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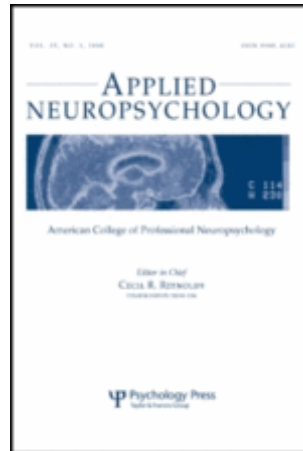
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# Self-reported memory and executive function in adult non-clinical hoarders.

Tom Heffernan<sup>1\*</sup>, Colin Hamilton<sup>1</sup> & Nick Neave<sup>1</sup>

1 Hoarding Research Group, Faculty of Health & Life Sciences, Northumbria University,  
Newcastle upon Tyne, NE1 8ST

Corresponding author: Tom Heffernan, Department of Psychology, Faculty of Health & Life Sciences, Northumbria University, Newcastle upon Tyne, NE1 8ST; email [tom.heffernan@northumbria.ac.uk](mailto:tom.heffernan@northumbria.ac.uk)

## ABSTRACT

Hoarding is the excessive acquisition of, and failure to discard of, large numbers of items, leading to personal distress. Impairments on memory and executive functions have been systematically associated with hoarding behavior, predominantly focusing upon clinical (mainly middle-aged-elderly) patients with hoarding and/or PTSD. We were interested in hoarding-related memory and executive problems in younger non-clinical hoarders or non-hoarders, based on their *Saving Inventory-Revised* scores. In total, 113 young adults (aged 18 – 35 years) were assigned to either a hoarder group (N=40) or non-hoarder group (N=73) determined by their scores on the *Saving Inventory-Revised* (SI-R). Working memory (WM) and inhibition control (IC) were measured using the *Adult Executive Functioning Inventory* (ADEXI) and the *Dysexecutive Questionnaire Revised* (DEX-R) measured general executive function (EF). The *Hospital Anxiety and Depression Scale* measured anxiety and depression. After controlling for gender and anxiety, the analysis revealed that the hoarders reported significantly more problems than the non-hoarders on both the IC and general EF. There was no significant between-group difference on the WM sub-scale ADEXI. Self-reported deficits in IC and EF are associated with hoarding behaviour. The IC deficits could explain hoarders' inability to resist urges to buy, and general EF deficits suggest other domains are involved.

**Key words:** Hoarding; Mood; Executive Function; Working Memory.

**Abstract:** 228 words.

**Total Manuscript Length:** 5199 words

## INTRODUCTION

Everybody accumulates possessions over their lifetime, and many of these items are given sentimental value. Indeed, humans show a strong tendency to collect or hoard possessions; such behavior may be adaptive by ensuring survival when resources become scarce (Grisham & Barlow, 2005). However, in a minority of cases this normal hoarding tendency becomes pathological, and the person hoards uncontrollably (Frost, Tolin, Steketee, Fitch, & Selbo-Bruns, 2009). Hoarding behaviors are characterized by the acquisition of, and failure to discard a large number of items that are of limited value. As a result, items accumulate causing living spaces to be cluttered, unusable, and, in some cases, unsafe. Hoarding causes significant distress or impairment in everyday functioning (American Psychiatric Association, 2013; Frost & Gross, 1993). Symptoms of hoarding begin in the middle teens but recognition that there may be a problem occurs around a decade later; a stressful event may precipitate hoarding in late adulthood (Grisham, Frost, Steketee, Kim & Hood, 2006). Estimates of the prevalence of hoarders have been reported to 2-5% (Pertusa, Frost, Fullana et al., 2010) and 1-6% (Samuels, Bienvenu, Grados et al., 2008), making it relatively common.

Over time, hoarding behaviors render living spaces uninhabitable due to excessive clutter. Normal household activities become difficult to maintain, and there is an increase in the risk of personal injury due to fire/toppling hazards and poor sanitation. The inability to use one's home as intended, and embarrassment about the clutter, tends to restrict social access, and hoarders are typically socially isolated, and are less likely to be co-habiting or married (Tolin, Frost, Steketee, Gray, & Fitch). This social isolation can be compounded by a range of other comorbid mental health conditions such as obsessive-compulsive disorder, schizotypal personality traits, social phobia, and anxiety/depression (Nutley, Camacho, Eichenbaum, Roane, et al., 2021; Roane, Landers, Sherratt, & Wilson, 2017).

Research assessing possible neuropsychological/cognitive deficits associated with hoarding behaviors have been strongly influenced by the Cognitive-Behavioral Model (CBM) proposed by Frost & Hartl (1996). The model hypothesizes three types of information processing deficits experienced by individuals who hoard. Firstly, hoarders display decision-making deficits, as they consistently avoid making decisions, or postpone making decisions, perhaps due to the fear of making mistakes (Warren & Ostrom, 1988). Subsequent research has shown strong links

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3 between hoarding and indecisiveness, and with perfectionism (Frost, Marten, Lahart & Rosenblate,  
4 1990; Frost & Shows, 1993). They also report more symptoms of inattention and hyperactivity  
5 (Hartl et al., 2005).  
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9 Secondly, hoarders show deficits in categorization and organization which renders it very  
10 difficult for them to organize, store and arrange their possessions. Rather than a lack of  
11 organization, hoarders seem to overextend organizational categories such that single books for  
12 example are regarded as being 'unique' and are thus stored separately from all other books. This  
13 results in piles of seemingly disorganized clutter. When asked to organize their possessions  
14 hoarders engage in 'churning', simply moving one item to another pile of items (Frost & Hartl,  
15 1996). In support, Wincze, Steketee & Frost (2007), found that hoarders created a large number of  
16 categories and experienced high levels of anxiety when asked to categorize personally-relevant  
17 items. In terms of categorization, hoarders appear to treat all of their items in the same manner,  
18 being unable to distinguish between high-value/important items and low value/unimportant items.  
19 This may be related to their tendency to 'anthropomorphize', i.e., to treat items as if they have  
20 human emotions and feelings (Neave, Jackson, Saxton, & Hönekopp (2015).  
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31 Finally, hoarders display difficulties with memory. They show a marked lack of confidence  
32 in their memory abilities and appear to overestimate the importance of remembering or recording  
33 information (which may be associated with perfectionism). For example, compulsive hoarders  
34 with OCD had poorer delayed visual and verbal recall, and used less effective organizational  
35 strategies for visual recall, they also displayed less confidence in their memory and greater worry  
36 about the consequences of forgetting (Hartl, Frost, Allen et al., 2004).  
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42 Case studies of individuals who began collecting 'useless' items following brain damage  
43 suggest that such information-processing deficits may be related to frontal lobe dysfunction  
44 (Anderson, Damasio, & Damasio, 2005; Wood, & Worthington, 2017). It could therefore be  
45 supposed that deficits in executive functioning might be underlying the key cognitive/behavioural  
46 symptoms of hoarding disorder. This certainly appears to be the case for elderly hoarders. In one  
47 study Ayers, Wetherell, Schiehser et al., (2013) examined executive function in geriatric hoarders.  
48 Compared to age-matched healthy controls the hoarders showed significant impairments on the  
49 Wisconsin Card Sort Task and on the Wechsler Adult Intelligence Test digit span and letter-  
50 numbering tasks, with the severity of hoarding symptoms correlating positively with executive  
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3 impairment. In other hoarding patient groups Grisham, Brown, Savage, Steketee & Barlow (2007)  
4 reported that hoarding patients experienced difficulties in identifying targets and non-targets,  
5 showed deficits in spatial attention, displayed slower and more variable reaction times, increased  
6 impulsivity and impaired spatial attention. In a follow-up study Grisham, Norberg, Williams,  
7 Certoma, & Kadib (2010) also found executive deficits in planning, categorization, and decision-  
8 making, as well as attentional difficulties in hoarders in comparison with non-clinical controls.  
9 While Tolin, Villavicencio, Umbach & Kurtz (2011) found no impairments in executive  
10 functioning in hoarders, they did report that hoarders had problems with sustained attention and  
11 memory strategies. To date, the evidence suggest that those domains most affected by hoarding  
12 are attention, memory, cognitive flexibility, cognitive inhibition, planning, problem solving and  
13 organization/categorization (Gledhill, Bream, Drury, & Onwumere, 2020; Woody, Kellman-  
14 McFarlane, & Welsted, 2014). Deficits in decision making, cognitive inhibition, and  
15 categorization appear to worsen with greater hoarding severity (Dozier, Wetherell, Twamley,  
16 Schiehser, & Ayers, 2016; Grisham, Norberg, Williams, Certoma, & Kadib, 2010; Mackin, Areán,  
17 Delucchi, & Mathews, 2011; Tolin et al., 2012).

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30 The research described previously has reported consistent associations between hoarding  
31 behaviors and executive impairments in clinical patient groups, the majority of such patients being  
32 middle-aged to elderly. We are interested in the extent to which such executive problems might  
33 exist in younger individuals, and in community samples for whom clinical diagnoses of hoarding  
34 have not been made. The aim of this study was thus to examine possible associations between  
35 hoarding severity, working memory and executive impairments, including cognitive inhibition, in  
36 a non-clinical sample of younger adults. As executive dysfunction is often seen in individuals  
37 diagnosed with anxiety disorders and depression (e.g. Mantella, Butters, Dew et al., 2007;  
38 Thompson, Hamilton, et al., (2006), and as depression and anxiety are often reported in clinical  
39 cases of hoarding (Frost, Steketee & Tolin, 2011) we included a measure of anxiety and depression  
40 in our survey.  
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## METHODS

### Design

As the primary aim of the current study was to determine the relationship between hoarding and executive function, the current sample employed a non-experimental, quantitative between-groups design, comparing non-clinical hoarders with non-hoarders. Age, gender, HADS (Depression and Anxiety scores) were employed as control variables. Outcome variables were the ADEXI-Working Memory, ADEXI-Inhibitory Control, and the DEX-R measure. Demographic data was comprised of age and gender of participant. The *Saving Inventory-Revised* was used to measure hoarding symptoms and was used to create the Hoarder and Non-Hoarder groups. The Adult Executive Functioning Inventory measured working memory and inhibition, and the *Dysexecutive Questionnaire Revised Adult Executive Functioning Inventory* measured global executive function. Finally, the *Hospital Anxiety and Depression Scale* provided a measure of anxiety and depression states.

### Participants

Participants for the study were recruited through canvassing students and asking for their help within a large lecture-based class at a North-East University. All participants were unpaid volunteers who studied on the Foundation Year at the university. From a sample of 113, forty cases who met the criteria for the hoarding group and seventy-three were non-hoarders. Hoarding status was determined by scores on the *Saving Inventory-Revised* (SI-R). The cut-off scores for the presence of hoarding on the scale were 14 for difficulty discarding, 9 for excessive acquisition, 17 for clutter, and 41 for the total SI-R score (Frost, Steketee & Grisham, 2004). Anyone scoring below these levels were classed as non-hoarders. The hoarding group was made up of 13 males and 27 females and had a mean age of 22.2 years (SD=3.44), whereas the non-hoarding group was made up of 34 males and 39 females and had a mean age of 21.7 years (SD=3.02). Each participant was over the age of 18 years and were all volunteer undergraduate students studying at a university in the North of England. Each participant provided written consent and was tested individually in a quiet room at the university. Testing was carried out by the administering of a series of questionnaires, which were administered in the same order.



## Materials

To measure hoarding we used the *Saving Inventory-Revised* (SI-R), A 23-item self-report measure of hoarding symptoms using a 5-point scale. This inventory measures three symptoms of hoarding: excessive acquisition, difficulty discarding items and clutter. Internal consistency is  $\alpha = .92$  and test-retest reliability of  $r = .86$ . The inventory is suitable for use in both clinical and non-clinical populations (Frost, Steketee & Grisham, 2004). The cut-off off scores for the presence of hoarding on the SI-R were 14 for difficulty discarding, 9 for excessive acquisition, 17 for clutter, and 41 for the total SI-R score (Frost, Steketee & Grisham, 2004).

Working memory and inhibition were measured using the Adult Executive Functioning Inventory (ADEXI: Holst & Thorell, 2016). The ADEXI is a 14-item questionnaire measuring working memory and inhibition. Examples of questions include: “I have difficulty remembering length instructions.” And “I have a tendency to do things without first thinking about what could happen.” Each item is rated on a 5 point Likert scale from 1=Definitely Not True; 2=True; 3=Partially True; 4=True and 5=Definitely True. The higher score indicates poorer working memory and cognitive inhibition as a part of executive function.

The Dysexecutive Questionnaire Revised (DEX R) was used as a global measure of executive functioning. The DEX-R is a 37-item self-report questionnaire constructed in order to sample a range of problems commonly associated with impairments to the set of processes that make up the central executive component in memory and is a valid and reliable measure of global executive function (Simblett, Ring, & Bateman, 2017). Examples of the questions included: “I have trouble making decisions.” And “I find it difficult to do or concentrate on two thing at once.” Scoring is based on a 5-point rating scale from 0=Never, 1=Occasionally, 2=Sometimes, 3=Fairly often and 4=Very often. A total score for the rating scale is calculated and the higher the score indicates more executive function problems experienced by the person.

Finally, mood (anxiety and depressed mood) was measured using the Hospital Anxiety and Depression [HADS] Scale (Snaith & Zigmund, 1994). This is a 14-item, self-report scale employing a four-choice response format. Seven items relate to generalized anxiety symptoms and 7 to the loss of interest and diminished-pleasure aspects of depression. The focus is on the last few days. Sample items include “I get a sort of frightened feeling, as if something awful is about to happen” (anxiety) and “I have lost interest in my appearance” (depression). Two separate

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3 scores are obtained, one for anxiety and one for depression. Higher scores on each scale indicate  
4 more severe symptomatology with scores of 8-10 indicating mild problems, 11-14, moderate  
5 problems and 15-21 severe problems.  
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## 11 **Procedure**

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13 Following institutional ethical approval, prospective participants were recruited on campus  
14 asked to participate recruited through advertising via email and advertising at the university where  
15 testing took place. All were volunteers and after being briefed about the study, provided written  
16 informed consent. After providing informed consent they were asked to provide basic demographic  
17 data (age and sex) and were then asked to complete the questionnaires. Each participant completed  
18 the SR-I first, followed by the ADEXI, DEX-R and finally the HADS. The questionnaires were all  
19 presented in the same order as described. On completion all participants were fully debriefed and  
20 provided with confidential helplines for those who may have been concerned about their hoarding  
21 behavior or any mental health issue they may wish to discuss, including The Samaritans, Mind.  
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## 31 **Statistical analysis**

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34 All the data was analysed using SPSS 26. An independent t-test was applied in order to assess  
35 whether the hoarder and non-hoarder group differed in terms of age. Chi-square analysis compared  
36 the gender distribution across the two groups. Two univariate ANOVAs were applied to the data  
37 to compare the two groups on mood (anxiety and depression). Four univariate ANOVAs were  
38 applied the Saving Inventory-Revised subscales to compare the two groups on excessive  
39 acquisition, difficulty discarding items, clutter, and total symptom scores. Finally, three univariate  
40 ANCOVAs, Bootstrapped samples = 5000, were applied to the data to compare the hoarders and  
41 non-hoarders on working memory, inhibition control and global executive function performance  
42 controlling for age, gender, depression, and anxiety.  
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## RESULTS

### Comparisons between Hoarders and Non-Hoarders on non-cognitive measures

Descriptive statistics for measures of age, hoarding sub-types and total hoarding score, as well as HADS anxiety and depression scores, can be found in Table 1. An independent t-test revealed no significant difference between the groups in terms of age ( $t(111) = .768, p = .444$ ). A Chi-Square analysis revealed no significant difference in the number of males and females in the hoarding group (13 males/27 females) and the non-hoarding group (34 males/39 females:  $\chi^2(1) = 2.10, p = .147$ ).

[Insert Table 1 here]

A series of one-way ANOVA's were conducted on the hoarding symptoms. Hoarders scored significantly higher on excessive acquisition ( $F(1,111) = 245, p < .001$ ), difficulty discarding ( $F(1,111) = 301, p < .001$ ), clutter ( $F(1,111) = 280, p < .001$ ) and total hoarding score ( $F(1,111) = 511, p < .001$ ), indicating hoarding. There were no significant between-group differences on HADS anxiety ( $F(1,111) = 0.574, p = .450$ ) nor depression ( $F(1,111) = 0.124, p = .720$ ).

## Comparisons between Hoarders and Non-Hoarders on working memory, inhibition and global executive measures

Descriptive statistics for performance on the Adult Executive Functioning Inventory (ADEXI) for working memory and cognitive inhibition as a measure of executive function, as well as for scores on the Dysexecutive Questionnaire – Revised (DEX-R) as a measure of global executive functioning, can be found in Table 2.

[Insert Table 2 here]

A series of one-way ANCOVA's were conducted on these measure measures as dependent variables. There was no significant difference between the hoarders and non-hoarders on ADEXI working memory scores ( $F(1, 107) = 0.429, p = .514, \text{partial } \eta^2 = .004$ ; in addition the HADS Depression measure contributed significantly to the model ( $F(1, 107) = 8.61, p = .004, \text{partial } \eta^2 = .075$ ). Hoarders reported significant lower scores on the ADEXI executive function inhibition scores ( $F(1, 107) = 8.43, p = .004, \text{partial } \eta^2 = .073$ ). Additionally, the HADS depression measure also significantly contributed to the model ( $F(1, 107) = 4.65, p = .033, \text{partial } \eta^2 = .042$ ). There was also a significant group difference in the DEX-R global executive function scores ( $F(1, 107) = 15.04, p < .001, \text{partial } \eta^2 = .123$ ). Gender ( $F(1, 107) = 5.39, p = .022, \text{partial } \eta^2 = .048$ ), HADS Depression ( $F(1, 107) = 4.24, p = .042, \text{partial } \eta^2 = .038$ ), and HADS Anxiety ( $F(1, 107) = 10.74, p = .001, \text{partial } \eta^2 = .091$ ) all significantly contributed to the model.

## DISCUSSION

Hoarding is defined as the excessive acquisition of large numbers of items that are of limited value and a failure to discard of these items, causing living spaces to be cluttered, unusable, and, in some cases, unsafe. Hoarding can cause distress, disrupt relationships, and interfere with everyday living. To date, the evidence suggest that those domains most affected by hoarding have been attention, memory, cognitive flexibility, cognitive inhibition, planning, problem solving and organization/categorization (Gledhill, Bream, Drury, & Onwumere, 2020; Woody, Kellman-McFarlane, & Welsted, 2014), which indicate executive function deficiencies in hoarders. In addition, deficits in decision making, cognitive inhibition, and categorization appear to worsen with increasing severity of hoarding symptoms and with age (Dozier, Wetherell, Twamley, Schiehser, & Ayers, 2016; Grisham, Norberg, Williams, Certoma, & Kadib, 2010; Mackin, Areán, Delucchi, & Mathews, 2011; Tolin et al., 2012). While previous research has focused on clinical samples of OCD patients and/or hoarders, often focusing upon the older populations, the current study aimed to explore the possible deficits in working memory and executive impairments, including cognitive inhibition, in a non-clinical sample of younger adult hoarders and comparing these with a group on young non-hoarders.

We found that overall, the hoarding group reported significantly more deficits than the non-hoarding group on their inhibition control and in general executive functions. However, there was no discernible difference between hoarders and non-hoarders in terms of basic working memory ability. These findings were observed after controlling for age, gender, anxiety and depression as covariates in the analysis, since these can have an independent impact upon executive function and working memory.

The finding that hoarders reported significant deficits in general executive function (measured by the DEX-R) is consistent with previous research in the field. The DEX-R measures a whole range of emotional, behavioural and cognitive executive functions. For example, attention, organisation, memory, behavioural-control, inhibiting the urge to act on impulse and planning for the future. For example, case studies of individuals who have developed hoarding symptoms following frontal lobe damage (Anderson, Damasio, & Damasio, 2005). Also work on elderly hoarders who showed impaired executive function when compared with age-matched healthy

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3 controls, for example, on measures such as the Wisconsin Card Sort Task, the Wechsler Adult  
4 Intelligence Test digit span and letter-numbering tasks (Ayers, Wetherell, Schiehser et al., 2013).  
5 Also, in hoarding patient groups who show deficits in spatial attention, slower reaction times,  
6 planning, categorization, decision-making and increased impulsivity (Grisham, Brown, Savage,  
7 Steketee & Barlow, 2007; Grisham, Norberg, Williams, Certoma, & Kadib, 2010), compared to  
8 non-clinical control groups.  
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14 Also, in the current study, hoarders also reported significantly more deficits in inhibitory  
15 control when compared with non-hoarders. Inhibitory control involves maintaining a goal in mind  
16 and suppressing any intrusive thoughts or impulses that might deflect you from this goal. Inhibitory  
17 control involves a range of executive functions, requiring selective attention, response inhibition,  
18 and cognitive flexibility. The finding that hoarders experience problems in inhibitory control is  
19 consistent with previous findings which have demonstrated hoarding related executive functions  
20 related to inhibitory control and the trend that inhibitory control deficits increase with greater  
21 hoarding severity (Dozier, Wetherell, Twamley, Schiehser, & Ayers, 2016; Grisham, Norberg,  
22 Williams, Certoma, & Kadib, 2010; Mackin, Areán, Delucchi, & Mathews, 2011; Tolin et al.,  
23 2012).  
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32 The finding that hoarders and non-hoarders did not differ significantly on working  
33 memory scores in contrast to previous research (Grisham, Brown, Savage, Steketee & Barlow,  
34 2007; Grisham, Norberg, Williams, Certoma, & Kadib, 2010; Samuels, Bienvenu, Krasnow,  
35 Wang, *et al.*, 2018) and may be explicable in terms of the nature of the tasks employed in this  
36 study. Previous studies have reported mixed findings with regards hoarding behaviour and this  
37 may be dependent upon how much executive resources are involved in the various working  
38 memory tasks that have been employed. have been involved in the various working memory tasks.  
39 Some working memory tasks might have incorporated executive measures, such as inhibition, that  
40 prevented proactive interference from prior trials. Other studies may not. In the self-report tasks  
41 used in the current study, inhibition would not be expected to have such an impact upon working  
42 memory.  
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53 Deficits in executive functions can offer some explanation of the everyday problems  
54 experienced by hoarders. Dysfunctional categorization may lead to the inability to categorize items  
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3 in terms of their importance (their monetary and emotional value), for example, deciding which  
4 items are of value and need to be kept and which are not and need to be discarded. Poor decision-  
5 making can result in putting off making a key decision (the decision to throw things away) because  
6 it can evoke a strong emotional response about the items they have acquired and cause a fear of  
7 making the 'wrong' decision discarding the items. As a result, many of the items kept are of little  
8 or no monetary value and become what others see as 'junk' or 'rubbish' around the house. In  
9 addition, deficits in sustained attention (the ability to maintain performance on a dull or  
10 monotonous task), the natural impulse to avoid unpleasant emotional arousal and reduced self-  
11 control, may all contribute to the avoidance behavior and lack of decision-making in hoarders. The  
12 result is an inability to de-clutter and discard of items that are no longer of any value. Thus, it  
13 seems feasible that a range of deficits in executive function may cause, or at least contribute to,  
14 the characteristics of hoarding behavior.  
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### 25 **Limitations and Future Research**

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27 One limitation of the current study is that the current study was focused upon non-clinical  
28 hoarders and, therefore, it does not cover the more severe forms of hoarding, such as those found  
29 in clinical samples. Perhaps a future study could compare non-clinical and clinical hoarders on the  
30 executive function and inhibitory control to compare the severity of executive function deficits  
31 between these two extreme groups. Comparing clinical and sub-clinical samples in the same study  
32 could help to discern whether executive deficits as vulnerability and maintaining factors in  
33 hoarding, or whether they are an epiphenomenon of the disorder.  
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39 A second limitation is that we did not consider the interpersonal status of the individual,  
40 whether they were single, in a current relationship or married. This may affect their attachment  
41 security (whether they have developed a secure feeling of attachment with others). People with  
42 high levels of insecurity do tend to form a greater attachment to objects, increasing the likelihood  
43 of hoarding symptoms. Since an insecure attachment style has also been associated with executive  
44 function deficits (Blair Nitzburg, DeRosse, & Karlsgodt, 2018), attachment style (Neave, Tyson,  
45 McInnes & Hamilton, 2016) style could be included in future research to understand its role in  
46 the relationship between non-clinical hoarding and executive function.  
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A further limitation of the study is that it did not include any measures of cultural background or generational experiences (such as the type of background one grows up in or prior trauma experiences) which can themselves lead to a range of psychopathologies, including hoarding (see e.g., Yee, 2020).

Finally, it would be insightful to examine executive functions in more ecologically valid scenarios, such as cluttered environments, emotional-laden scenarios or even in the context of the hoarders' own home. It would also be useful to conduct longitudinal studies of non-clinical hoarders. Future studies on the impact of non-clinical HD may benefit from following participants over time, in order to observe any changes to their hoarding behaviour as time passes or assess what impact different life-style changes and/or stressors in the environment has upon hoarding behaviour.

## **Conclusion**

The findings from the present study suggest that executive dysfunction may contribute to the occurrence and severity of hoarding behaviour in a non-clinical sample of young adults. It is important to note that these findings were independent of age, sex, or mood. Hoarders report more problems in their general executive function, such as decision-making, planning, attentional control. Hoarder also appear to have specific problems in their inhibitory control, an executive function that permits an individual to inhibit their impulses and natural, habitual, or dominant ways of behaving, such as resisting the urge to buy more and more items that are unnecessary. These findings provide further insight into the cognitive sequelae to hoarding and may be beneficial in guiding interventions in the future. For example, clinicians could follow-up on hoarding patient reports of executive dysfunction with formal neuropsychological testing incorporating objective measures of IC, EF, and WM, in order to better determine which might be the best course of treatment.

## **Ethics approval and consent to participate**

Approval for this study was granted by the ethics committee at Northumbria University, UK. Informed consent was obtained from all participants.

## **Disclosure statement**



No potential conflict of interest was reported by the authors.

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### **REFERENCES**

- American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders*. 5<sup>th</sup> edition.
- Anderson, S. W., Damasio, H., and Damasio, A. R. (2005). A neural basis for collecting behaviour in humans. *Brain*, *128*, 201–212.
- Blair, M.A., Nitzburg, G., DeRosse, P., & Karlsgodt, K.H. (2018). Relationship between executive function, attachment style, and psychotic like experiences in typically developing youth. *Schizophrenia Research*, *197*, 428-433.
- Dozier, M. E., Wetherell, J. L., Twamley, E. W., Schiehser, D. M., & Ayers, C. R. (2016). The relationship between age and neurocognitive and daily functioning in adults with hoarding disorder. *International Journal of Geriatric psychiatry*, *31*(12), 1329-1336.
- Frost, R.O., & Gross, R.C. (1993). The hoarding of possessions. *Behavior Research and Therapy*, *31*, 367-381.
- Frost, R.O., & Hartl, T.L. (1996). A cognitive-behavioral model of compulsive hoarding. *Behavior Research and Therapy*, *34*, 341-350.
- Frost, R.O., Marten, P., Lahart, C., & Rosenblate, R. (1990). The dimensions of perfectionism. *Cognitive Therapy and Research*, *14*, 449-468.
- Frost, R.O. & Shows, D.L. (1993). The nature and measurement of compulsive indecisiveness. *Behavior Research and Therapy*, *31*, 683:692.
- Frost, R.O., Steketee, G., & Grisham, J. (2004). Measurement of compulsive hoarding: saving inventory-revised. *Behavior Research and Therapy*, *42*, 1163-1182.
- Frost, R.O., Steketee, G., & Tolin, D.F. (2011). Comorbidity in hoarding disorder. *Depression and Anxiety*, *28*, 876 – 884.

- 1  
2  
3 Frost, R.O., Tolin, D.F., Steketee, G., Fitch, K.E., & Selbo-Bruns, A. (2009). Excessive acquisition  
4 in hoarding. *Journal of Anxiety Disorders*, 23, 632-639.
- 5  
6 Grisham, J.R., & Barlow, D.H. (2005). Compulsive hoarding: current research and theory. *Journal*  
7 *of Psychopathology and Behavioral Assessment*, 27, 45-52.
- 8  
9  
10 Grisham, J.R., Brown, T.A., Savage, C.R., Steketee G., & Barlow, D.H. (2007).  
11 Neuropsychological impairment associated with compulsive hoarding. *Behavior Research and*  
12 *Therapy*, 45, 1471-1483.
- 13  
14 Grisham, J.R., Frost, R.O., Steketee, G., Kim, H-J., & Hood, S. (2006). Age of onset of compulsive  
15 hoarding. *Anxiety Disorders*, 20, 675-686.
- 16  
17 Grisham, J.R., Norberg, M.M., Williams, A.D., Certoma, S.P., & Kadib, R. (2010). Categorization  
18 and cognitive deficits in compulsive hoarding. *Behavior Research and Therapy*, 48, 866-872.
- 19  
20  
21 Hartl, T.L., Frost, R.O., Allen, G.J., Deckersbach, T., Steketee, G., Duffany, S.R et al., (2004).  
22 Actual and perceived memory deficits in individuals with compulsive hoarding. *Depression*  
23 *and Anxiety*, 20, 59-69.
- 24  
25  
26 Holst, Y., & Thorell, L. B. (2018). Adult executive functioning inventory (ADEXI): Validity,  
27 reliability, and relations to ADHD. *International Journal of Methods in Psychiatric Research*,  
28 27(1), e1567.
- 29  
30  
31  
32  
33  
34  
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39  
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58  
59  
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- Mantella, R.C., Butters, M.A., Dew, M.A., Mulsant, B. H., Begley, A.E., Tracey, B., Shear, M.K.,  
Reynolds III, C.F., & Lenze, E.J. (2007). Cognitive impairment in late-life generalized anxiety  
disorder. *American Journal of Geriatric Psychiatry*, 15, 673-679.
- Neave, N., Jackson, R., Saxton, T & Hönekopp, J. (2015). The influence of anthropomorphic  
tendencies on human hoarding behaviors. *Personality and Individual Differences*, 72, 214-  
219.
- Neave, N., Tyson, H., McInnes, L., & Hamilton, C. (2016). The role of attachment style and  
anthropomorphism in predicting hoarding behaviors in a non-clinical sample. *Personality and*  
*Individual Differences*, 99, 33-37.
- Nutley, S. K., Camacho, M. R., Eichenbaum, J., Nosheny, R. L., Weiner, M., Delucchi, K. L., ...  
& Mathews, C. A. (2021). Hoarding disorder is associated with self-reported  
cardiovascular/metabolic dysfunction, chronic pain, and sleep apnea. *Journal of Psychiatric*  
*Research*, 134, 15-21.

- 1  
2  
3 Pertusa, A., Frost, R.O., Fullana, M.A., Samuels, J., Steketee, G., Tolin, D., Saxena, S., Leckman,  
4 J.F., & Mataix-Cols, D. (2010). Refining the diagnostic boundaries of compulsive hoarding: a  
5 critical review. *Clinical Psychology Review, 30*, 371-386.  
6  
7  
8 Roane, D. M., Landers, A., Sherratt, J., & Wilson, G. S. (2017). Hoarding in the elderly: a critical  
9 review of the recent literature. *International Journal of Psychogeriatrics, 29(7)*, 1077-84.  
10  
11  
12 Samuels, J.F., Bienvenu, O.J., Grados, M.A., Cullen, B., Riddle, M.A., Liang, K-Y., Eaton, W.W.,  
13 & Nestadt, G. (2008). Prevalence and correlates of hoarding behaviour in a community-based  
14 sample. *Behaviour Research and Therapy, 46*, 836-844.  
15  
16  
17  
18 Samuels, J., Bienvenu, O. J., Krasnow, J., Wang, Y., Grados, M. A., Cullen, B., ... & Nestadt, G.  
19 (2018). Self-reported executive function and hoarding in adults with obsessive-compulsive  
20 disorder. *Comprehensive Psychiatry, 81*, 53-59.  
21  
22  
23 Simblett, S. K., Ring, H., & Bateman, A. (2017). The Dysexecutive Questionnaire Revised (DEX-  
24 R): An extended measure of everyday dysexecutive problems after acquired brain  
25 injury. *Neuropsychological Rehabilitation, 27(8)*, 1124-1141.  
26  
27  
28  
29 Snaithe RP & Zigmund AS (1994). *The Hospital Anxiety and Depression Scale*. NFER-Nelson  
30 Publishing Company Ltd., Berks. UK.  
31  
32  
33 Thompson, J. M., Hamilton, C. J., Gray, J. M., Quinn, J. G., Mackin, P., Young, A. H., & Nicol  
34 Ferrier, I. (2006). Executive and visuospatial sketchpad resources in euthymic bipolar disorder:  
35 Implications for visuospatial working memory architecture. *Memory, 14(4)*, 437-451.  
36  
37  
38 Tolin, D. F., Frost, R. O., Steketee, G., Gray, K. D., & Fitch, K. E. (2008). The economic and  
39 social burden of compulsive hoarding. *Psychiatry Research, 160(2)*, 200-211.  
40  
41  
42 Tolin, D.F., Villavicencio, A., Umbach, A., & Kurtz, M.M. (2011). Neuropsychological  
43 functioning in hoarding disorder. *Psychiatry Research, 189*. 413-418.  
44  
45  
46 Warren, L.W., & Ostrom, J.C. (1988). Pack rats: world class savers. *Psychology Today, 22*, 58-  
47 62.  
48  
49 Wood, R. L., & Worthington, A. (2017). Neurobehavioral abnormalities associated with executive  
50 dysfunction after traumatic brain injury. *Frontiers in Behavioural Neuroscience, 11*, 195.  
51  
52  
53  
54  
55  
56  
57  
58  
59  
60

1  
2  
3 Yee, D. (2020). *Hoarding Embodied: Trauma-Informed Psychosomatic Therapy for Treatment of*  
4 *Hoarding Disorder-A Narrative Inquiry* (Doctoral dissertation, California Institute of Integral  
5 *Studies*).  
6  
7  
8  
9  
10  
11  
12  
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16  
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**Table 1**

Means and standard deviations (in brackets) comparing Hoarders and Non-Hoarders on age, Savings Inventory (Revised) for Excessive Acquisition, Difficulty Discarding, Clutter and Total Hoarding symptoms, as well as the Hospital Anxiety and Depression Scale scores for anxiety and depression scores.

	<b>Hoarders (N = 40)</b>	<b>Non-Hoarders (N = 73)</b>	<b>Significance</b>
Age	22.2 (3.44)	24.3 (5.45)	(p = .590)
SI-R Excessive Acquisition	14.5 (2.69)	5.46 (3.08)	(p <.001)
SI-R Difficulty Discarding	16.8 (3.03)	5.46 (3.49)	(p <.001)
SI-R Clutter	16.5 (4.30)	4.58 (3.20)	(p <.001)
SI-R Total Hoarding	47.9 (6.44)	15.5 (7.69)	(p <.001)
HADS Anxiety	6.92 (2.95)	7.47 (4.07)	(p = .574)
HADS Depression	3.25 (2.32)	3.43 (2.91)	(p = .124)

**Table 2**

Means and standard deviations (in brackets) comparing Hoarders and Non-Hoarders on the Adult Executive Functioning Inventory (ADEXI) for working memory and cognitive inhibition (executive function), as well as for scores on the Dysexecutive Questionnaire – Revised (DEX-R) which measure global executive functioning.

	<b>Hoarders (N = 40)</b>	<b>Non-Hoarders (N = 73)</b>	<b>Significance</b>
ADEXI Working Memory	23.2 (6.35)	22.8 (5.73)	(p = .741)
ADEXI Cognitive Inhibition	15.6 (3.09)	13.6 (3.48)	(p < .01)
DEX-R	64.6 (18.2)	53.6 (21.7)	(p < .01)