Zephyr: Exploring Digital Behaviour Change Interventions to Treat Hoarding

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Abstract
Hoarding disorder is a complex condition that has attracted little research attention, despite adversely affecting 2-5% of the population. We review the options and difficulties in the treatment of hoarding disorder using technology. We present a novel intervention design, delivered on tablets, that combines a Cognitive Bias Modification game with goal tracking functionality. We outline two experiments in progress: a lab study to measure the impact of our game on a non-hoarding population, and a probe study to determine the suitability of the intervention for participants with hoarding disorder.

Author Keywords
Nonconscious behaviour change using technology; hoarding; cognitive bias modification; goal setting.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Hoarding is the continuous acquisition of extra useless possessions together with the inability to discard objects with limited value [6]. It has received little research attention within the generalised space of behaviour change, let alone within the Human-

Computer Interaction behaviour change community. This is partly because hoarding has only recently (2013) been classed as a separate disorder to Obsessive Compulsive Disorder (OCD) by the American Psychiatric Association (APA) in their Diagnostic and Statistical Manual of Mental Disorders (DSM-5, [2]). It is also difficult to engage with potential research participants: sufferers tend to be socially isolated and have significant co-morbidities with other mental health disorders [19]. Hoarding disorder is considered "notoriously difficult to treat" [23], partly because there is no agreement on an underlying cause.

Nevertheless, hoarding disorder is relatively prevalent and has a serious adverse impact on sufferers. Around 2-5% of the population may be affected by the disorder [15,18]. Sufferers may become unable to function in their homes due to clutter and it can threaten physical health, particularly the health of elderly hoarders [19]. The scale of clutter also makes the introduction of digital behaviour change intervention (DBCIs) difficult: any technology introduced into the home runs the risk of becoming part of the sufferer's collection of items.

The goal of our research is to develop a DBCI that is effective within a hoarding context. To that end, we have worked closely with Clouds End [26], a UK Community Interest Company (CIC) that supports people with hoarding issues and provides services to organisations who deal with them.

Hoarding constitutes a substantial public health burden [22], since official agencies including local authorities and fire services have legal obligations to deal with hoarders but limited resources with which to do so [4]. Low-cost, short-term interventions such as the removal of clutter are commonly used, but they do not treat the underlying issue and hoarding behaviours thus tend to re-occur [3,22].

We have instead designed a low-cost intervention that can be delivered on a tablet. The intention is designed such that hoarders can complete their own training in their own homes with minimal human support.

Related work

There is no agreed effective treatment for hoarding and there are few experts working with sufferers. It has often been treated in the same way as OCD, primarily with anti-obsessional medications and cognitive-behavioural therapy (CBT). The effectiveness of this treatment has been poor [19]. Although one recent small-scale study indicates that 12 CBT sessions *in situ* may improve outcomes [10], such approaches are labour-intensive and therefore costly.

Several neuropsychological studies have shown that hoarders have impaired attention, motivation, executive control and decision making [8,19,23]. We therefore examined approaches to treat similar issues in other domains to determine what might be transferable to a DBCI hoarding intervention that does not require expensive personpower to implement.

Targeting impaired attention

One tool to retrain attention is Cognitive Bias Modification (CBM) for attention (CBM-A). There is evidence that biases affecting attention can be altered by requiring participants to practice alternative cognitive paths (or biases) [9]. Implementations of CBM-A are starting to emerge in DBCIs (e.g. [16,20])

as part of interest in nonconscious behaviour interventions [1,17].

One method of CBM-A is by using a Dot Probe Test (DPT) [14]. Participants are required to respond as quickly as possible to the appearance of a cue (e.g. a dot or a letter on a screen) which follows the display of two words – one meaningful to the bias under training and one benign. The location of the target (either mostly contiguous with the meaningful word or mostly contiguous with the benign words) can be used to train participants to attend or not attend to the relevant words [14].

Another method of CBM-A is image attentional training: participants are asked to quickly locate a target picture within a grid of distractors. Dandeneau et al. [5] trained socially anxious participants to select the one photo of a smiling face within a grid of 15 hostile faces and found that the training had the greatest effects on participants with low self-esteem.

We discussed appropriate interventions with a hoarding disorder expert, Heather Matuozzo, who runs Clouds End. Based on a wealth of experience working with hoarders, Heather believes that hoarders' environments tend to be self-reinforcing, and that CBM-A could be beneficial to train people to attend to their environment differently. We therefore developed a DBCI that uses image attentional training to encourage participants to divert their attention away from their hoards towards tidier spaces.

Targeting executive control, decision making and motivation

Heather works with clients to define small areas as targets for decluttering goals. Alongside this established approach, there is evidence that hoarders have a reduced ability to develop a consistent decluttering strategy [8] and that hoarders tend to avoid decluttering behaviour [23]. We therefore concluded that goal tracking functionality could be beneficial.

Goal-setting theory (GST) emphasises that hard, specific goals are more effective than easy, vague ones; that goals needed to be accepted and understood by participants; and that feedback on goal progress is important [12]. We therefore implemented a version of the pre-existing target area selection process in our DBCI, also providing feedback in line with GST

The goal tracking functionality addresses malfunctions in executive control by providing a consistent reminder to participate in decluttering behaviour. It addresses decision-making deficits by asking participants to select a small specific area to focus on. Finally, it boosts motivation by providing feedback.

Intervention design

We built our DBCI on tablets for several reasons: we wanted a low-cost, easily portable intervention platform, and tablets are more difficult to misplace in a cluttered environment than smartphones. We wanted to deliver our interventions using the relatively larger screen size of the tablet to make it more likely that image detail was clear to participants.

We named our DBCI "Zephyr" to indicate a gentle, non-threatening approach to hoarding participants. Zephyr has two parts: a training game and a goal tracking function.

Training game

Our CBM-A training game is shown in Figure 1. It is based on the social anxiety training of Dandeneau et al. [5] with some minor modifications (a) to the images to adapt them to the domain of hoarding and (b) to the image numbers and size for use on a tablet.

We used a 3x3 image selection grid with images 175dp square to ensure that image details were clear.

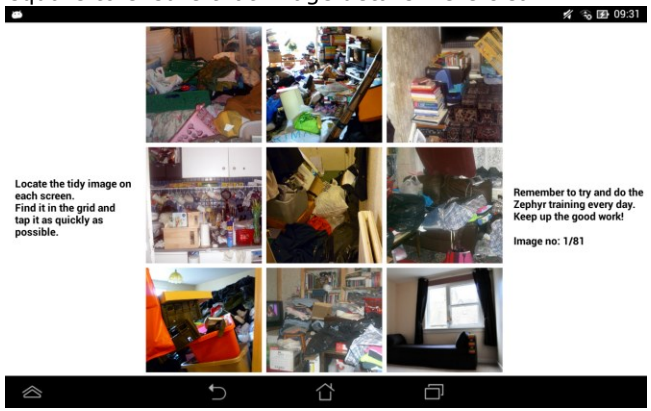

Figure 1 Training game screenshot

Participants are asked to locate and tap the one tidy image in a grid of 9 images: the other images are of cluttered spaces. Each target image is shown once in each of the 9 image locations, making 81 grids in each training session. In contrast to the Dandeneau et al. experiment [5], all images are presented in colour to preserve clutter detail and to present a more realistic scenario to participants. Completion of the training tasks prompts participants to move on to the goal tracking function.

Goal tracking function

During a pre-intervention training phase, participants are asked to select a target area within their homes for decluttering. After each training session, this function prompts participants to use the tablet's camera function to take a photograph of their target area. The tablet then displays a thumbnail of the photo and participants are asked to drag the thumbnail onto an image scale based on the Clutter Image Rating (CIR) scale [7] to indicate progress (or otherwise) in tidying the target area. The CIR is a series of photographs labelled 1-9 that is commonly used to rate clutter severity [6], and it is a scale familiar to the hoarders with whom Clouds End works.

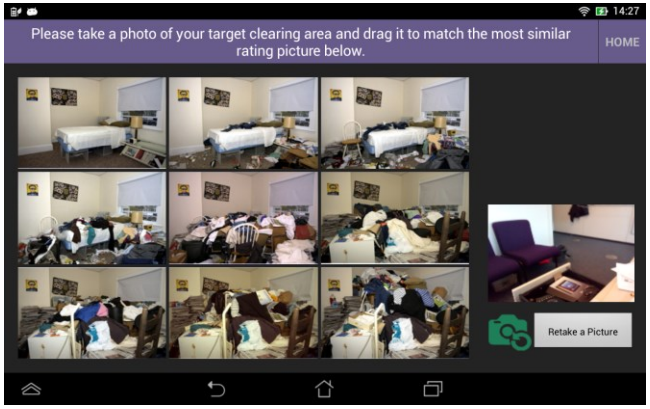

Figure 2 Goal tracking screenshot. CIR images [21] © Oxford University Press, featured by permission of Oxford University Press, USA, www.oup.com.

After rating, participants receive feedback on their progress: a short motivational statement if their clutter has either got worse or not improved; a congratulatory statement if their clutter has reduced; and a request to select a new target area if their clutter rating is 1 (the lowest on the scale, i.e. the area is clutter-free).

Experiment protocol

We have designed a two-stage experimental approach:

- Experiment 1 – lab test. Our research question is: does one session of our training game change measures of cognitive activation in a non-hoarding population?
- Experiment 2 – in-the-wild probe run by Clouds End. The research question is: is an 8-week intervention with hoarders asked to complete daily training and goal tracking tasks on tablets an acceptable intervention?

Evaluation

The gold standard for determining the efficacy of any DBCI is a measure of long-term behavioural change. However, such data is difficult to capture [11], especially in this domain where hoarders are difficult to recruit.

We therefore determined some interim measures to evaluate our DBCI in the lab. We need to assess whether our intervention has an impact on the relative attention paid to 'tidy' concepts versus 'hoarding' concepts. We have designed both an emotional Stroop test [25] and a modified Dot Probe Test (DPT, [13]) as a measure of the efficacy of our approach on emotional reactance to hoarding-related words. In the emotional Stroop test, participants are asked to name the colours of 3 sets of words: hoarding-related (clutter words), tidy-related words and neutral words. A DPT can be used to measure bias as well as to treat it. In our DPT, participants are measured on their reaction times to letters that appear in one location on a screen after having been shown two words from the 3 word sets (cluttered, tidy and neutral).

We decided against testing the goal tracking function on our non-hoarding lab participants because it is meaningless in the context of a one-session lab test.

In the in-the-wild probe run by Clouds End, participants complete a pre- and post-intervention CIR. Following the intervention, participants undertake a structured interview to explore the suitability of the approach. During the intervention, reaction time data is monitored for the training game for both groups.

Experiment 1 details

Target numbers for the lab experiment are 30: 15 in an intervention group and 15 in a control group. Participants are drawn from a population of students and staff at the University of Birmingham, in return for a small monetary gift. All participants complete a brief demographics and hoarding questionnaire. They then complete an emotional Stroop test and a DPT as outlined above as pre-test measures.

Participants then complete one of two interventions on a tablet: intervention group participants (n=15) complete the CBM-A training game, while the control group complete a CBM-A intervention with the same functionality where target photos are five-petalled flowers within a grid of seven-petalled flowers (replicating the control group of similar research [5]).

The trials are presented in one block with no breaks to better replicate the in-the-wild procedure where participants are asked to complete the task in one go. Participants then retake the emotional Stroop and DPT tests as post-intervention measures.

Experiment 2 details
Clouds End are currently recruiting 10 hoarders to trial the intervention. Each participant will receive a tablet and be asked to complete the training game and goal tracking function at least once a day for a period of 4 weeks. They will receive notifications to remind them to complete the tasks. Participants will be free to withdraw at any time and will have emergency phone numbers for support if necessary.

Discussion & future work

Our first step is to complete our lab experiments and analyse the data. Experiment 1 will indicate whether the training game has an impact on cognitive variables in the short term. Experiment 2 will indicate whether a long-term intervention using tablets is viable for participants suffering from hoarding disorder.

If we can determine that the intervention both has a short-term impact and is acceptable as a longer-term intervention for hoarders then we will seek funding to conduct a larger-scale trial.

One major issue is the grey area surrounding the applicability of CBM-A to hoarding. This is a general problem for CBM techniques: it is not known which biases should be tackled for any given emotional or behavioural problem, nor which CBM techniques work best, nor whether the biases should be tackled individually or together [24].

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