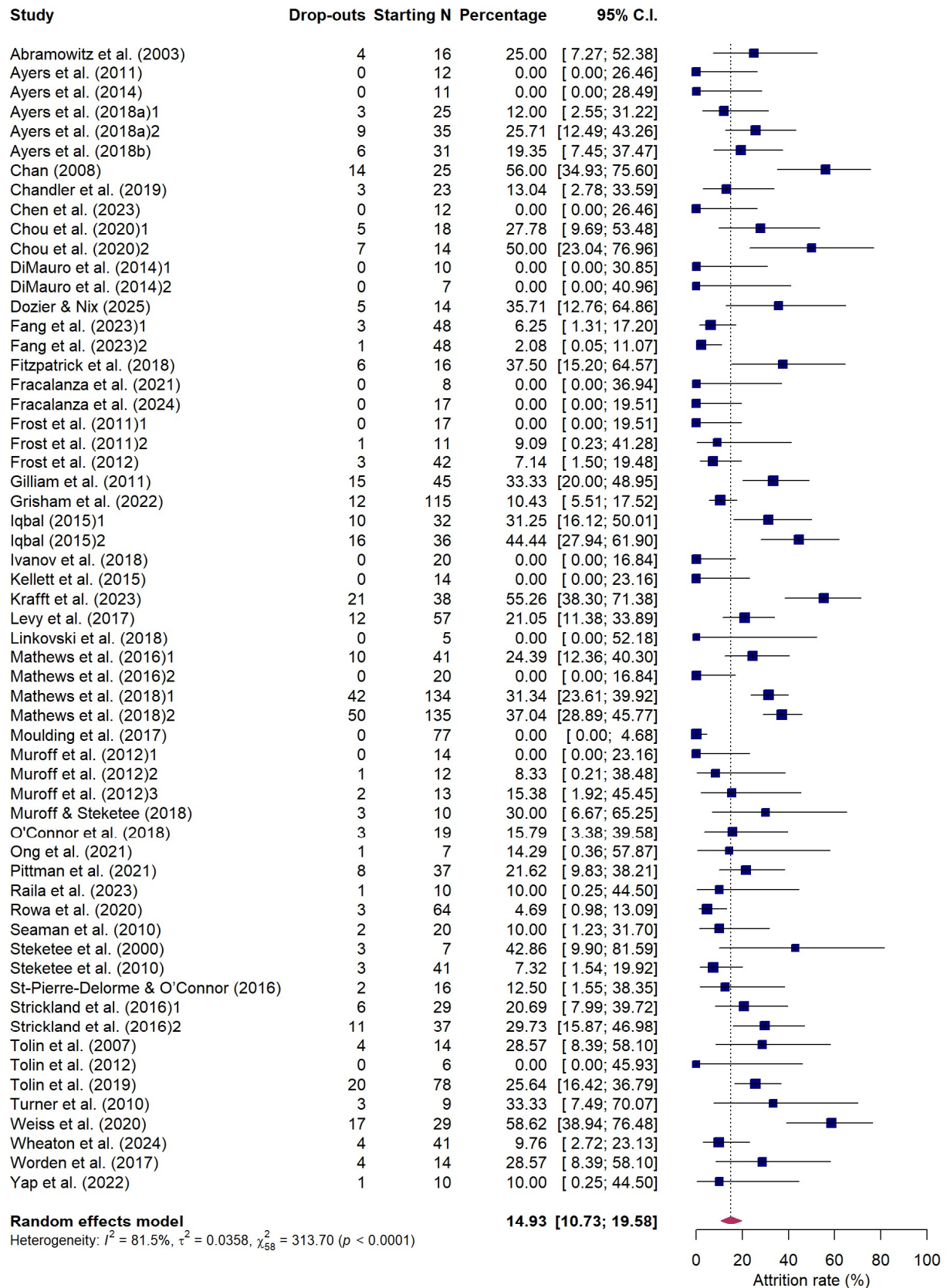


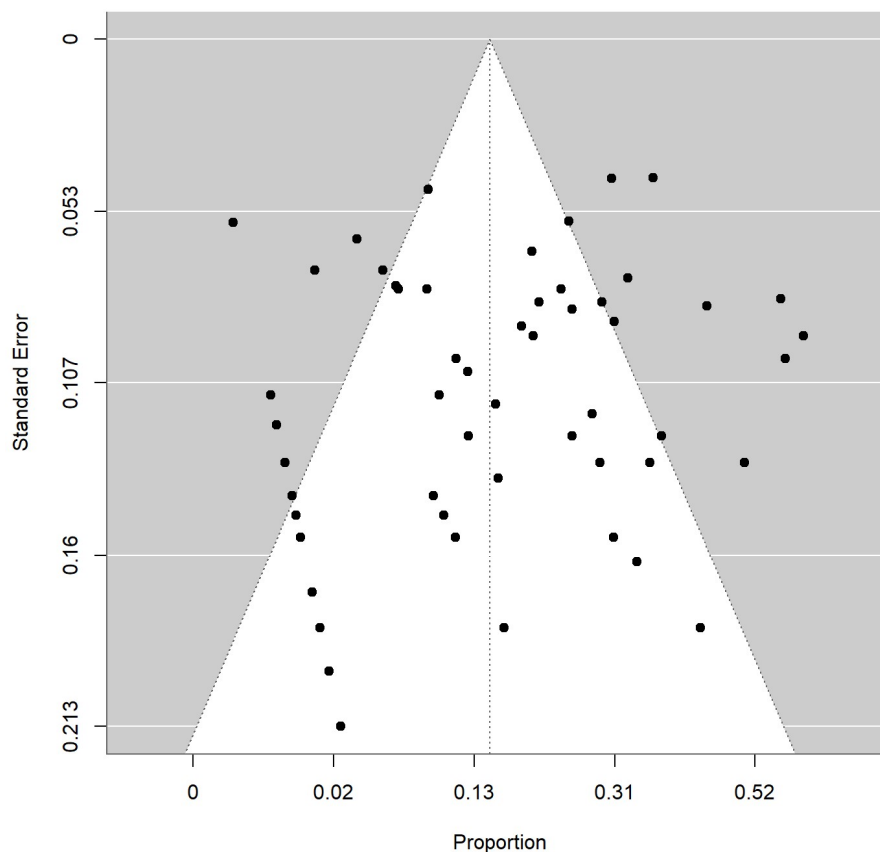
Figure 4*Forest plot for treatment dropout rate for HD*

Treatment Dropout

The random-effects proportional meta-analysis for HD treatment dropout included $n=1766$ participants, where $n=360$ did not complete treatment in $k=48$ studies (see Figure 4). The pooled dropout rate was 14.93% (95% CI[10.73-19.58]). Statistically significant heterogeneity was detected ($Q(58)=313.70$, $p<0.0001$, $I^2=81.12\%$, 95% CI[72.25-87.40]). Pooled dropout estimates using leave-one-out analysis gave a range of 14.3-15.6%, indicating a stable rate. Visual inspection of a funnel plot (see Figure 5) revealed no asymmetry. Kendall's tau was non-significant ($\tau=0.062$, $p=0.492$), as was Egger's meta-regression model ($Z=-1.428$, $p=0.153$). Rosenthal's method for failsafe N ($p=0.05$) indicated 24562 null-result studies would be required to become non-significant, and the Orwin test result was 203 (with a 10% target rate). These results do not indicate the presence of publication bias.

Figure 5

Funnel plot for dropout rates across studies



Moderator analysis results are presented in Table 4. There was no effect of any categorical variable on dropout rates. Separate meta-regressions used to explore the effect of continuous variables on dropout rates indicated that only number of sessions had a significant effect ($B=0.01$, 95% CI[0.00-0.02], $p<0.05$), with longer therapies predicting higher dropout. This is likely due to greater opportunity to dropout from longer HD interventions.

Table 4

Moderator analyses for dropout rate

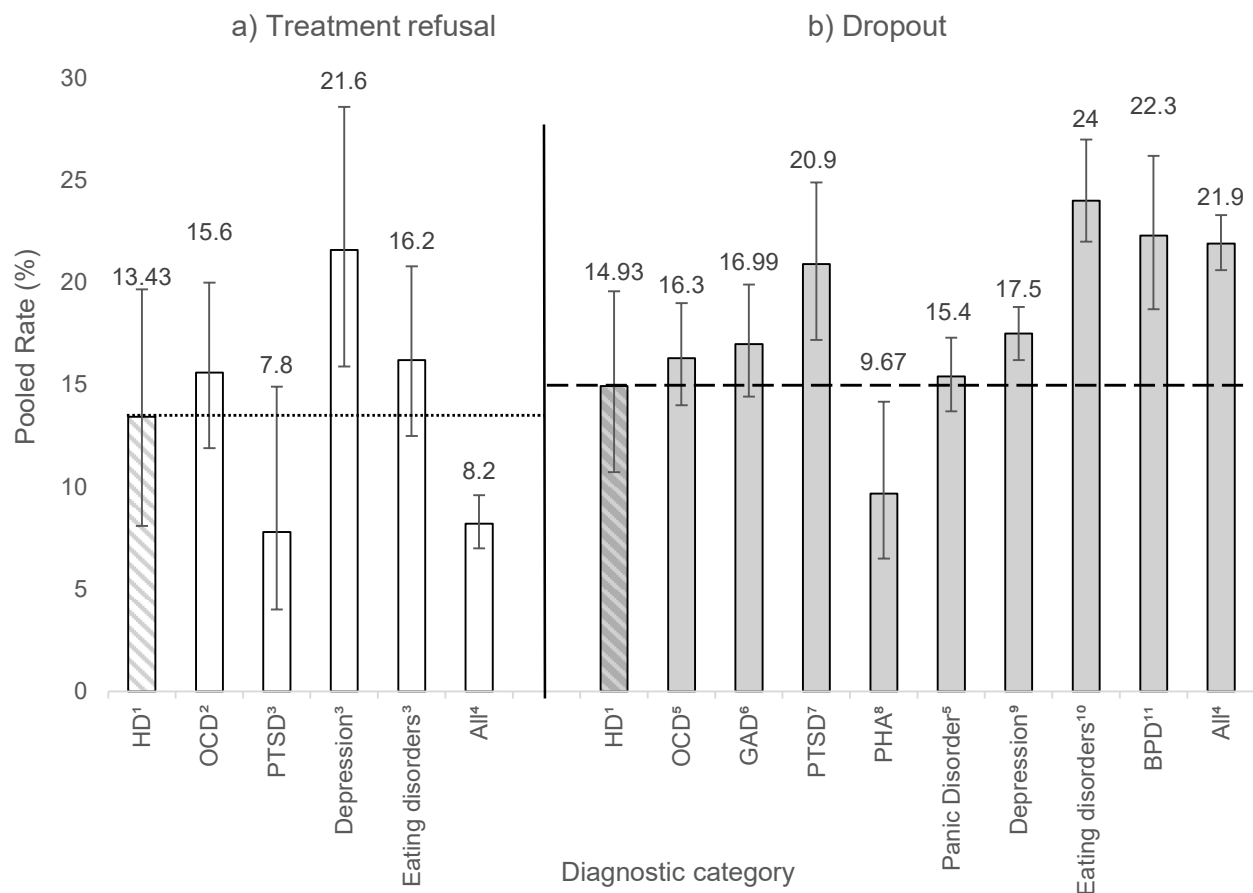
Categorical variable	Subgroup	k	Pooled proportion	95% CI	p	I^2 (%)^a	R^2 (%)
Therapy type	Exposure therapy	5	0.18	0.10-0.27	0.387	81.15**	0.00
	CBT	27	0.16	0.11-0.22			
	BIT	11	0.15	0.10-0.19			
	CREST	6	0.13	0.07-0.19			
	Other	10	0.12	0.04-0.21			
Delivery	Face-to-face	46	0.15	0.10-0.20	0.799	81.94**	0.00
	Online	9	0.14	0.07-0.22			
	Combined	4	0.13	0.02-0.30			
Format	Individual	18	0.16	0.09-0.24	0.780	81.42**	0.00
	Group	34	0.15	0.10-0.20			
	Combined	7	0.14	0.05-0.24			
Home visits	Yes	24	0.15	0.09-0.21	0.804	80.08**	0.00
	No	34	0.13	0.07-0.21			
Setting/design	Research	40	0.16	0.11-0.22	0.472	80.95**	0.00
	Clinical practice	14	0.12	0.05-0.21			
Continuous variable	Scale	k	B coefficient	95% CI	p	SE	R^2 (%)
Quality score	(rating 0-100)	59	0.00	-0.00-0.00	0.403	0.00	0.92
Number of sessions	(3 to 41)	58	0.01	0.00-0.02	0.048*	0.00	6.63

Note. Abbreviations: k = number of studies included; SE = standard error. CI = confidence interval. R^2 = % of variance explained. * $p<0.05$. ** $p<0.0001$.

^aPooled within group estimate of heterogeneity, statistical significance according to Q statistic.

Figure 6

Treatment refusal and dropout rates in interventions for HD and other conditions



Note. OCD: Obsessive-Compulsive Disorder. PTSD: Post-Traumatic Stress Disorder. GAD: Generalised Anxiety Disorder. PHA: Pathological Health Anxiety. BPD: Borderline Personality Disorder.

^aDashed lines represent pooled treatment refusal and dropout rates from this study. Error bars represent 95% confidence intervals for pooled estimates.

^bPooled estimates drawn from: ¹This study; ²Leeurwerik et al. (2019) CBT for OCD intervention studies; ³Fernandez et al. (2015) CBT RCTs for different disorders; ⁴Swift et al. (2017) psychotherapy/pharmacotherapy comparative trials for different disorders; ⁵Gersh et al. (2017) individual psychotherapy outcome studies for GAD; ⁶Varker et al. (2021) RCTs of guideline-recommended treatments for PTSD; ⁷Shi et al. (2024) RCTs for different interventions for PHA; ⁸Swift & Greenberg (2014) treatment dropout rates for different disorders; ⁹Cooper & Conklin (2015) RCTs of different interventions for depression; ¹⁰Linardon et al. (2018) CBT RCTs for eating disorders; ¹¹Iliakis et al. (2021) RCTs of different interventions for BPD.

Benchmarking

Figure 6 reports the benchmarking of HD treatment refusal and dropout rates against similar proportional meta-analyses for other disorders. For both treatment refusal and dropout, 95% confidence intervals overlap when compared individually with other disorders

(except eating disorders for which dropout rate is higher), suggesting that HD interventions do not have markedly different treatment refusal and dropout rates to interventions for other disorders.

Discussion

This review aimed to qualitatively and quantitatively assess the acceptability of psychological interventions for HD, as difficulties engaging and retaining HD patients in treatment have been consistently referenced in the intervention literature over time. This was achieved by (a) undertaking a systematic review of existing research using Sekhon et al.'s (2017) framework of treatment acceptability and (b) completing proportional meta-analyses of treatment refusal and dropout rates. Treatments deemed acceptable by patients encourage better adherence and are more likely to produce clinically significant improvement (Lopez-Pinar et al., 2024). In the context of concern in research and clinical practice that HD patients may fail to benefit from treatment as much as some other clinical populations (Bloch et al., 2014), the need to understand and empirically test acceptability is clear.

Psychological treatments for HD are most often based on CBT models, with growing interest in CREST and ACT. Other therapies (e.g. CFT, MI) have very limited supporting evidence for their use with HD. Interventions for HD exhibit variability in content and delivery format, with increasing literature on internet-delivered options and novel additional features (e.g. contingency management, VR decluttering). 13.43% of participants assessed for eligibility declined to participate in planned HD interventions. The HD treatment refusal rate has not previously been known, and there is now a need for research targeting better post-assessment engagement. For those that begin treatment, the pooled dropout rate was 14.93%. These figures are consistent with treatment refusal and dropout rates found in psychological interventions for other disorders (Swift & Greenberg, 2014), correcting a common

assumption that HD patients are more reluctant to engage with treatment and generate higher levels of dropout than other clinical populations (Ayers et al., 2019). High levels of heterogeneity, however, indicate that these findings are inconsistent. Treatment refusal and dropout appear roughly similar across different HD treatments, but dropout was seen to increase slightly in longer interventions, consistent with increased opportunity for patient disengagement over longer periods of therapeutic time.

Perceptions of intervention from those without experience of HD treatment were generally negative: painful, overwhelming, and exposing patients to anticipated criticism, judgment or socio-legal consequences (Linkovski et al., 2018; Robertson et al., 2016). Such concerns are common barriers to accessing therapy for many conditions (Mancebo et al., 2011; Rowa et al., 2015) and may have contributed to the treatment refusal rate found here. The consequences of non-engagement with therapy for HD could be potentially catastrophic (e.g. eviction, physical harm) and anticipated experiences of stigma and social judgment, common for people with HD, are likely to reduce treatment engagement (Prosser et al., 2024). Acceptability related to lived experience of HD treatment (as opposed to pre-emptive assumptions) was greater. Client feedback ratings indicated positive responses and high satisfaction across different therapies (e.g. DiMauro et al., 2016; Worden et al., 2017), with participants particularly valuing positive therapeutic relationships with clinicians and peers (Davidson et al., 2021; McGrath et al., 2024). Strong therapeutic alliances should be prioritised in HD interventions – they are known to reduce dropout (Sharf et al., 2010), improve treatment outcomes (Baier et al., 2020) and reduce perceived isolation (Storey et al., 2022), all of which are notable issues for HD patients (Davidson et al., 2021). Other therapeutic elements essential to acceptability were concrete behavioural tools; skill development; consistency; structure; and treatment responsiveness to individual needs (Wheaton et al., 2024; Rodriguez et al., 2016). Mixed feedback was gathered regarding

relative acceptability of different therapeutic formats, with polarised views around group interventions and home visits.

Adherence to intervention-related tasks offers another behavioural measure of acceptability (Milosevic et al., 2015). There was a consistent discrepancy between session engagement, and subsequent poor compliance with homework. Many studies reported that patients struggled to complete homework tasks or apply acquired skills independently, despite expressed motivation (Mathews et al., 2018; Tolin et al., 2007). Patients expressed satisfaction with interventions but lower estimations of progress in terms of symptom improvement. Many expressed discontent or demoralisation about therapy ending, perceived need for more support, and lack of confidence in retaining or applying skills. This finding suggests that HD interventions may contribute to care dependency (Geurtzen et al., 2018), in which positive feelings about therapy mask a relinquishing of agency and self-efficacy (Parker et al., 2013). Whether this arises from features of the patient or intervention is unclear. HD patients may have different treatment goals and expectations to those held by clinicians, and experience interventions as ‘useful’ but inconsistent with their views of ‘progress’. People with HD demonstrate high levels of perfectionism (McCabe-Bennett et al., 2025) - unrealistic expectations and fear of making mistakes may prevent perceived improvement (Burgess et al., 2017). Understanding the relationship between idiographic goals and nomothetic outcomes on validated HD measures would be beneficial.

The interventions described in this review exhibited high levels of treatment variability and flexibility. Few studies applied strict adherence or compliance criteria, and those that did lost more participants to exclusion than voluntary withdrawal (Tolin et al., 2019). Significant within-intervention and between-patient flexibility was the rule rather than the exception, although few studies monitored this by assessing protocol adherence. Without significant adaptation and accommodation, it is likely that dropout from HD interventions

would be higher. Treatment personalisation was identified as a key requirement for patient engagement (Rodriguez et al., 2016) and may contribute to better therapeutic outcomes (Owen & Hilsenroth, 2014). Using data to personalise treatment experiences would be a useful direction for future research. In the current literature, however, therapy variability makes it difficult evaluate patient response to HD interventions ‘as intended’. Future outcome research would benefit from assessing aspects of treatment integrity (protocol adherence, differentiation and competency; Cox et al., 2019), as well as applying clear criteria for engagement and adherence.

Treatment samples in the reviewed literature were overwhelmingly female, despite no evidence of significant gender differences in HD at a population level (Cath et al., 2017; Iervolini et al., 2009). Men are widely underrepresented in HD research (Martin et al., 2018), and the reviewed interventions are clearly under-accessed by males. While this may be indicative of wider gender biases around psychological help-seeking (Nam et al., 2010), it may also be related to the acceptability of HD interventions themselves. Rodriguez et al.’s (2016) finding that fewer men endorsed common treatment options as acceptable suggests additional barriers or different affective attitudes for men. This review was unable to expand on this tentative finding, however, due to limited male representation in the literature.

Many studies (particularly those with in-home components) applied exclusion criteria around HD severity, often excluding participants with higher levels of risk (e.g. eviction, suicidality), extreme clutter or significant psychiatric comorbidities (Wheaton et al., 2024). This potentially prevents many people with HD, for whom functional disruption and concurrent psychosocial issues are widespread (Bratiotis et al., 2021; Nordsletten et al., 2013), from being participants in treatment trials and having the opportunity to refuse or drop out from treatments. It was impossible to assess the acceptability of HD treatments for those with more severe symptoms or poorer cognitive function (Ivanov et al., 2018), who may

place treatment for HD lower on personal lists of priorities (Turner et al., 2010) and need ‘coercing’ into treatment (e.g. via risk of eviction; Ricci et al., 2023), and so the estimates produced here may be underestimates. Current treatments were not considered desirable or accessible by broader, more representative samples of people with HD (Robertson et al., 2020). Shame and overwhelm makes treatment-seeking even more unlikely when clutter is most severe (McGrath et al., 2024). Acceptability may therefore be inversely related to HD severity and treatment need, with insight as a moderating factor – those with poor insight demonstrate more severe symptoms, but less willingness to accept therapeutic intervention (Drury et al., 2015). This may contribute to a discrepancy between those (often externally motivated) patients seeking ‘practical’ decluttering support (Chou et al., 2023; Ayers et al., 2012) and those seeking insight-oriented treatments (McGrath et al., 2024). Given HD patients’ expressed need for interventions to be the ‘right fit’ and personalised (Mathews et al., 2018; Rodriguez et al., 2016), these disparate, competing preferences are a challenge for the development of services and treatments for HD as a unitary condition.

Limitations and Strengths

The inclusion of different outcome methodologies, and corresponding critical appraisal tools, limits this review’s ability to consistently assess study quality. Overall, this was evaluated as ‘moderate’, and the attribution of a significant number of studies as ‘good’ or ‘above average’ is consistent with other reviews of HD intervention research (O’Brien & Laws, 2025). Inconsistent definitions of treatment refusal, completion and dropout lead to difficulties ensuring that the same concept is being assessed throughout this review and meta-analysis. In some studies (e.g. Krafft et al., 2023) it was possible to ‘complete’ treatment despite missing key intervention components, undermining the validity of dropout as a measurement of engagement. In some studies, diagnostic certainty of the presence of HD could be challenged, and studies did not consistently report reasons for dropout, or clinical or

demographic differences between dropouts and completers, limiting the generalisability of findings.

Very few studies undertook reliable or thorough assessment of patient satisfaction, a key component of acceptability, or only did so with treatment completers, providing no understanding of the relationship between satisfaction and dropout. Similarly, qualitative evidence was generally of poor quality or not sufficiently focussed on individual interventions to understand lived experiences of HD treatment. In undertaking this review, no formal approach was applied to extraction and coding of data within Sekhon's (2017) framework, making it possible that interpretations and assumptions have been made by the primary author about whether, and how, study findings load onto domains of acceptability. The inclusion of diverse interventions and study designs allows for a comprehensive overview of research in the area, but limits the review's specificity about the acceptability of particular interventions.

Clinical Implications

Many people with HD experience significant reluctance and anxiety about entering treatments that they believe may be coercive. Increased education and choice around available treatments prior to commencement would clearly be beneficial to better engage HD populations and potentially reduce treatment refusal rates. Patient goals for treatment may differ from those set by services, and assessments should consider patient motivation for change (internal/external), treatment priorities (decluttering/insight) and idiographic markers of change. Due to difficulties implementing therapeutic learning, collaboration on goals, change methods and homework design is of particular importance with HD populations. HD treatment is likely to require significant therapist and protocol flexibility, and services and patient contracts must allow for this without losing treatment integrity. Sensitivity to therapeutic endings is required, as HD patients may experience this as demoralising and

discouraging of further treatment-seeking. Long-term follow-up and testing the efficacy of booster sessions is indicated.

Directions for Future Research

Further research into patient lived experiences of specific HD interventions is required. Qualitative research into barriers preventing people from seeking treatment, or experiences of treatment refusal and dropout would be useful, as well as with patients who have poor outcomes or relapse in follow-up. Future HD intervention research would benefit from developing and using universal definitions of treatment refusal and dropout, and from systematic collection and reporting of adverse effects. Recruitment for HD treatment trials should prioritise representative, demographically balanced samples and use diagnostically accurate assessments. Intervention outcome studies could examine progress on idiographic goals alongside nomothetic symptom measures and would benefit from routinely assessing client motivation and satisfaction. Considering findings in this review around patient choice and treatment personalisation, a patient preference trial between behavioural and insight-focussed interventions for HD is indicated, as is a clinical trial of pre-treatment engagement interventions.

Conclusion

This systematic review and meta-analysis identified a pooled HD treatment refusal rate of 13.43% and a dropout rate of 14.93%, which do not appear significantly higher than for other clinical presentations. This addresses the clinical assumption that patients with HD dropout at differentially high rates. Interventions for HD elicit positive affective attitudes in those who receive them and are experienced as useful and defined by helpful therapeutic relationships. There exists widespread negative anticipation of HD treatment, but few reports of adverse effects, suggesting a need for improved pre-treatment psychoeducation and

engagement work. Positive therapeutic experiences did not necessarily translate to other domains of acceptability, and accessing and engaging with HD therapy remains burdensome for many, due in part to aetiological features of the disorder (i.e. concurrent psychosocial or medical issues). HD patients' perceptions of interventions as helpful are counterbalanced by lower self-efficacy, with significant challenges in adhering to homework and maintaining therapy skills and gains. HD interventions may be more acceptable to some demographic groups than others. For many, particularly those most severely affected by HD, significant barriers to, and concerns about, interventions make treatment-seeking unlikely.

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PRISMA 2020 Checklist

Appendix A: PRISMA Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE	1	Identify the report as a systematic review.	P 1
ABSTRACT	2	See the PRISMA 2020 for Abstracts checklist.	P2-3
INTRODUCTION	3	Describe the rationale for the review in the context of existing knowledge.	P6
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	P6
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	P7
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	P8/9
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	P8
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	P71
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	P10
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	P10
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	P10
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	P10
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	P11
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	P11
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	P16-23
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	P11
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	P11
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	P11/12
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	P12
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	P12
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	N/A
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	N/A



PRISMA 2020 Checklist

Section and Topic	Item #	Checklist item	Location where item is reported
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	P14
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	N/A
Study characteristics	17	Cite each included study and present its characteristics	P17-23
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	P17-23
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	P37, P39
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	P13-16
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	P36-40
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	P41-P42
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	P36, P40
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	N/A
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	N/A
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	P43-P48
	23b	Discuss any limitations of the evidence included in the review.	P48-P49
	23c	Discuss any limitations of the review processes used.	P49
	23d	Discuss implications of the results for practice, policy, and future research.	P50
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	P8
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	P7
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	N/A
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	N/A
Competing interests	26	Declare any competing interests of review authors.	N/A
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	P72

Appendix B: Search terms

hoard* AND (psych* therap* OR psych* intervention OR psychotherap* OR therap*)

PubMed

Search fields: Title / Abstract

Filters: Humans; English language; Adult populations (80 and over: 80+ years / Adult: 19-44 years / Aged: 65+ years / Adult: 19+ years / Middle Aged: 45-64 years / Middle Aged + Aged: 45+ years / Young Adult: 19-24 years)

PsycInfo

Search fields: Original Title / Title / Abstract / Key Concepts / Heading Word

Search limits: Human, English Language, Age groups (300 Adulthood age 18 yrs & older; 320 Young Adulthood age 18 to 29 years; 340 Thirties age 30 to 39 years; 360 Middle Age aged 40 to 64; 380 Aged age 65 yrs and older; 390 Very old aged 85 yrs and older)

Scopus

Search fields: Title / Abstract / Keyword

Search limits: English Language, Human

Appendix C: Data Extraction Form

Intervention	Individual or group	F2F / Online	No. of sessions	Home visits	No of home ses.	Attrition N	Attrition %	Treatment retu	Adverse effects	Affective Attitude	Burden	Perceived Effectiveness	Ethnicity	Intervention C	Opportunity C	Self-efficacy
CBT - EXP	Individual	F2F	15	No		4	25	NR	None reported							
CBT for HD (SAF)	Individual	F2F	26	Yes - included	9	3	12	NR	None reported							
CREST	Group	F2F	26	Yes - included	4	0	16	NR	None reported							
Exposure Therapy	Group	F2F	26	Yes - included	4	3	25.71	See above	None reported							
CREST	Individual	F2F	26	Yes - included	4	6	19.35	See above	None reported							
CREST	Individual	F2F	24	Yes - included	Not reported	0	NR		None reported							
CBT for HD (SAF)	Individual	F2F	26	Yes - included	3 to 6	0	NR		None reported							
CBT	Group	F2F	16 to 20	No	2	3	12	NR	Two patients experienced an increase in hoarding							
CBT	Group	F2F	12	Yes	0	4	16		None reported							
Social Cognition Interact	Group	Online	12	No	0	0	0		None reported							
CFT	Group	F2F	16	No	0	5	27.78		None reported							
CBT	Group	Online	15	Yes	12	6	63.16		None reported							
CREST	Individual	F2F	26	Yes - included	Not reported	0	19.35	NR	None reported							
Cognitive remediation	Individual	Online	24	No	0	0	0		None reported							
Relaxation training	Individual	Online	24	No	0	0	0		None reported							
ACT	Group	F2F	8	No	0	0	0		None reported							
Rational Emotional Beh Group	Group	F2F	8	No	0	1	2.08	NR	None reported							
Hearing Plus E-Therap	Combined	Combined	20	No	0	6	37.5	NR	None reported							
Written Imaginal Expos	Individual	Online	3	No	0	0	0	NR	None reported							
Written Imaginal Expos	Group	F2F	3	No	0	0	0	NR	None reported							
Buried in Treasures fac	Group	F2F	13	No	2	1	8.33	See above	None reported							
Buried in Treasures fac	Group	F2F	13	Yes - assessment	0	0	0		None reported							
Buried in Treasures fac	Group	F2F	13	No	3	15	7.14		None reported							
CBT for HD (SAF)	Group	F2F	16 to 20	No	0	10	33.33	NR	None reported							
CREST	Group	F2F	22	No	10	16	31.25		None reported							
Exposure Therapy	Group	F2F	22	No	16	0	44.44	See above	None reported							
CBT for HD (train) + CO	Combined	Combined	16	No	0	0	0		None reported							
CBT for HD (SAF)	Individual	F2F	12	Yes - included	12	0	0		None reported							
ACT Facilitated self-hel	Individual	Online	16	No	21	0	55.26		None reported							
CBT for HD (SAF)	Group	F2F	16 to 20	No	12	0	21.05	NR	None reported - demo data missing for 18 completers							
Buried in Treasures fac	Combined	F2F	15	Yes - additional	10	0	0		None reported							
CBT for HD (SAF)	Group	F2F	16	Yes - additional	2	42	26.25		None reported							
Buried in Treasures fac	Group	F2F	15	Yes - additional	50	0	30.67	See above	None reported							
CBT for HD (SAF) - Micro	Group	F2F	15	No	2	10	24.39		None reported							
Buried in Treasures fac	Group	F2F	15	No	0	NR	0	NR	2 participants had won							
Facilitated self-help	Group	F2F	12	Yes - additional	N/A	0	NR		1 participant had worse							
CBT for HD (SAF)	Individual	Online	26	No	4	0	0		Six of the eight participant							
CBT for HD (SAF)	Group	F2F	20	Yes - additional	3	0	30	NR	None reported - 6 ate							
CBT for HD with additio	Group	F2F	20	Yes - additional	8	0	8.33	See above	None reported, Reason							
Buried in Treasures fac	Individual	Remote	20	No	0	0	0		None reported							
CBT for HD + personal r	Combined	F2F	20	No	0	0	0		None reported							
ACT for HD	Individual	Both options avail	Up to 20 (m=13.7)	No	3	15.79	0	See above	Zero reported that they did not attempt the reading, 0% reported less than 10% of the reading. No clinician inx							
CREST	Individual	F2F	20 to 40	Yes	not reported	1	14.29		One participant reported							
Buried in Treasures fac	Combined	Combined	24	No	1	8	21.62	NR	None reported							
Not reported	N/A	N/A	N/A	N/A	N/A	1	10		Four clients dropped out because they were not							
Not reported	N/A	N/A	N/A	N/A	N/A	1	NR		Three participants withdr							
CBT for HD (SAF)	Group	F2F	12	No	3	4.69	NR		Participants were asked to							
CBT for HD (SAF)	Individual	F2F	12	No	2	10	NR		Among the 203 participant							
CBT for OGD	Individual	F2F	12 to 18	No	3	9.76	NR		Factors that made the							
CBT for HD	Individual	F2F	26	Yes - included	6.5	4	9.76		Completion = attending 8+12 sessions							
CBT for HD (Hant & For	Combined	F2F	29 (15 group, 14 i	Yes - included	14	3	42.86	NR	3 declined and 4 discontinued before week 10. It is noteworthy that of 73 patients with hoarding problems who qualified initially for the stud							
CREST	Group	F2F	20	Yes - included	3	6	20.69	NR	Interestedly, the three p							
Exposure Therapy	Group	F2F	20	Yes - included	3	11	29.73	NR	70 people allocated, only 66 accounted for as either completers / dropouts, 4 missing???? Specifically, treatment co							
CBT for HD (SAF)	Individual	F2F	26	Yes - included	6.5	4	26.67	NR	Hypothesised that high anxiety sensitivity would lead to greater dropout in EIT than CREST due to immediate state of in vivo exposure. Howev							
CBT for HD	Group	F2F	16	No	20	0	25.64		One patient discontinued. The median homework adherence rating was 4, indicating that the patient "did 26-50% of the homework or its eq							
CBT for HD (SAF)	Individual	F2F	28 to 41 (m=35.3)	Yes - included	35.3	5	45.45		7 dropped out of own accord during treatment. An episode of noncompliance was defined as a missed session, c							
CBT for HD (SAF)	Individual	F2F	15	Yes - additional	17	0	58.62	NR	2 None reported. Of 11,							
Buried in Treasures fac	Group	F2F	16	Yes - additional	10	4	9.76		None reported.							
CBT for HD	Group	F2F	16	No	20	0	25.64	NR	First, two ways that uncl							
CBT for HD + confingn	Group	F2F	15	Yes - additional	6	4	28.57	NR	The average score on the CCH across all treatment sessions was 3.30 (SD = 0.54) and ranged from 1.75 to 4.00.							
Buried in Treasures fac	Group	Remote	15	No	1	1	10		None reported.							
Inference Based Therat	Combined	F2F	29	No	0	2	12.5	NR	Treatment completers in							
CBT for HD (SAF)	Group	F2F	16	No	0	0	NR		Program attendance was good with only one dropout, but only nine attended the support group with available atten							
BIT + Emotion regulatio	Group	F2F	15	No	12	0	10.43	NR	participants reported that virtually sorting and d							
Motivational Interviewi	Individual	F2F	6	Yes	6	5	35.71		With regards to the measure of depression, the participants expressed that they would tra							
									None reported							
									No one deteriorated during treatment according							
									, ten patients elected to discontinue for unknown reasons. One client was an administrative withdrawal in which t							
									5 One patient deteriora							
									Of the 13 participants wh							
									Study conducted during pandemic, attributed as leading to high							
									When sorting in the home, the clinician can more							

Part Two: Empirical Study

The Impact of Clutter on Executive Function

Abstract

Objectives. Hoarding disorder (HD) is conceptualised to be associated with deficits in executive functioning, but little research has explored the specific role of clutter in this relationship. This study aimed to a) develop an ecologically valid hoarding environment in virtual reality (VR) and b) test the impact of exposure to excessive clutter compared to no clutter in this environment on participants completing tasks of attention.

Design. A within-subject counterbalanced repeated measures design was used to identify differences in attention performance in cluttered and uncluttered VR environments.

Methods. Healthy community participants (N=44) spent time in cluttered and uncluttered VR houses completing two continuous performance tasks (X-CPT and AX-CPT) within each home environment. Environment and task order were randomised. Participants rated experienced realism, sense of presence and subjective distress in both environments. Repeated-measures multivariate analysis of variance tested the effects for clutter and relevant covariates.

Results. VR environments were realistic and immersive and participants experienced significantly greater distress in the cluttered environment. There were slower mean reaction times and more omission errors in the cluttered home. Differences in commission errors and sustained attention were non-significant. Increased distress in the cluttered home predicted greater deterioration in X-CPT reaction time and omission errors.

Conclusions. Exposure to clutter is detrimental to attention (particularly selective attention and response initiation) and may contribute to HD information processing deficits. Responses to clutter appear heterogeneous and distress influences attentional ability in cluttered environments. VR offers a valid and immersive means of better understanding the mechanisms of HD.

Practitioner Points

- VR offers a realistic, immersive and ecologically valid means of exposure to HD-related clutter.
- Community controls experience greater difficulties with attention (particularly selective attention and response initiation) in a highly cluttered VR environment, suggesting that clutter could maintain the information processing deficits conceptualised in HD.
- Community controls experience increased distress when exposed to VR clutter, and this distress plays a role in reducing attentional ability.

Introduction

Hoarding Disorder

Hoarding Disorder (HD) consists of four main symptoms: (1) emotional attachment to possessions irrespective of their value; (2) distress at the idea of discarding such items; (3) the accrual of these items so that clutter builds to the degree that living areas no longer function as intended and (4) significant impairment to personal functioning (American Psychiatric Association, 2013). HD affects around 2.5% of the general population (Postlethwaite et al., 2019) and is associated with poorer quality of life (Tolin et al., 2019), poorer psychological, physical and socioeconomic functioning (Ong et al., 2015; Dozier & Ayers, 2017) and high levels of distress (Archer et al., 2019). Clutter creates significant environmental risks (e.g. fire hazards, squalor, infestation) and burden to the individual, their families/carers and neighbours/wider community (Tolin et al., 2008). Current understanding of HD is still limited, and further exploration is required to validate models and develop interventions that are acceptable and effective (Mataix-Cols & Fernández de la Cruz, 2018).

The dominant conceptualisation of HD is the cognitive-behavioural (CBT) model of hoarding (Frost & Hartl, 1996). Whilst historic vulnerability is acknowledged, this model primarily considers present-day factors contributing to excessive acquisition, clutter and difficulty discarding, including emotional attachments and beliefs about possessions, dysfunctional emotional responses and behavioural avoidance (Steketee & Frost, 2003). Information processing deficits are a key aspect of the model, particularly in the initial development of clutter and then also with difficulties engaging in treatment. Information processing concerns executive functioning (EF); a set of cognitive processes that enable performance of goal-directed behaviour and includes attention, inhibition, cognitive flexibility and working memory (Miyake et al., 2000). Testing of the role of information

processing in HD has not been conducted at the same rate as other aspects of the CBT model and there are also contradictory findings in the EF evidence base (Woody et al, 2014).

Findings indicate that participants with a diagnosis of HD score more poorly on measures of decision-making and procrastination (Prohaska et al., 2017; Grisham et al., 2007), inhibitory control (e.g. Rasmussen et al., 2013; Morein-Zamir et al., 2014; Sunol et al., 2020), and categorisation and organisation (e.g. Grisham et al., 2010). However, relatively few of these findings have been replicated, with subsequent studies failing to detect such differences (e.g. Mackin et al., 2016; Tolin, et al., 2011; Woody et al., 2014).

Attention and HD

Attention is the ability to identify important information, attend and respond to that information over time, resisting distraction by other stimuli (Knudsen, 2007). These processes are critical to managing information and could be argued to underpin the deficits (i.e., decision-making, categorisation, memory) that have been conceptualised as a core part of HD (Frost & Hartl, 1996; Chun & Turk-Browne, 2007; Nunez et al., 2015; Deng & Sloutsky, 2016). Clinical observation and self-reported complaints from people with HD indicate high levels of inattention (Hartl et al., 2005) and there is evidence that people with HD may struggle with sustained visual attention (Gledhill et al., 2021), response inhibition and development of attentional strategies (e.g. Grisham et al., 2007; McMillan et al., 2013). Around a third of people with HD also exhibit symptoms of attention deficit hyperactivity disorder (ADHD; Frost et al., 2011; Sheppard et al., 2010). This comorbidity appears to particularly apply to the inattention and impulsivity ADHD subscales, rather than hyperactivity (Lynch et al., 2015). There is some debate as to whether these high correlations constitute a true comorbidity, or whether these ADHD-like characteristics are an inherent part of HD (Worden et al., 2023).

Different aspects of attention are most commonly assessed using a continuous performance task (CPT), during which participants are required to respond or withhold a response to specific stimuli (Conners, 2000). The Gledhill et al. (2021) systematic review found that 3 out of 4 studies evidenced poorer attention on CPT in people with HD compared to healthy controls and argued that these information processing differences increased vulnerabilities to both excessive acquiring and poor discard. Other measures of attention have been used, such as the Weschler Digit Span (Weschler, 2008; McMillan et al., 2013), Weschler Spatial Span (Weschler, 2009; Testa et al., 2011) and Stroop Colour Word test (Stroop, 1935; de Kort et al., 2012), although more rarely, and with more mixed results (Woody et al., 2014). Digit span performance has been found to be significantly more affected in HD samples in some studies (e.g. Ayers et al., 2013; Mackin et al., 2011), but not in others (e.g. McMillan et al., 2013; Mackin et al., 2016). Similar conflicting results are mirrored in the spatial span evidence base (McMillan et al., 2013; Testa et al., 2011).

Despite these inconsistent findings around the role and impairment of attention in HD, the CBT model continues to posit a ‘predispositional’ vulnerability model, whereby neurocognitive deficits underly and precede the development of HD (Frost & Hartl, 1996). Information processing deficits cause or exacerbate the development of clutter by way of excessive acquisition and poor discard (Steketee & Frost, 2003). Clutter is central to the aetiology of HD, as both a product and a precondition of the disorder (Frost & Hartl, 1996). Little empirical research has, however, examined the nature of the assumed relationship between clutter and information processing. Visual environments are well known to interact with underlying abilities in attentional and decision-making processes (Orquin et al., 2021), and one early study found that living in cluttered and chaotic environments was associated with greater self-reported difficulties with attention (Dumas et al., 2005). Raines et al. (2014) manipulated the environment and randomly allocated participants with HD to a cluttered or

uncluttered condition, where they completed measures of memory (California Verbal Learning Test) and attention (CPT). There were no significant differences in cluttered vs uncluttered environments, although increased hoarding severity was associated with poorer sustained attention on the CPT. Raines et al., (2014) suggested that the lack of significant differences was due to (a) those with HD feeling more comfortable when surrounded by clutter and (b) heterogeneity in sensitivity to clutter.

The habituation of people with HD to high levels of clutter in their homes means that research in this population is likely to carry risk of significant bias and not therefore reliably test the relationship between clutter and attention. Two studies have attempted to address this by including and comparing non-clinical participants. Woody et al., (2021) randomly allocated participants to complete a CPT in either a cluttered or uncluttered environment. The environments were clinical testing rooms, one of which was filled with clutter, including some objects belonging to participants. Despite completing diagnostic assessments, and reporting data from HD and ‘healthy’ samples, all participants were recruited with self-reported hoarding tendencies, and this may limit confidence in considering them completely free of the EF difficulties associated with HD. No effect for environment (cluttered/uncluttered) was found on attention, although participants (particularly ‘healthy’ controls) reported being more distressed and distracted in the cluttered condition. Norberg et al. (2023) further built on this by exploring sustained attention and response inhibition using a CPT in both HD and healthy samples across both uncluttered and cluttered environments. The uncluttered environment was a clinical office and the cluttered environment was a living/waiting room containing commonly hoarded items. No main effect for environment was found, although HD participants demonstrated higher levels of inattentiveness across conditions.

These initial findings suggest that clutter may not produce attentional deficits itself but rather interact with underlying HD characteristics to create such difficulties. A key methodological challenge in reliably studying the relationship between a hoarded environment and information processing, however, is the ecological validity of the environment and appropriately integrating testing into such an environment. Testing environments need to have ecological validity and so be able to elicit the same information processing, thoughts and feelings experienced in the cluttered home environment. All previous studies unfortunately utilised single room clinical spaces – although Norberg et al. (2023) describe the cluttered environment as a ‘living room’, it was described to participants as a waiting room within a clinical research facility. This therefore fails to mirror how clutter accumulates in and across all living spaces in HD (Demanuele, 2023). Houses are hoarded across the whole home environment and hoarding is not therefore limited to single rooms. Also, only Norberg et al. (2023) used a validated measure to benchmark the level of clutter to which participants were exposed, and uncertainty therefore exists as to whether testing conditions reliably reflected a hoarded home. Additionally, none of the studies enabled participants to dynamically interact with the clutter and/or to move around within the environment, as would be the case in a hoarded home. Whilst navigating and using spaces becomes suppressed by high levels of clutter (National Health Service, 2022; Simmonds & Janney, 2013), people with HD still move around their homes.

Virtual Reality and HD

Testing information processing in a cluttered home environment is likely to be impractical and potentially unreliable or unsafe. Virtual reality (VR) offers a promising means of recreating the home hoarded environment. VR is being increasingly used in psychological therapy for anxiety and related disorders as a way of recreating clinically useful environments (Oing & Prescott, 2018). VR offers a safe, accessible and acceptable

alternative to in-vivo exposure, which can be perceived as overwhelming, unachievable and off-putting (Kim et al., 2009). The use of VR in HD research is in its infancy (Muroff & Otte, 2019), with very few examples of therapeutic usage (Raila et al., 2023; St-Pierre-Delorme & O'Connor, 2016; Chasson et al., 2020). VR has been used to a limited degree to investigate the aetiology and mechanisms of HD. McCabe-Bennett and colleagues (2020a; 2020b) used VR hoarded environments to explore the relationship between clutter, feelings of claustrophobia, emotional reactivity and experiential avoidance. Somaratne et al., (2021) investigated emotional processing and self-reported information processing difficulties in cluttered environments. Results found that those with higher levels of HD reported greater attachment to items and reduced ability to categorise and make appropriate decisions about clutter. Across both intervention and experimental studies, the quality, level of clutter and degree of immersion in the VR environments varied widely, and no VR studies have explored participants' cognitive processing in vivo.

The Current Study

This study therefore wanted to combine and expand two areas of HD research where current evidence is lacking or inconclusive – that is, (a) the direction and nature of the relationship between HD symptoms (particularly clutter) and attentional deficits and (b) to explore the use of VR to create immersive and ecologically valid experiences of HD-related clutter. Establishing the relationship between clutter and attentional difficulties in HD has significant clinical implications - if clutter contributes to the development of such difficulties, then it acts as a maintaining factor for other aspects of HD (e.g. distress, acquisition, difficulties with discarding and engaging with treatment) and so would be a useful target for intervention. However, it is difficult to accurately assess the impact of clutter in participants with HD, as their responses may be affected by habituation, variability in emotional reactions to cluttered environments and test reliability in cluttered home environments. Therefore,

using a non-clinical, healthy community sample will act as a useful proof-of-concept study (Kendig, 2018) before progressing onto testing in a clinical sample should the results show differences. This study is therefore the first to test for possible baseline attentional deficit in a realistic (i.e., immersive and navigable hoarded home) cluttered environment. The use of an innovative and novel VR environment enhances the likelihood of detecting any effect on attention.

Aims

This proof-of-concept study sought to explore the impact of highly cluttered environments on attention in a sample of healthy, non-clinical participants, and to provide feasibility evidence around the use of VR in recreating the impact of cluttered environments associated with HD.

Hypotheses

H₁: Participants will have slower reaction times on a CPT in a cluttered environment than in an uncluttered environment.

H₂: Participants will commit more omission and commission errors on a CPT in a cluttered environment than in an uncluttered environment.

H₃: Participants will have poorer sustained attention (i.e. greater deterioration from start to finish of task) on a CPT in a cluttered environment than in an uncluttered environment.

H₄: Participants will experience the VR environment as realistic and immersive and will experience some emotional response to the VR clutter.

Materials & methods

Design

This study used a within-subjects repeated measures counterbalanced design. Each participant completed CPT tasks within both cluttered and uncluttered VR environments. Scores from the uncluttered environment acted as the control. The design and protocol for this study was approved by the University of Sheffield Ethics Committee (Appendix A).

VR Environment

The cluttered and uncluttered home environments were built in collaboration with XRTherapeutics, using Unity (v2022.3.7f1). The environment was loaded onto a commercially available Meta Quest 2 headset and was experienced by participants using a stationary boundary. Screenshots of the uncluttered and cluttered environments can be found in Figures 1 and 2. The two houses (cluttered and uncluttered) were on an urban street and participants walked down the street to access the homes. Each home environment consisted of a kitchen, hallway/living space and bedroom. In the final room, a CPT task was embedded into a flatscreen TV. Both environments were calibrated to run at 60 frames per second to ensure consistency of experience and of assessment of response times. Participants were able to switch condition within the VR environment (i.e. without removing the headset). Participants were randomly allocated to starting condition and then crossed over once testing was completed.

Figure 1

Screenshots of uncluttered environment

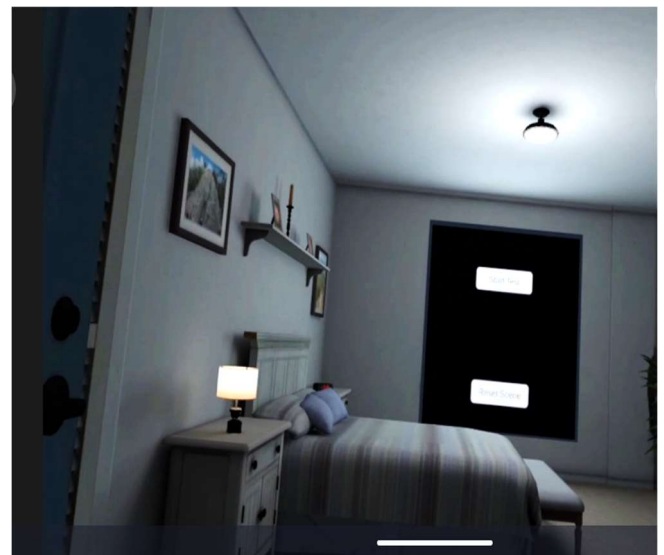


Figure 2*Screenshots of cluttered environment***Patient and Public Involvement**

Members of a local support group for people with hoarding difficulties were consulted concerning aims, rationale and design. Participants from this group (n=8, all female, age range 46-73) identified strongly with experiencing attentional difficulties, reporting struggling to be organised, plan and/or sustain focus on day-to-day tasks. Most felt unsure whether the cognitive difficulties they described preceded or arose from the clutter around

them and all felt that living in a cluttered environment made it difficult to engage with decision-making (e.g., “don’t know where to start” and quickly feeling “overwhelmed” by clutter). One participant, however, described feeling reassured by their items (books and paperwork). Two participants reported that even when they were elsewhere or when their home was relatively tidy, they were constantly aware of the clutter that remained or was hidden; this was referred to as “mental clutter” and distracted people from prioritising environmental clutter, as well as impacting decision-making and concentration related to other day-to-day activities.

This supports the idea that research on attention in patients with HD diagnoses or clinically significant symptoms is likely to carry inherent bias in the fact that it is impossible to obtain a true baseline due to the clutter already in existence (i.e., mentally or physically). Heterogeneity within HD populations in terms of their response to clutter (i.e. different emotional responses and perceived impact described above; Raines et al., 2014) is likely to impact findings in research with this population. The above consultation consolidates the argument for needing further clarification via a proof-of-concept study around the relationship between clutter and information processing as this interaction is evidently felt by HD populations.

Pilot

Prior to testing with research participants, the VR environment was piloted, initially using a small sample (n=3) of healthy controls unfamiliar with the research project. This was intended to benchmark the level of clutter and to identify any issues with the environment or the protocol. Pilot participants completed the Clutter Image Rating Scale (CIRS; Frost et al., 2008), rating each of the living spaces in the VR environment (kitchen, hallway, bedroom). The CIRS is widely used to determine hoarding severity and demonstrates good reliability in

both self-report and clinician-administered formats (Dozier & Ayers, 2013; Sagayadevan et al., 2016).

The aim in this project was to achieve a CIRS rating of at least 6 in the hoarded VR home, as this would indicate a considerable level of hoarding, but maintain some ability to navigate within the environment. In this initial scoping pilot, the VR environment scored a mean of 3.67 (SD=0.47) on the CIRS for the kitchen, 2.33 (SD=0.47) in the hallway and 3.00 (SD=0.82) in the bedroom. Pilot participants also completed the IGroup Presence Questionnaire (see: Measures) and although the environments scored 5.00 (graded as excellent; Melo et al., 2023) for overall presence, they scored 2.17 (unacceptable) for experienced realism. Qualitative feedback was that there was insufficient clutter and that the clutter itself was not realistic or emotionally impactful. The quantity, texture (“bright and shiny”) and content (“all the same stuff, no variety”) of the clutter were therefore key targets for further development of the VR environment. Changes included reducing lighting and reflection, significantly increasing the quantity and variety of cluttered items, reducing the cleanliness of surfaces and extending the clutter to outside the home. The pilot also identified several technological and administrative issues, including glitches in the VR experience and the likelihood of fatigue due to prolonged wearing of the headset. These were resolved through further product development and amendment of the CPT protocol to seven rather than ten repetitions, with a maximum total administration time of 30 minutes. Changes were reviewed by two members of the research team who had not previously experienced the VR environment. All areas of the VR environment were rated by both as 6 or above on the CIRS, and tests were undertaken to ensure the technology was valid and functional. Face validity was also explored with members of a local hoarding support group (n=3, all female, age range 46 to 73). Feedback was that the cluttered environment was very overwhelming, realistic and immersive. Average CIRS ratings were 7.33 (SD=0.94) for the kitchen, 5.67

(SD=0.47) for the hallway/living space and 6.00 (SD=0.82) for the bedroom. This was deemed sufficient to begin delivery of the study protocol.

Measures

The following study measures were utilised and administered using Qualtrics secure research platform (<https://www.qualtrics.com/>).

Demographic Information

A bespoke questionnaire gathered participants' age, gender, ethnicity and education level, as well as their previous experience using VR equipment and current utilisation of online immersive gaming.

Hoarding Rating Scale – Self-Report (HRS-SR)

This 5-item self-report questionnaire screens for HD (Tolin, Frost, & Steketee, 2010) and participants rate the distress and functional impact caused by clutter and difficulties discarding items. The measure demonstrates excellent internal consistency (Carey et al., 2019) and can be administered either as a semi-structured interview or, as in the current study, as a self-report questionnaire. The HRS demonstrated good reliability in the current sample ($\alpha=0.82$). HRS-SR scores of 14 and above are indicative of clinically significant symptoms of HD (Tolin et al., 2010).

Continuous Performance Task (CPT)

A continuous performance task assessed sustained and selective attention and required participants to either respond or withhold responding dependent on the stimuli presented. The specific CPT used followed the protocol developed by Rosvald et al. (1956; Cohen et al., 1999). This involves two tasks, one in which participants are asked to identify each letter X in a series of 31 letters (X-CPT). The next task requires participants to select Xs that follow the letter A in a series of 31 letters (AX-CPT). Each of these tasks was repeated 7 times within

each condition. Participants were randomly allocated to begin with one or the other of these tasks to manage practice effects. The use of two distinct tasks was anticipated to use different executive functions – X-CPT is believed to load particularly onto selective attention, target identification and response initiation, while the AX-CPT additionally implicates working memory, proactive and reactive cognitive and inhibitory control (Sharifian et al., 2021). Participants completed the CPT on a flatscreen TV within the VR environment. Responses were given using the Quest 2 handset buttons, and mean reaction time, missed correct answers (omission errors) and unforced incorrect answers (commission errors) were recorded by the headset.

IGroup Presence Questionnaire (IPQ)

This 14-item measure (Schubert et al., 2001) evaluates the degree of presence experienced in VR environments, assessing domains of involvement, spatial presence and experienced realism. The measure demonstrates acceptable to good internal reliability (Berkman & Catak, 2021). Responses are given on a 7-point Likert scale. All questions in the measure were utilised during the piloting process to inform development. During data collection, two questions were chosen to assess experienced realism (“How real did the virtual world seem to you?”) and sense of presence (“In the computer-generated world, I had a sense of “being there”). These items are both scored from -3 to +3 but one is reverse scored – higher scores indicate lower realism and greater sense of presence. Cronbach’s alpha was low in the current study ($\alpha=0.54$).

Subjective Units of Distress Scale (SUDS)

SUDS (Wolpe, 1969) is a single-item measure assessing subjective anxiety, fear or distress in specific situations or in response to specific stimuli. Emotional response is rated on an 11-point Likert scale, and SUDS has clinical face validity as a global measure of

emotional distress (Tanner, 2012). SUDS scores were given for each condition to determine the acceptability and impact of the VR environments.

Recruitment

Study participants were recruited from a non-clinical community population. Various methods were employed, including use of social media, distribution of recruitment material in community centres and use of a research portal for undergraduate students at the University of Sheffield. Participants who completed the study were eligible for either research credits or a £5 Amazon voucher as recognition for their time.

Participants

A sample of healthy adult community participants was recruited. Potential participants were excluded at screening when they had a history of motion sickness, existing or suspected neurological conditions, current mental health conditions (including a diagnosis or clinically significant symptoms of HD) or used immersive or VR gaming for 20+ hours per week. A preliminary g*power calculation for an appropriate sample size to conduct a repeated-measures MANOVA able to detect a medium effect size with 80% power at an alpha level of $p < .05$ indicated a sample size of 44 was required. Effect size was estimated based on means and standard deviations from a relevant paper using a similar within-subjects design and a CPT (Mani, Bedwell, & Miller, 2005).

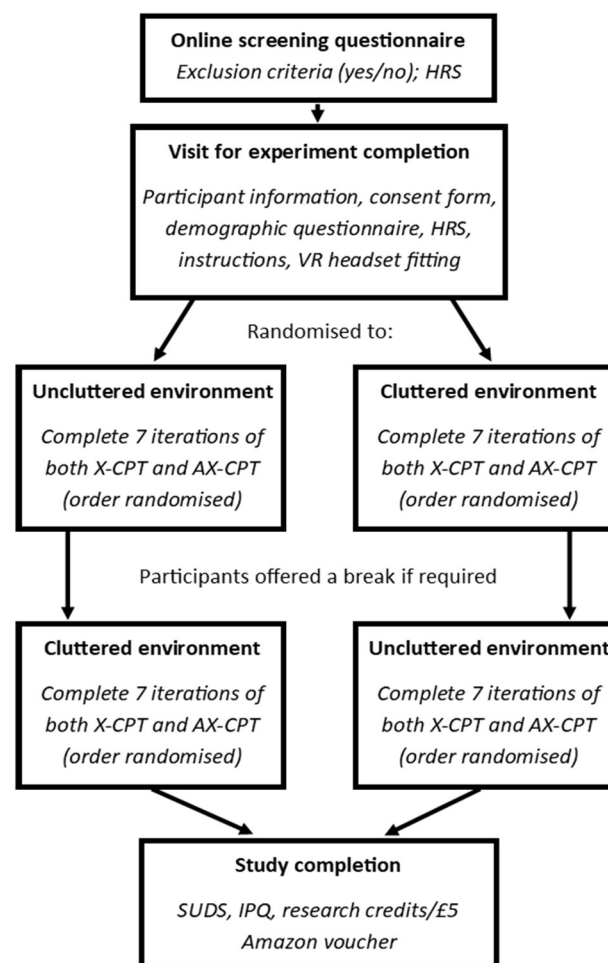
Procedure

Participants initially completed an online screening questionnaire to confirm eligibility (Figure 3). Eligible participants provided written consent, following which they completed demographic questions and the HRS-SR. The order in which participants were exposed to the cluttered and uncluttered environment was randomly determined by a random number generator within the VR programme, as was the order of task completion. In each

environment, participants spent three to four minutes navigating the rooms of the house with a view to becoming fully immersed. They then completed the CPT within the virtual environment, which was embedded in a flat screen television in the bedroom in each house. Participants were offered a break between the two environments if required. Following completion of the task under both conditions, participants completed remaining survey questions (IPQ items and SUDS).

Figure 3

Study Design and Procedures



Data Analysis Strategy

All statistical analysis was undertaken using IBM SPSS (version 29.0.2.0). Data were assessed to detect violations of statistical assumptions around normality and multicollinearity. Shapiro-Wilk statistics and visual inspection of histograms for dependent variables indicated that only mean reaction times (for both tasks and in both conditions) were normally distributed, all other CPT outcomes demonstrated significant skew and kurtosis. This was also true of IPQ and SUDS responses. A logarithmic transformation was therefore applied to the latter, and a $\log(x+1)$ transformation applied to CPT data to account for 'zero' data points. Despite these transformations, the prevalence of 'zero' scores meant significant skew remained for omission and commission errors. Non-normally distributed CPT data was therefore excluded from the MANOVA and non-parametric tests performed on these outcomes instead. Other data were transformed to enable appropriate analysis (e.g. transcribing IPQ items from a -3 - +3 scale to a 1-7 scale; calculating means scores across task sets).

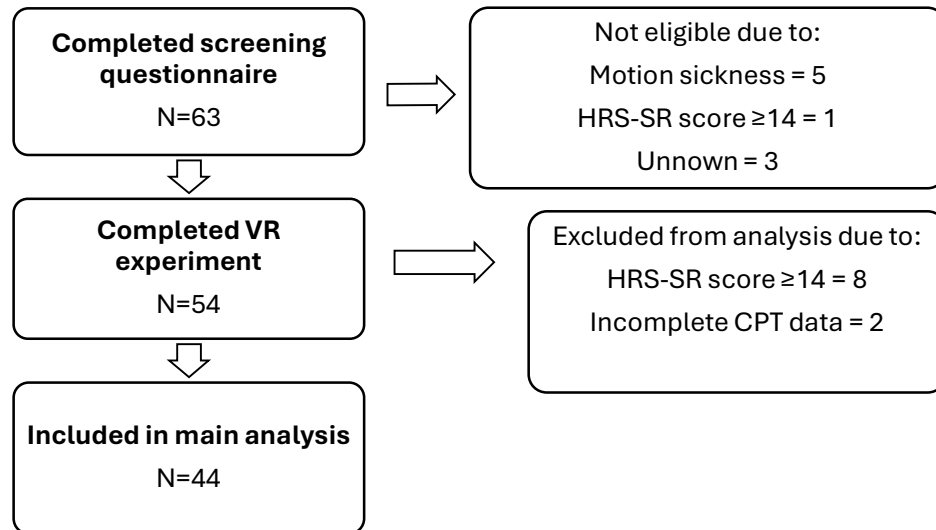
For mean reaction time data, a chi-square test on Mahalanobi's distance identified one multivariate outlier. However, inspection of z-scores for reaction time outcomes and plots did not indicate that this case differed significantly on any individual variable. Five univariate outliers (where $-3 > z > 3$) were identified on omission and commission errors. Principal analyses were run separately with these cases included and excluded. No differences were identified in the pattern or significance of results. These outliers were therefore retained in the principal analysis. Pearson correlation coefficients indicated no multicollinearity in the dependent variables (all $-0.9 < r < 0.9$).

A one-way within-subject repeated measures MANOVA was undertaken to consider the effect of cluttered/uncluttered condition, with X-CPT and AX-CPT mean reaction times as dependent variables. Bonferroni corrections were applied to account for multiple

comparisons and Pillai's Trace statistics examined for significance. Related samples Wilcoxon Signed-Rank Tests were used to identify differences in missed responses (omission errors) and incorrect responses (commission errors) between conditions. One-way repeated measures ANOVAs were used to explore changes in mean reaction time, commission and omission errors across the seven task iterations, and a 2x7 MANOVA was used to understand the effect of condition on the same outcomes over time in each task. Paired t-tests were used to investigate differences across conditions in participants' reported distress and sense of realism and presence. Missing data were excluded on an analysis-by-analysis basis. Sensitivity analyses (independent sample t-tests) were completed to identify any differences between the main sample and excluded cases. Further post-hoc exploratory analyses were undertaken to examine the existence and role of covariates that may impact the relationship between clutter and CPT performance. In all analyses, significance was determined where $p < 0.05$.

Results

54 participants were recruited, with N=44 usable datasets, ensuring the study was sufficiently powered. Despite scoring below the clinical threshold on the HRS at screening, N=8 participants had HRS scores in the clinical range at the point of testing. Many had anecdotal reasons for this increase (e.g. house moves, renovations, housemates). Nevertheless, these participants were excluded from principal analyses, although their data were retained for sensitivity analysis (Figure 4). A further N=2 participants presented incomplete data due to technical issues with the VR environment. Their data have therefore been excluded from all analysis. Table 1 summarises sample demographics.

Figure 4*Participant flow***Table 1***Sociodemographic characteristics of participants*

Characteristic	Included (44)		Excluded (10)	
	N / Mean	% / SD	N / Mean	% / SD
Age	28.45	12.41	26.10	15.65
Gender				
Male	15	34.1	0	0
Female	29	65.9	10	100
Ethnicity				
White British	34	77.3	8	80
White European	4	9.1	0	0
Mixed White / Asian	2	4.5	0	0
Chinese	1	2.3	1	10
Pakistani	1	2.3	0	0

Mixed White / Black Caribbean	1	2.3	0	0
Any other mixed heritage	1	2.3	0	0
Irish	0	0	1	10
Highest level education				
A Level	18	40.9	7	70
Undergraduate degree	13	29.5	3	30
Masters degree	10	22.7	0	0
Doctorate	2	4.5	0	0
Other (Higher National Certificate)	1	2.3	0	0
Hours gaming per week	0.41	1.17	0.40	0.84
Previous VR use				
Never	14	31.82	6	60
Once	20	45.45	4	40
Occasional (<1x per month)	10	22.73	0	0
HRS score	5.16	3.27	16.90	6.21

Counterbalancing procedures were effective, with 52.3% of participants randomly allocated to the uncluttered environment first and 47.4% beginning within the cluttered environment. T-tests exploring differences in CPT scores by completion order were all non-significant.

Experience of Hoarded and Non-Hoarded VR Environments

Mean SUDS scores were 0.95 (SD=1.12) in the uncluttered environment (approximately corresponding to ‘alert and calm with no acute distress’) and 2.50 (SD=1.53) in the cluttered environment (minimal to mild distress). Mean experienced realism was -0.80 (SD=1.58) in the uncluttered and -0.09 (SD=1.74) in the cluttered environments (lower scores indicate greater perceived realism on this item). Sense of presence mean scores were 0.90

(SD=1.58) and 0.47 (SD=1.68) for uncluttered and cluttered environments respectively, with greater scores indicating more felt presence.

There was a significant correlation between experienced realism and sense of presence in each of the environments ($r=-0.446$, $p=0.004$ in the uncluttered environment; $r=-0.428$, $p=0.006$ in the cluttered environment; negative correlations are due to the 'realism' item being inverse scored. Intercorrelation across conditions was moderate for realism ($r=0.694$, $p<0.001$) and felt presence ($r=0.626$, $p<0.001$). There was no correlation between distress experienced in the two environments ($r=0.203$, $p=0.186$). Experienced realism in the uncluttered condition, however, was correlated significantly with distress experienced in the cluttered condition ($r=-0.360$, $p=0.016$). Experienced distress was also correlated significantly with X-CPT outcomes in the corresponding condition: mean reaction time in the uncluttered condition ($r=0.308$, $p=0.042$) and both mean reaction time ($r=0.395$, $p=0.008$) and missed responses ($r=0.336$, $p=0.026$) in the cluttered condition. Participants experienced the uncluttered environment as significantly more realistic than the cluttered environment ($t(43)=-3.583$, $p<0.001$) and experienced significantly more distress in the cluttered environment ($t(43)=6.015$, $p<0.001$). No significant differences were found for sense of presence across the two environments ($t(39)=1.903$, $p=0.064$). Anecdotal feedback from participants varied widely. Some commented on immediately feeling overwhelmed when entering the cluttered house. Physical agitation was noticed in a few participants while navigating the cluttered house. However, many observed after completing the experiment that the clutter was not distressing for several reasons: i) the clutter did not belong to them; ii) there was no expectation to *do* anything with the clutter (e.g. tidy/find something); iii) they retained an awareness that it was VR and therefore not real.

Mean Reaction Time

Mean reaction times were significantly correlated across tasks and conditions. (X-CPT $r=.706$ between conditions; AX-CPT $r=.752$ between conditions; X/AX $r=.402$ in cluttered condition; X/AX $r=.598$ in uncluttered condition). There was a main effect for condition on mean reaction time in X- and AX-CPT ($F(2,42)=33.691$, $p<0.001$, Pillai's Trace=0.616, partial eta squared=0.616). Univariate tests indicated that a similar pattern of effect was found in each of the tasks. Mean reaction times on the X-CPT differed significantly across conditions ($F(1,43)=38.671$, $p<0.001$, partial eta squared=0.473), with a mean increase of 0.030 seconds (95% CI [0.020-0.040], $p<0.001$) in the cluttered condition (Figure 5). Similarly, there was an effect for condition on reaction times in the AX-CPT ($F(1,43)=37.574$, $p<0.001$, partial eta squared=0.473), with a mean difference of 0.027 seconds (95% CI [0.018-0.036], $p<0.001$; Figure 6).

Figure 5

Estimated marginal means of X-CPT mean reaction time

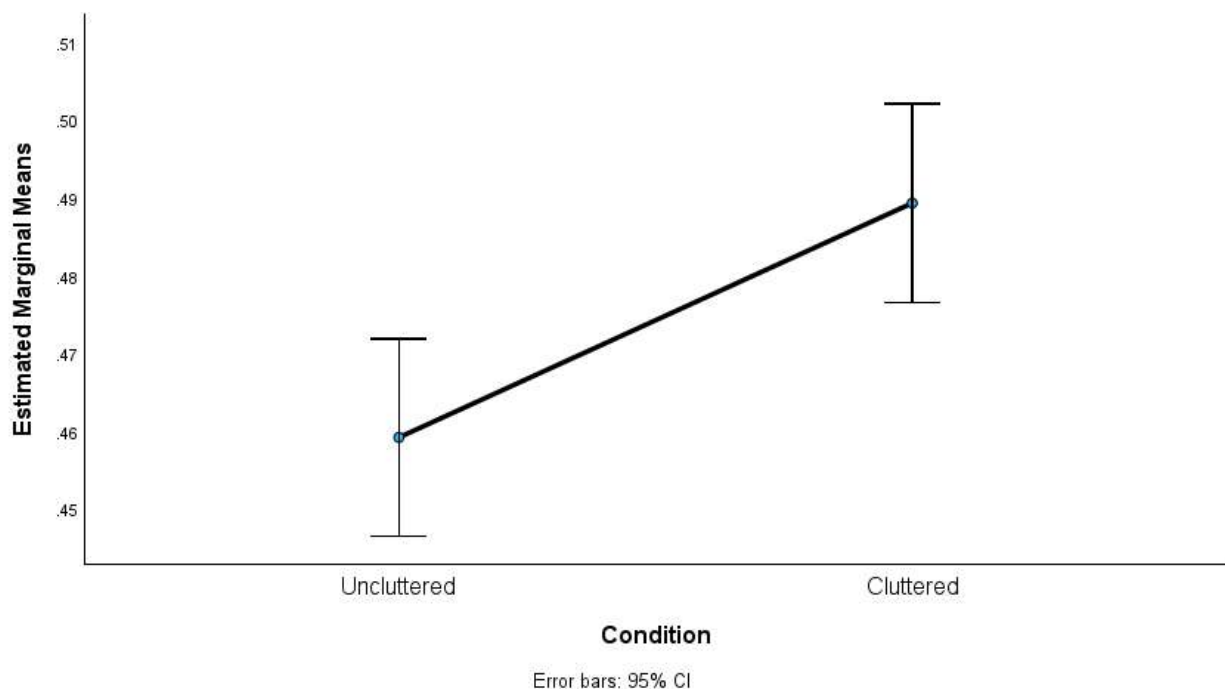
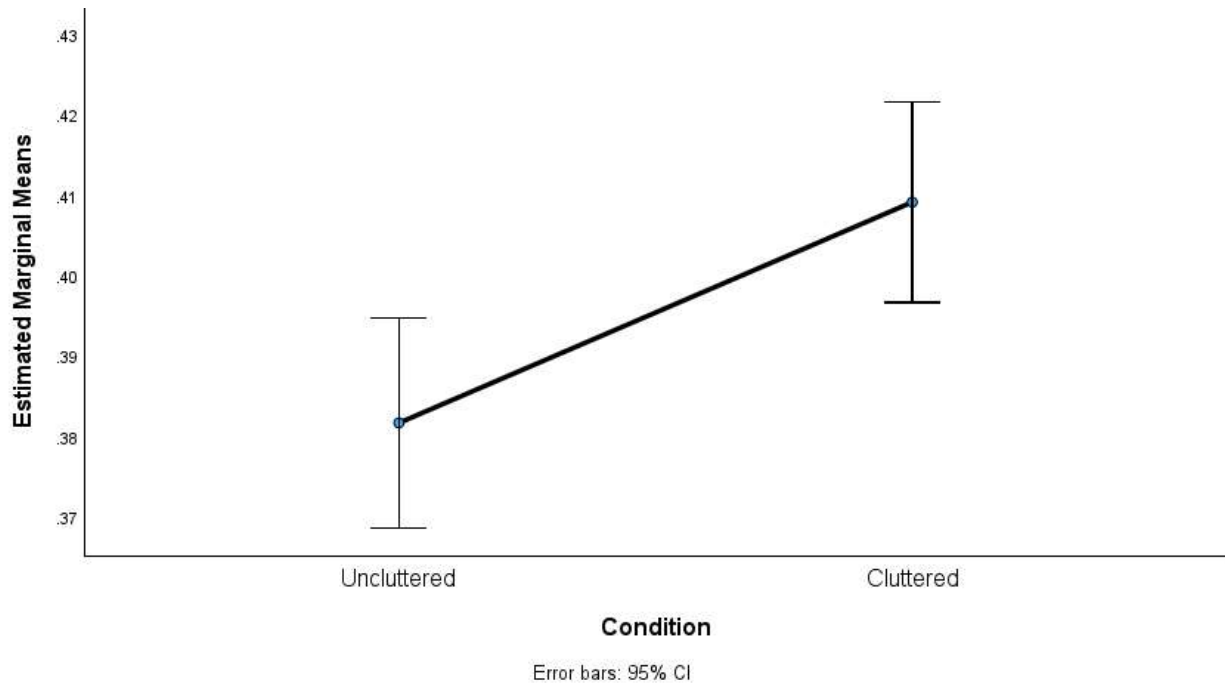


Figure 6

Estimated marginal means of AX-CPT mean reaction time



Omission Errors

During the X-CPT, participants missed fewer (Mdn=0.071) correct responses in the uncluttered environment than in the cluttered environment (Mdn=0.143) and this difference was significant ($W=102.50$, $Z=-2.296$, $p=0.022$). In the AX-CPT, there was also a (non-significant) increase in missed responses between the uncluttered condition (Mdn=0.000) and cluttered condition (Mdn=0.071; $W=134.00$, $Z=-1.851$, $p=0.064$).

Commission Errors

There was no difference in median incorrect responses across conditions in either the X-CPT ($W=172.00$, $Z=-0.421$, $p=0.673$) or the AX-CPT ($W=209.00$, $Z=-0.186$, $p=0.852$).

Sustained Attention

No significant main effect for time was found on X-CPT mean reaction times in the uncluttered environment. However, a main effect for time was found in AX-CPT mean

reaction times in the uncluttered environment after a Greenhouse-Geisser correction was applied ($F(4.528, 194.710)=3.253, p=0.10, \text{partial eta squared}=0.070$). In the cluttered environment the effect of time on X-CPT mean reaction times approached significance ($F(6, 248)=2.059, p=0.059, \text{partial eta squared}=0.048$), but no effect for time was found on AX-CPT reaction times. No effects for time were found on any task for missed or incorrect answers. There was a significant main effect for both time ($F(6, 246)=2.833, p=0.011, \text{partial eta squared}=0.065$) and condition (reported above) on X-CPT mean reaction time, but no significant time x condition interaction (Figure 7). In the AX-CPT, no significant effect for time was found on mean reaction time (Greenhouse-Geisser corrected $F(4.809, 206.773)=1.353, p=0.245, \text{partial eta squared}=0.031$). However, there was a significant time x condition interaction (Figure 8; Greenhouse-Geisser corrected $F(4.283, 184.153)=2.843, p=0.023, \text{partial eta squared}=0.062$).

Figure 7

Estimated marginal means for X-CPT across task iterations

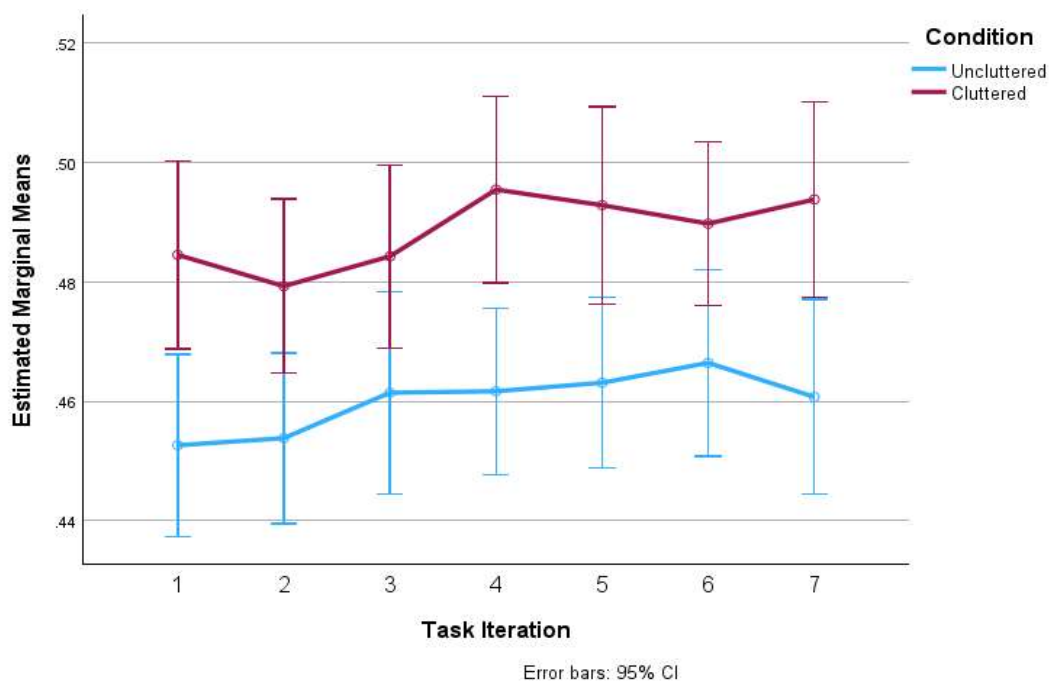
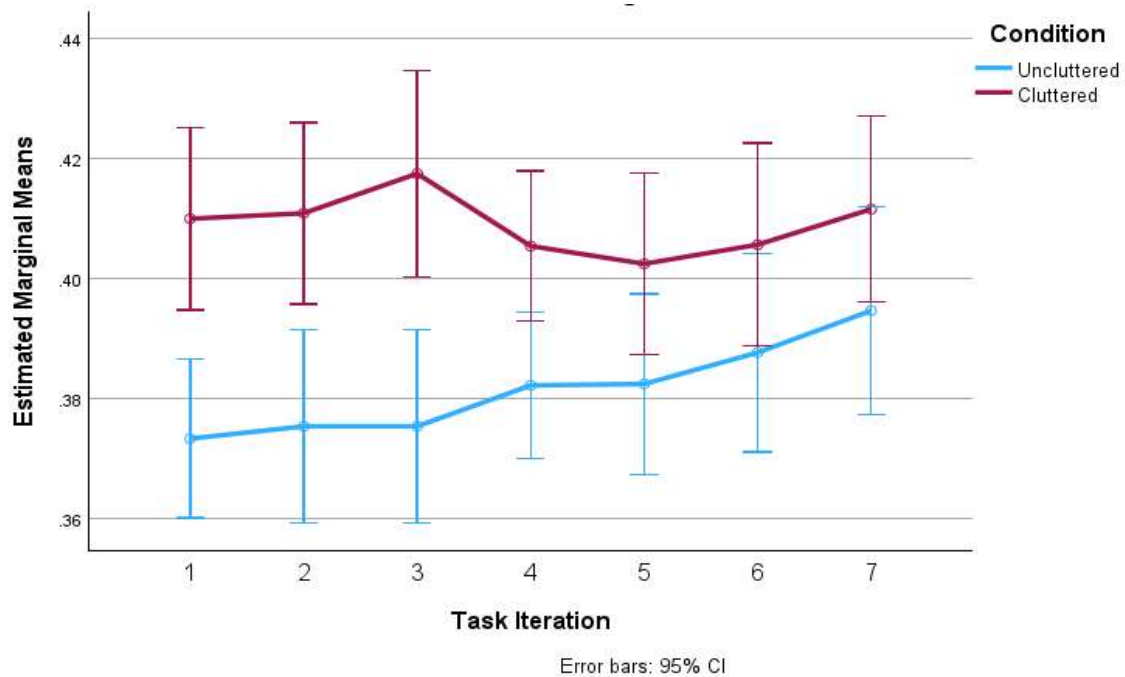


Figure 8*Estimated marginal means for AX-CPT across task iterations***Post-Hoc Exploratory Analyses**

Due to significant correlations between distress and CPT outcomes in both conditions, further exploratory analyses were undertaken to identify whether individual differences in subjective experience, demographics and clinical features contributed to variation in CPT scores. Multivariate linear regression determined whether any variables of interest (demographics, HRS, IPQ or SUDS score) predicted CPT outcomes. No participant characteristics, including demographics and HRS score predicted any outcomes in either condition. In the cluttered condition, distress scores predicted X-CPT mean reaction time ($B=0.013$, 95% CI [0.003 , 0.024], $p=0.017$) and approached significance in predicting X-CPT omission errors ($B=0.149$, 95% CI [-0.007 , 0.304], $p=0.060$). Difference in distress scores between cluttered and uncluttered conditions (rather than raw distress scores) significantly predicted both outcomes on the X-CPT in the cluttered condition ($B=0.009$, 95% CI [0.001 , 0.016], $p=0.030$ for mean reaction time; $B=0.188$, 95% CI [0.038 , 0.339], $p=0.016$ for

omission errors). A repeated measures MANCOVA was undertaken with change in distress scores across conditions as a covariate, to further understand the relationship between this change and X-CPT outcomes. This indicated a main effect for condition (described above) as well as a significant interaction between condition and difference in distress ($F(3, 40)=4.272$, $p=0.010$, Pillai's Trace=0.243, partial eta squared=0.243). Univariate tests indicated that this interaction was significant for mean reaction time and omission errors but not for commission errors, with greater increases in distress in the cluttered condition predictive of greater deterioration in scores (Figures 9-11).

Sensitivity Analyses

Excluded participants were found to differ significantly from the main sample on gender ($t(43)=4.716$, $p<.001$), with a higher proportion of females in the excluded group and on the severity of HRS score ($t(50)=-9.674$, $p<.001$), with excluded participants scoring significantly higher. Excluded participants also reported significantly higher distress in the cluttered environment ($t(50)=-3.247$, $p<0.01$). However, they did not differ significantly on any CPT outcomes - an apparent difference in missed responses in the uncluttered X-CPT was negated when accounting for a significant Levene's statistic indicating unequal variance.

Figure 9

X-CPT changes in mean reaction time across conditions against changes in distress score

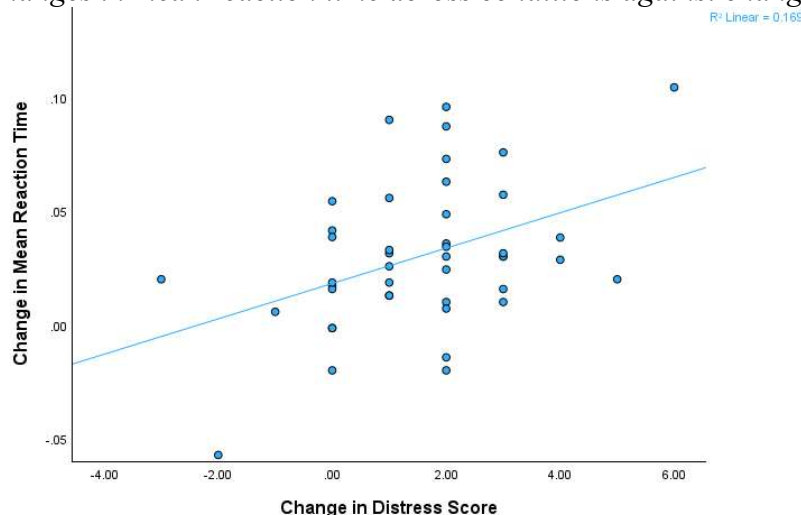
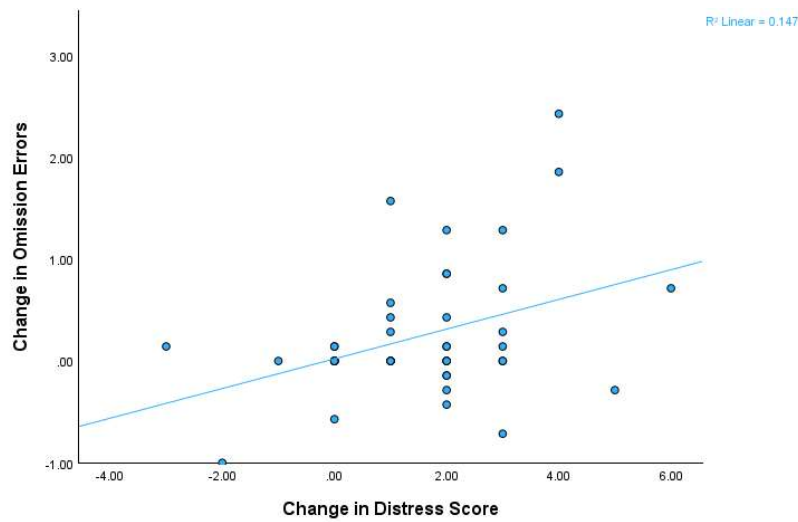
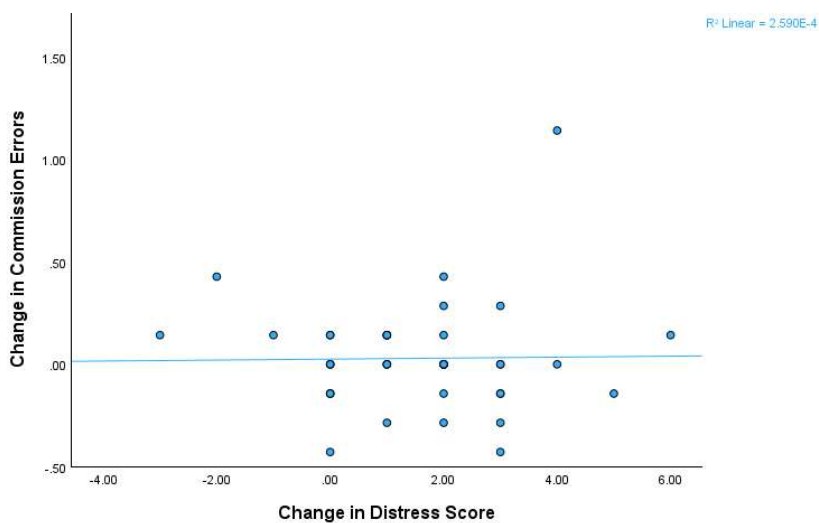


Figure 10

X-CPT change in omission errors across conditions by change in distress score

**Figure 11**

X-CPT change in commission errors across conditions by change in distress score



Discussion

This innovative and proof-of-concept study aimed to examine how performance on a task of attention was affected by exposure to high-level clutter in a VR environment, to better test and therefore understand the role of clutter within the aetiology of HD. The study found that healthy participants had significantly slower reaction times in a cluttered environment

across two different tasks and were also more likely to make more omission errors. The fact that these deficits were found in both X-CPT and AX-CPT tasks (loading onto different executive functions) indicates that participants exposed to high-level clutter had more difficulty with general inattention, response initiation and response to cues. There was no difference in the rate of commission errors across the two conditions, indicating that participants did not experience more difficulty with impulsivity or response inhibition in the cluttered environment. These findings differ from the very limited existing research into the effects of clutter on attention. Neither study exploring this interaction in healthy participants (Woody et al., 2021; Norberg et al., 2023) found a significant deterioration in CPT performance in a cluttered environment, and there are several possible explanations for this discrepancy. It is likely that the higher levels of clutter to which participants were exposed in the current study (CIRS rating 6 rather than 4 in Norberg et al., 2023), as well as exposure to clutter within a full home environment, rather than in a limited one-room environment, contributed to an increased effect. The ability to move through the hoarded home and associated clutter combined with instructions to participants to fully immerse themselves in the clutter may also have played a role (i.e., rather than trying to ignore it as an ‘inconvenience’, e.g. Norberg et al., 2023). It should be noted that there are methodological differences (including the use of a different CPT) which limit direct comparability between studies.

The induction of attentional difficulties (particularly around initiation and increased inattention) in healthy participants through exposure to clutter has significant implications for current understanding of HD. It suggests that the relationship between information processing deficits and clutter may be bidirectional. Rather than simply being a product of underlying difficulties, cluttered environments actively reduce attentional ability. The deficit created then would presumably contribute to increased procrastination (Ferrari, 2000), less effective

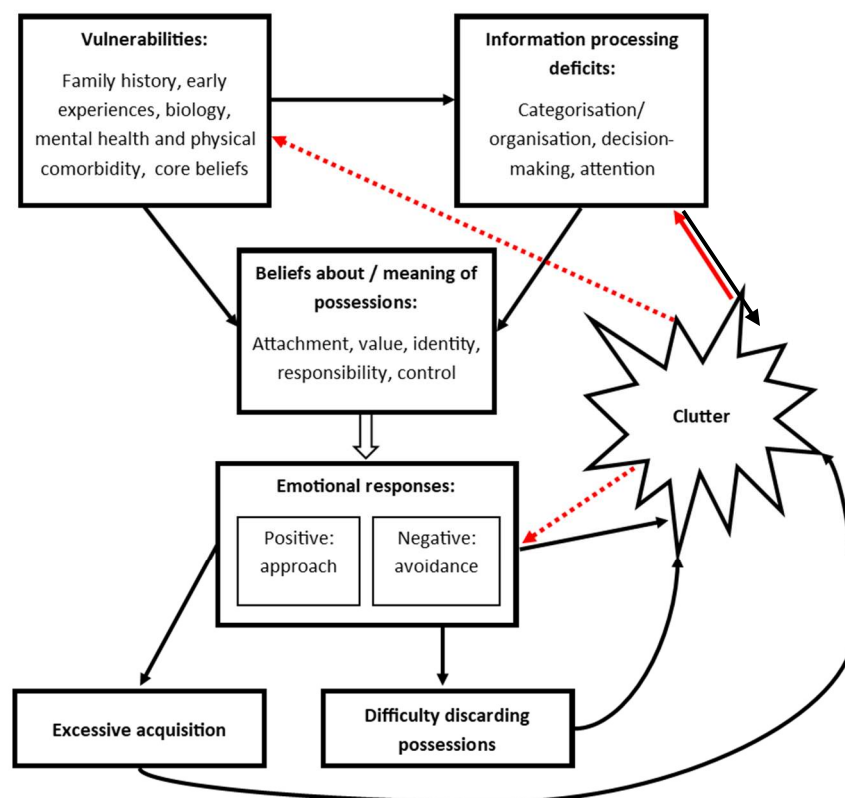
decision-making (Drigas & Karyotaki, 2019) and difficulty developing and initiating strategies (Martin & Ewert, 1997). These factors combine to underpin and maintain HD symptoms such as excessive acquisition, difficulty discarding and inability to pursue treatment (Burgess et al., 2017; Ferrari & Roster, 2017; Gleason et al., 2021; Ayers et al., 2018). Figure 12 shows a suggested updated CBT model of HD demonstrating this circularity. Reducing clutter should therefore continue to be a key focus for HD treatment, as its continued presence is likely to detrimentally affect ability to apply attention effectively and responsivity to treatment. Interventions have already been developed which explicitly target executive function difficulties in HD populations (e.g. Cognitive Rehabilitation and Exposure/Sorting Therapy; Ayers et al., 2014), but these interestingly do not concurrently emphasise decluttering (O’Laws & Brian, 2025). The findings of the current study suggest that a two-pronged approach to address key maintaining factors of HD: offering attentional and cognitive skills training alongside proactive reduction of clutter.

This feedback loop between attention and clutter suggests that exposure to highly cluttered environments over prolonged periods could be in and of itself a risk factor for the development of HD by way of ADHD-like symptoms (Guzick et al., 2020; Sivakanthan et al., 2021). HD demonstrates high levels of familial heritability (Hirschtritt & Mathews, 2014), and it is possible that early life exposure to high-level clutter affects cognitive development and the ability to utilise executive functions that could be protective against developing HD in later life, thus increasing vulnerability. Living with HD means consistent exposure to clutter and the attentional risks this seems to impose. The executive functions particularly affected by clutter appear to be selective attention, response initiation and cue recognition. Findings around sustained attention were more inconsistent. Participants’ ability to maintain focus throughout the tasks did not deteriorate significantly more in the cluttered condition, and no significant differences were found for the AX-task, which relies on response

inhibition. This may suggest that differences found on those executive functions elsewhere in the literature (Woody et al., 2014; Gledhill et al., 2021) may be attributable to other features of HD, or be an underlying characteristic of HD, rather than a product of clutter.

Figure 12

Circular cognitive behavioural model of HD



Note. Adapted from Steketee (2014). Black arrows indicate existing relationships identified in theoretical and empirical literature. Red arrows indicate relationships suggested by this study's findings, i.e. bidirectionality of clutter-information processing link. Red dashed lines indicate relationships hypothesized by this study (i.e. clutter/distress; early life clutter/late vulnerability).

This study also provided feasibility evidence around the use of a VR environment to replicate clutter levels akin those seen in HD. A full home was created in VR (included a hoarded exterior after responding to feedback) rather than relying on a single room. The environment was scored as greater than neutral on measures of both experienced realism and

sense of presence. Applying the Melo et al. (2023) criteria indicates that realism in the uncluttered environment and sense of presence in both environments were deemed ‘excellent’ (i.e., grade A). Perceived realism in the cluttered environment appeared slightly lower (grade B – ‘very good’), and this difference with the cluttered environment was statistically significant. Anecdotally, several participants said they couldn’t believe the cluttered environment was a realistic representation of a house affected by HD, or that “people live like this” – it is possible that they therefore scored it lower on this measure. Overall, findings indicate that this VR experience is realistic and immersive and offers an accessible means of exposure to high levels of clutter.

Participants reported significantly higher levels of distress, anxiety or discomfort in the cluttered environment. This is consistent with findings from other studies that have experimentally manipulated clutter levels (Woody et al., 2021; Norberg et al., 2023) as well as a broader literature indicating that cluttered environments negatively impact on subjective wellbeing (e.g. Prohaska et al., 2017; Roster et al., 2016). In this study, average distress scores fell within the ‘minimal to mild’ range, indicating that the emotional impact of the cluttered environment was not as detectable or overwhelming as intended. It should be noted, however, that there was greater variance in distress scores in the cluttered environment than in the uncluttered environment, perhaps suggesting that there is significant heterogeneity in individual responses to clutter. This is supported by anecdotal and observational data from participants which indicated that some participants did indeed find exposure to the cluttered environment intense and unpleasant.

Distress around clutter was not significantly correlated with any identified variables (e.g. demographic variables, HRS score) other than perceived realism of the uncluttered environment. This makes it difficult to determine what it is about some participants that makes them more susceptible than others to experiencing distress in cluttered environments.

This is of significance as distress predicted several outcomes related to attentional performance. In the uncluttered environment, distress predicted increased reaction times on the X task, and in the cluttered environment increased distress predicted slower reactions and more omission errors. Multivariate analysis suggested that people who reported greater increase in distress from uncluttered to cluttered condition also demonstrated greater deterioration in X-task response time and omissions across conditions. It is of interest that a similar pattern of findings was not found for the AX task, which suggests that the cueing of responses in this task may counteract the effects of distress. Research on the interaction of anxiety with attentional control suggests that anxiety increases visual search array (Spalding & Nicholls, 2021) – the presence of cues may facilitate moving from non-target to target items and negate this increased distractibility. Conversely, the literature suggests that state anxiety is associated with increased reactivity and oversensitive alerting (Pacheco-Unguetti et al., 2010). This was not demonstrated in this study, where the lack of change in commission errors in the context of increase in distress suggests that clutter-related distress may not impact response inhibition as much as inattention or response initiation. This uneven pattern for the role of distress in modulating attention has been found elsewhere, with heightened emotion sometimes sharpening and sometimes interrupting attention (Meyers et al., 2013). Regardless, there may be some interaction between clutter and distress, and this warrants further attention as another potential maintaining factor in HD (see Figure 12).

Participants who were excluded from the main analysis due to elevated self-reported hoarding symptoms also exhibited much higher levels of distress in the cluttered environment. This is reflective of a debate within the literature regarding the emotional relationship between HD and clutter. There is some evidence that healthy participants are likely to experience more acute distress than people with HD in cluttered environments (e.g. Woody et al., 2021), and the concept of ‘clutter blindness’ implies that people with HD can

feel more comfortable in such environments (Frost & Steketee, 2022). However, the same population are also likely to experience higher levels of claustrophobic fear in cluttered environments (McCabe-Bennett et al., 2020a) and findings from studies that have manipulated clutter levels have found that HD participants exhibit higher levels of distress across conditions (Norberg et al., 2023; Woody et al., 2021). This builds a picture of HD as a disorder with high levels of emotional reactivity (McCabe-Bennett et al., 2020b) with marked heterogeneity in terms of emotional response to clutter (Frost & Steketee, 2022).

Strengths and Limitations

Participants identified several limitations related to the VR environment, especially inability to interact with the clutter (e.g. picking it up). Participants reported limited distress because clutter was largely uniform in nature, it did not belong to them and there was no expectation for them to reduce the clutter. In terms of measurement, despite every effort to ensure consistency of experience between the two environments, the rendering process produces possible variability in reaction times score (± 0.016 seconds). Mean scores have been utilised throughout, which should limit the impact of this individual-item variance on overall findings – however, no method was used to quantify the exact speed of rendering and resultant response variability.

Additional weaknesses pertain to data collection which may limit interpretability. The use of single items from the IPQ, rather than the full scale, is likely to have negatively impacted on the validity of findings around how realistic and immersive participants found the VR environment and makes comparison with other VR hoarded environments challenging (e.g. McCabe-Bennett et al., 2020; Chasson et al., 2020). The poor internal reliability demonstrated by the IPQ in this sample is also notable and issues have been found in the literature with the concept of assessing VR presence and realism retrospectively (Graf & Schwind, 2020). Similarly, the use of a different CPT protocol, although necessary for

integration into the VR environment, limits comparability with the Conners-3 utilised by Woody et al. (2021) and Norberg et al. (2023). In terms of participant characteristics, more extensive demographic data, including details of underlying neurocognitive differences (e.g. ADHD history) would have been beneficial to explore variability in the impact of clutter. The use of the HRS-SR to assess presence or absence of hoarding symptoms was also a challenge in this study. Despite initial screening scores being below the clinical threshold, several participants' scores moved above this cut-off in a short space of time, suggesting that the HRS-HS may be measuring changes to life circumstances rather than HD.

Nevertheless, in terms of strengths, this proof-of-concept study enabled a novel and ecologically valid way of testing the impact of HD-related clutter, with significant implications for aetiological understanding and clinical approaches. Although the VR environment built for this study elicited levels of distress that were lower than anticipated, it received excellent user response in terms of perceived realism and sense of presence and so offers an acceptable and feasible approach to recreating hoarded environments.

Directions for Future Research

Further research should be undertaken using VR environments to further examine what within-subject factors contribute to increased distress in cluttered environments. The environment could also be adjusted to include increased interaction and personalisation, to better explore what it is about clutter that is impactful. This is likely to indicate areas of vulnerability that may exacerbate information processing difficulties in such environments. Having shown validity and usability as an environment for cognitive testing, future research should also explore the impact of clutter on other executive functions (e.g. decision-making, categorization) to ascertain whether clutter also exacerbates or maintains HD-related deficits in these areas. The current study suggests that further research using this VR environment with a clinical sample is now clearly indicated.

Conclusion

This proof-of-concept study extends the literature exploring the role of information processing difficulties in HD by examining the impact of high-level clutter in a VR environment on attention in a sample of healthy participants. Participants experienced the VR environment as realistic and immersive and experienced significantly more distress in the cluttered environment. Participants had slower mean reaction times and more omission errors in the cluttered environment on a CPT, with no change in commission errors. Although average levels of distress were not high, within-subject increase in distress was associated with greater deterioration in reaction time and omission errors on the X-CPT. These findings are important for the evolution of the CBT model for HD, as they suggest bidirectionality between clutter and inattention, with clutter therefore also acting as a maintaining factor in HD. It also supports the feasibility of using VR as an ecologically valid and effective tool for potential exposure to clutter discard in future clinical outcome studies. Future research in clinical samples should focus on exploring the impact of clutter on other executive functions, understanding heterogeneity in emotional responses to clutter and better understanding the moderating role of distress in the impact of clutter.

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Appendices

Appendix A: Ethical approval letter



Downloaded: 08/02/2024
Approved: 06/11/2023

Rachel Belin
Registration number: 210154777
Psychology
Programme: Doctorate in Clinical Psychology

Dear Rachel

PROJECT TITLE: The Impact of Clutter on Executive Function
APPLICATION: Reference Number 056627

On behalf of the University ethics reviewers who reviewed your project, I am pleased to inform you that on 06/11/2023 the above-named project was **approved** on ethics grounds, on the basis that you will adhere to the following documentation that you submitted for ethics review:

- University research ethics application form 056627 (form submission date: 31/10/2023); (expected project end date: 31/05/2025).
- Participant information sheet 1127967 version 2 (07/10/2023).
- Participant consent form 1127968 version 2 (07/10/2023).

If during the course of the project you need to [deviate significantly from the above-approved documentation](#) please inform me since written approval will be required.

Your responsibilities in delivering this research project are set out at the end of this letter.

Yours sincerely

Department Of Psychology Research Ethics Committee
Ethics Administrator
Psychology

Please note the following responsibilities of the researcher in delivering the research project:

- The project must abide by the University's Research Ethics Policy: <https://www.sheffield.ac.uk/research-services/ethics-integrity/policy>
- The project must abide by the University's Good Research & Innovation Practices Policy: https://www.sheffield.ac.uk/polopoly_fs/1.6710661/file/GRIPPolicy.pdf
- The researcher must inform their supervisor (in the case of a student) or Ethics Administrator (in the case of a member of staff) of any significant changes to the project or the approved documentation.
- The researcher must comply with the requirements of the law and relevant guidelines relating to security and confidentiality of personal data.
- The researcher is responsible for effectively managing the data collected both during and after the end of the project in line with best practice, and any relevant legislative, regulatory or contractual requirements.

Appendix B: Participant information sheet



Participant Information Sheet: The Impact of Clutter on Executive Functioning

You are being invited to take part in a research project. Before you decide whether or not to participate, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Purpose of the project

The aim of this study is to explore the impact of varying amounts of environmental clutter on a person's attention and executive function. This will help to inform our understanding of mental health difficulties relating to clutter, including hoarding disorder. The study is being completed as part of the main researcher's training in clinical psychology, but may also be published in scientific journals to enhance current research on this topic.

Why am I being invited?

This study is focused on non-clinical participants, and it is believed that you:

- Are aged 18 years or over
- Have no history of motion sickness
- Have no existing or suspected neurological conditions
- Have no current mental health difficulties including a diagnosis or clinically significant symptoms of hoarding disorder
- Do not engage with online gaming for 20+ hours per week

We are hoping to recruit around 45 participants for this study, after which there will be no further recruitment.

Do I have to take part?

No. The decision to take part in this study is up to you. You may wish to discuss this information sheet with friends or family before agreeing to take part, or ask further questions of the research

team. If you wish to do so, please contact: rachel.belin@sheffield.ac.uk / m.simmonds-buckley@sheffield.ac.uk / Stephen.kellett@nhs.net.

If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You can also change your mind about participating up to the point that you have completed the tasks. Withdrawal after this point will not be possible due to the anonymisation of data. There will be no negative consequences to your withdrawal, and you do not have to give a reason.

Please note that by agreeing to participate in this study, this will **not** create a legally binding agreement or employment contract.

What will happen to me if I take part? What will I have to do?

The first part of the study will require you to complete two questionnaires. Once complete, you will be set up with the virtual reality headset and be asked to navigate around a house with 3 rooms. In the final room, you will be asked to complete a task on a screen within the virtual reality environment. This process will then be repeated in a similar virtual house with 3 similar rooms. During this time, your task responses will be recorded and the virtual reality headset will also record your brain activity and eye movements. It is expected that the completion of the two tasks will take around 30 minutes.

What are the possible benefits of taking part?

While there may not be any immediate benefit to taking part, the current study hopes to inform future research and improve understanding and treatment of hoarding disorder. On completing the study, you will also be eligible for either research credits via SONA or a £5 Amazon gift voucher.

What are the possible risks of taking part?

It is possible that the use of the virtual reality headset will trigger an episode of motion sickness. The environment is not fast-paced – this risk is therefore minimal, but it is important that you are made aware of this risk before agreeing to continue. If this happens, it is important that you let the main researcher know and you can stop the task at any time.

It is also possible that you could find the virtual reality environment distressing due to the level of clutter. It is anticipated that this will pass after leaving the environment. However, if you are in any way upset by the experience or continue to experience distress, it is important that you access support around this. If you are a member of the University of Sheffield, you can reach out to the Student Mental Health, Counselling and Therapies Service (mentalhealthcounselling@sheffield.ac.uk ; 0114 222 4134). Alternatively, you can access Sheffield Talking Therapies (<https://www.sheffieldtalkingtherapies.nhs.uk/>) where you can also find a range

of self-help resources, or services at Sheffield Mind (<https://www.sheffieldmind.co.uk/>). If you have further questions or concerns about hoarding behaviours, please go to <https://hoardinguk.org/>

How will you use information about me?

All information you provide to this study will be kept strictly confidential. Your consent form and demographic questionnaire will be kept securely in the University of Sheffield Clinical and Applied Psychology Unit. All data collected by the virtual reality headset will be anonymised and stored in encrypted files. These will only be accessible to people in the research team involved in the analysis of the data during the completion of the research project. At the end of the project, the data will be used to submit a report for publication. As it is anonymised, you will not be able to be identified from any reports or publications. If you wish to receive a copy or be notified when the research is complete, please let the researcher know.

Once the study is complete, anonymised data will be submitted to the University of Sheffield's Online Research Data Repository where it will be accessible to other researchers and third parties. Again, this information will not allow any individuals to be identified.

Your email address will be obtained from your consent form and shared with University of Sheffield finance department to allow for an Amazon voucher to be issued. The finance department will retain this email address and confirmation of receipt of the voucher securely for 10 years.

Who is organising and funding the research?

The research is sponsored by the University of Sheffield as part of the lead researcher's training in Clinical Psychology.

Who is the data controller?

The University of Sheffield will act as the Data Controller for this study. This means that the University is responsible for looking after your information and using it properly. In order to collect and use your personal information as part of this research project, we must have a basis in law to do so, under the General Data Protection Regulations (GDPR).

The basis that we are using is that the research is 'a task in the public interest'. As we will be collecting some data that is defined in the legislation as more sensitive (information about your health) we also need to let you know that we are applying an additional 20 condition in law: that the use of your data is 'necessary for scientific or historical research purposes'.

Further information, including details about how and why the University processes your personal information, how we keep your information secure, and your legal rights (including how to complain if you feel that your personal information has not been handled correctly), can be found in the University's Privacy Notice <https://www.sheffield.ac.uk/govern/dataprotection>

Who has ethically reviewed this project?

This research has received approval from the University of Sheffield Research Ethics Committee.

What if something goes wrong or I want to make a complaint?

If you are dissatisfied with any aspect of the research and wish to make a complaint, please contact Rachel Belin (rbelin1@sheffield.ac.uk) in the first instance. If you feel your complaint has not been handled in a satisfactory way you can contact the research supervisors (Dr Melanie Simmonds-Buckley – m.simmonds-buckley@sheffield.ac.uk; Dr Stephen Kellett – Stephen.kellett@nhs.net) or the Head of the Department for Psychology (Dr Chris Martin – psy-hod@sheffield.ac.uk).

If the complaint relates to how your personal data has been handled, you can find information about how to raise a complaint in the University's Privacy Notice:
<https://www.sheffield.ac.uk/govern/data-protection/privacy/general>.

If you wish to make a report of a concern or incident relating to potential exploitation, abuse or harm resulting from your involvement in this project, please contact the project's Designated Safeguarding Contact (Dr Melanie Simmonds-Buckley - m.simmonds-buckley@sheffield.ac.uk). If the concern or incident relates to the Designated Safeguarding Contact, or if you feel a report you have made to this Contact has not been handled in a satisfactory way, please contact the Head of the Department for Psychology (Dr Chris Martin – psy-hod@sheffield.ac.uk) and/or the University's Research Ethics & Integrity Manager (Lindsay Unwin; l.v.unwin@sheffield.ac.uk).

Appendix C: Consent form



The Impact of Clutter on Executive Function: Consent form

One copy of this consent form should be retained and one given to the participant

Please tick the appropriate boxes	Yes	No
Taking Part in the Project		
I have read and understood the project information sheet dated DD/MM/YYYY or the project has been fully explained to me. (If you will answer No to this question please do not proceed with this consent form until you are fully aware of what your participation in the project will mean.)	☐	☐
I have been given the opportunity to ask questions about the project.	☐	☐
I agree to take part in the project. I understand that taking part in the project will include - The completion of questionnaires - Using a virtual reality headset to navigate different environments and complete a task in each environment	☐	☐
I agree to my data being collected. This will include: - Information about my demographics (age, gender, ethnicity) - Questionnaire scores - Task scores		
I understand that my taking part is voluntary and that I can withdraw from the study at any time until I have completed all the tasks. I do not have to give any reasons for why I no longer want to take part and there will be no adverse consequences if I choose to withdraw. I understand that once I have completed the study I will not be able to withdraw due to the anonymisation of data.	☐	☐
How my information will be used during and after the project		
I understand my personal details such as name, phone number, address and email address etc. will not be revealed to people outside the project.	☐	☐
I understand and agree that other authorised researchers will have access to this data only if they agree to preserve the confidentiality of the information as requested in this form.	☐	☐
I understand and agree that other authorised researchers may use my anonymised data in publications, reports, web pages, and other research outputs, only if they agree to preserve the confidentiality of the information as requested in this form.	☐	☐
I give permission for anonymised data to be deposited in ORDA so it can be used for future research and learning. This will be the information about my demographics, questionnaire and tasks scores that I provide.	☐	☐
I would like to be notified when the study is complete and be signposted to any publications.		
So that the information you provide can be used legally by the researchers		
I agree to assign the copyright I hold in any materials generated as part of this project to The University of Sheffield.	☐	☐

Name of participant [printed]

Signature

Date

Name of Researcher [printed]

Signature

Date

The template of this consent form has been approved by the University of Sheffield Research Ethics Committee and is available to view here: <https://www.sheffield.ac.uk/rs/ethicsandintegrity/ethicspolicy/further-guidance/homepage>

Appendix D: Demographics Questionnaire



Participant Questionnaire

ID number:

Age:

Gender: ☐ Male ☐ Female ☐ Non-binary ☐ Prefer not to say

Ethnicity:

Asian or Asian British

- ☐ Indian
☐ Pakistani
☐ Bangladeshi
☐ Chinese
☐ Any other Asian background

Black, Black British, Caribbean or African

- ☐ Caribbean
☐ African
☐ Any other Black, Black British or Caribbean background

Other ethnic group

- ☐ Arab
☐ Any other ethnic group

Mixed or multiple ethnic groups

- ☐ White and Black Caribbean
☐ White and Black African
☐ White and Asian
☐ Any other mixed heritage background

White

- ☐ British, English, Welsh, Scottish, Northern Irish
☐ Irish
☐ Gypsy or Irish Traveller
☐ Roma
☐ European
☐ Any other white background

☐ Prefer not to say

Highest level of educational qualification:

- ☐ No qualifications
☐ GCSE
☐ Apprenticeship
☐ AS-level
☐ A-level
☐ Undergraduate degree

- ☐ Masters degree
☐ Doctorate
☐ Post-doctoral qualifications
☐ Vocational qualifications
☐ Qualifications obtained outside UK:

.....

Do you take part in online gaming? If so, how many hours do you do this per week?

Have you used Virtual Reality environments before? Yes / No

If yes, how often do you use this?

- ☐ Daily
- ☐ Weekly
- ☐ Monthly
- ☐ Less than monthly
- ☐ Only used it once

Appendix E: Hoarding Rating Scale – Self-Report

Hoarding Rating Scale

Please use the following scale when answering items below:

- 0 = no problem
 2 = mild problem, occasionally (less than weekly) acquires items not needed, or acquires a few unneeded items
 4 = moderate, regularly (once or twice weekly) acquires items not needed, or acquires some unneeded items
 6 = severe, frequently (several times per week) acquires items not needed, or acquires many unneeded items
 8 = extreme, very often (daily) acquires items not needed, or acquires large numbers of unneeded items

1. Because of the clutter or number of possessions, how difficult is it for you to use the rooms in your home?

0	1	2	3	4	5	6	7	8
Not at all		Mild		Moderate		Severe		Extremely
Difficult								Difficult

2. To what extent do you have difficulty discarding (or recycling, selling, giving away) ordinary things that other people would get rid of?

0	1	2	3	4	5	6	7	8
No		Mild		Moderate		Severe		Extreme
difficulty								Difficulty

3. To what extent do you currently have a problem with collecting free things or buying more things than you need or can use or can afford?

0	1	2	3	4	5	6	7	8
None		Mild		Moderate		Severe		Extreme

4. To what extent do you experience emotional distress because of clutter, difficulty discarding or problems with buying or acquiring things?

0	1	2	3	4	5	6	7	8
None/ Not at all		Mild		Moderate		Severe		Extreme

5. To what extent do you experience impairment in your life (daily routine, job / school, social activities, family activities, financial difficulties) because of clutter, difficulty discarding, or problems with buying or acquiring things?

0	1	2	3	4	5	6	7	8
None/ Not at all		Mild		Moderate		Severe		Extreme

Appendix G: Clutter Image Rating Scale

Clutter Image Rating Scale: Kitchen

Please select the photo below that most accurately reflects the amount of clutter in your room.



1



2



3



4



5



6



7



8



9

Appendix F: IGroup Presence Questionnaire

English IPQ Items

Number	IPQ item name	loading on ...	English question	English anchors (-3 to +3)	Copyright (item source)
1	G1	PRES	In the computer generated world I had a sense of "being there"	not at all-- very much	Slater & Usoh (1994)
2	SP1	SP	Somehow I felt that the virtual world surrounded me.	fully disagree-- fully agree	IPQ
3	SP2	SP	I felt like I was just perceiving pictures.	fully disagree-- fully agree	IPQ
4	SP3	SP	I did not feel present in the virtual space.	did not feel-- felt present	???
5	SP4	SP	I had a sense of acting in the virtual space, rather than operating something from outside.	fully disagree-- fully agree	IPQ
6	SP5	SP	I felt present in the virtual space.	fully disagree-- fully agree	IPQ
7	INV1	INV	How aware were you of the real world surrounding while navigating in the virtual world? (i.e. sounds, room temperature, other people, etc.)?	extremely aware-- moderately aware--not aware at all	Witmer & Singer (1994)
8	INV2	INV	I was not aware of my real environment.	fully disagree-- fully agree	IPQ
9	INV3	INV	I still paid attention to the real environment.	fully disagree-- fully agree	IPQ

10	INV4	INV	I was completely captivated by the virtual world.	fully disagree-- fully agree	IPQ
11	REAL1	REAL	How real did the virtual world seem to you?	completely real--not real at all	Hendrix (1994)
12	REAL2	REAL	How much did your experience in the virtual environment seem consistent with your real world experience ?	not consistent-- moderately consistent-- very consistent	Witmer & Singer (1994)
13	REAL3	REAL	How real did the virtual world seem to you?	about as real as an imagined world-- indistinguishable from the real world	Carlin, Hoffman, & Weghorst (1997)
14	REAL4	REAL	The virtual world seemed more realistic than the real world.	fully disagree-- fully agree	IPQ

Note. Highlighted items used with study participants. Full measure used with pilot participants. PRES=overall presence. SP=spatial presence. INV=involvement. REAL=experienced realism.

Appendix G: Subjective Units of Distress

The distress thermometer – Subjective Units of Distress Scale (SUDS)

Try to get used to rating your distress, fear, anxiety or discomfort on a scale of 0-100. Imagine you have a 'distress thermometer' to measure your feelings according to the following scale. Notice how your level of distress and fear changes over time and in different situations.

