Psychiatry Research 265 (2018) 215–220

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Subjective cognitive function in hoarding disorder

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ARTICLE INFO

Keywords:
Hoarding
Neuropsychology
Memory
Attention
Beliefs

ABSTRACT

The aim of the present study was to examine subjective cognitive impairment among adult patients with hoarding disorder (HD). Eighty-three patients with HD and 46 age- and gender-matched healthy control (HC) participants received a diagnostic interview and completed measures of subjective cognitive functioning and motivations for saving behavior, as well as measures of hoarding severity, depression, anxiety, stress, and obsessive-compulsive disorder (OCD) symptoms. The HD group reported more impairment than did the HC group in domains of memory, distractibility, blunders, memory for names, and inattention. These differences generally remained significant when controlling for comorbid symptoms. In the HD group, the degree of cognitive impairment was significantly correlated with severity of saving and acquiring behaviors, although results were attenuated when controlling for comorbid symptoms (overall HD severity, but not saving behavior specifically, remained significantly correlated with cognitive impairment). Subjective cognitive impairment was further associated with a desire to save possessions in order to avoid forgetting, and these results remained significant when controlling for comorbid symptoms. These results comport with current behavioral models of HD that emphasize decision-making deficits, as well as clinician observations suggestive of impaired cognitive function, and complement a growing body of neuropsychological testing studies.

1. Introduction

Hoarding disorder (HD) is a newly recognized diagnosis in DSM-5 (American Psychiatric Association, 2013), defined as a persistent inability to discard possessions, often accompanied by excessive acquiring, resulting in severe clutter in the home. The current cognitive-behavioral model of HD implicates deficits in decision making (Frost and Hartl, 1996). Behaviorally, patients with HD tend to be significantly tangential in session and can show limited insight into the severity of their symptoms (Drury et al., 2015; Mataix-Cols et al., 2013), suggesting potential cognitive deficits in this patient group. However, there is currently limited research focusing specifically on cognitive function in individuals with HD. Cognitive functioning is generally measured by performance on neuropsychological tests, although it can also be measured subjectively via self-report measures. Importantly, subjective cognitive functioning in individuals with HD may play an important role in the maintenance of certain HD symptoms, such as saving items to avoid forgetting (Steketee et al., 2003), regardless of whether deficits are found in neuropsychological testing.

Formal neuropsychological testing suggests that HD is characterized by deficits in the areas of sustained attention (Grisham et al., 2007; Raines et al., 2014; Tolin et al., 2011) and categorization of personal belongings, (Grisham et al., 2010; Wincze et al., 2007) although neuropsychological performance in other domains has yielded mixed results (Woody et al., 2014). Hoarding is associated with high rates of comorbid attention-deficit/hyperactivity disorder (ADHD) (Frost et al., 2011; Sheppard et al., 2010), further highlighting the likelihood of cognitive deficits in this population. Consonant with, and perhaps more consistent than, the neuropsychological findings of impaired cognitive function, individuals with HD report high levels of *subjective* cognitive dysfunction. Subjective cognitive impairment is of interest because it may predict functioning and quality of life beyond the contribution of objective neuropsychological test scores (Hill et al., 2017; Naismith et al., 2007; Potvin et al., 2016). On standardized self-report measures, HD patients report greater deficits in attentional capacity than do obsessive-compulsive disorder (OCD) patients or healthy controls

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https://doi.org/10.1016/j.psychres.2018.05.003
Received 24 January 2018; Received in revised form 2 May 2018; Accepted 3 May 2018
Available online 04 May 2018
0165-1781/

(Moshier et al., 2016). In one study, 75% of participants with HD scored at least one standard deviation above the normative mean for age- and gender-matched community controls on a self-report measure of the inattentive symptoms of attention-deficit/hyperactivity disorder (ADHD) (Frost et al., 2011). Additionally, individuals with HD report low confidence in memory (Hartl et al., 2004). Taken together, these studies underscore the significant impairment in several cognitive processes among HD patients, as measured by both neuropsychological and self-report assessments.

Recently, Samuels et al. (2017) examined subjective executive function deficits by administering the Behavior Rating Inventory of Executive Function-Adult Version (BRIEF-A; Roth et al., 2005) to 431 adults diagnosed with OCD. Participants were classified according to the presence (n = 143) or absence (n = 288) of clinically significant hoarding symptoms. The hoarding group reported more executive dysfunction than did the non-hoarding group, on the shift, initiate, working memory, plan/organize, task monitor, and organization of materials scales. The use of hoarding-related OCD (as determined by symptom checklist), rather than DSM-5 HD, limits the conclusions that can be drawn about HD. Furthermore, although Samuels et al. controlled for the presence of major depressive disorder, they did not control for severity of depression, which can be considerable in hoarding regardless of comorbid diagnosis (Wheaton et al., 2008). Finally, the absence of a healthy control (HC) group makes it difficult to understand the degree of impairment in the study groups.

The aims of the present study were to extend prior research on subjective cognitive impairment by comparing patients with DSM-5 HD with an age- and gender-matched sample of HC participants; it was predicted that HD patients would report significantly greater cognitive impairment across a range of dimensions than would HC participants. Additionally, we sought to determine the relationships among self-reported cognitive impairment, HD severity, depression, anxiety, and non-hoarding OCD symptoms; though significant correlations among all measures were expected, we predicted that subjective cognitive impairment would correlate with HD symptom severity in the HD group even when controlling for the other measures. Finally, the study aimed to examine subjective cognitive impairment as a specific predictor of memory-related motivation for saving; it was predicted that among HD patients, those reporting greater cognitive impairment would endorse a greater belief in the need to save items as a memory aid.

2. Methods

2.1. Participants

Eighty-three adult outpatients meeting DSM-5 (American Psychiatric Association, 2013) criteria for HD were sampled as part of a large clinical trial examining the neural mechanisms of CBT response in hoarding disorder. To be included in the study, clinical participants were required to (1) have a primary diagnosis of HD on the *Diagnostic Interview for Anxiety, Mood, and Obsessive-Compulsive and Related Neuropsychiatric Disorders* (Tolin et al., 2018a) that was of at least moderate severity on the *Clinician's Global Impression-HD* (Tolin et al., 2018b); (2) be aged 20–65; (3) be taking no psychiatric medications or on a stable dose of psychiatric medications (antidepressants, benzodiazepines and stimulants were allowed) for at least 8 weeks; (4) be willing and able to abstain from the use of stimulant or benzodiazepine medications on the day of testing; (5) be free of serious mental illness such as schizophrenia, bipolar disorder, or active substance abuse; (6) be right-handed, and (7) be free of non-removable metal in the body, claustrophobia, or other factors that would preclude functional magnetic resonance imaging (fMRI). Of the 135 prospective clinical participants that were interviewed, 47 were excluded due to failing to meet inclusion criteria; the most common reasons for exclusion were diagnoses of HD of less than moderate severity, not a primary diagnosis of HD, and presence of co-occurring serious mental illness. An additional 4 participants met inclusion criteria but discontinued prior to completing the study measures.

Forty-six healthy control (HC) participants were also recruited. To be eligible for the study, the HC participants were required to (1) have no current or past psychiatric diagnosis or treatment; (2) be age- and gender-matched to the HD sample (recruitment of HCs was deliberately lagged behind that of the HD group in order to recruit similar ages and genders); (3) be right-handed; and (4) be free of non-removable metal in the body, claustrophobia, or other factors that would preclude fMRI. Of 62 prospective HC participants who were interviewed, 16 were excluded due to failing to meet inclusion criteria. The most common reasons for exclusion in the HC sample were an abnormal MRI finding, current or past Axis I psychiatric disorder, or current significant psychiatric symptoms, as evidenced by a global severity greater than normal.

2.2. Measures

DSM-5 diagnoses were assessed using the *Diagnostic Interview for Anxiety, Mood, and Obsessive-Compulsive and Related Neuropsychiatric Disorders* (DIAMOND; Tolin et al., 2018), a semi-structured clinical interview. The DIAMOND HD diagnosis shows excellent inter-rater reliability (κ = 0.86), very good test-retest reliability (κ = 0.64), and strong convergence with the Saving Inventory–Revised (SI-R) (Tolin et al., 2018); Illness severity was assessed using the *Clinician's Global Impression-Hoarding Disorder* (CGI-HD; Tolin et al., 2018b), a variation of the original CGI (Guy, 1976) in which HD symptom severity is rated on a scale from 1 (normal, not at all ill) to 7 (extremely ill). A score of 4 (moderate) or higher was required for the HD group. The CGI-HD shows good inter-rater and test-retest reliability (Tolin et al., 2018b).

Hoarding symptom severity was assessed with the *Saving Inventory-Revised* (SI-R; Frost et al., 2004) a 23-item self-report measure that yields a total score as well as three subscales: *Clutter* (α = 0.98 in the present sample), *Saving* (α = 0.96 in the present sample), and *Acquiring* (α = 0.94 in the present sample). The SI-R readily discriminates HD from OCD patients and community controls, and correlates significantly with ratings of clutter and impairment (Frost et al., 2004). For sample description, we also administered the *Hoarding Rating Scale-Interview* (HRS-I; Tolin et al., 2010), a 5-item clinician-rated interview of the severity of clutter, difficulty discarding, acquisition, distress, and impairment (α = 0.97 in the present sample). The HRS-I has good convergent validity and reliably differentiates HD patients from those with obsessive-compulsive disorder (OCD) and HCs (Tolin et al., 2010, 2018b).

Motivations to save were measured using the *Saving Cognitions Inventory* (SCI; Steketee et al., 2003), a 24-item self-report measure that yields four subscales: emotional attachment (e.g., “Losing this possession is like losing a friend”), concerns about memory (e.g., “Saving this means I don't have to rely on my memory”), control over possessions (e.g., “I like to maintain sole control over my things”), and responsibility towards possessions (e.g., “I am responsible for the well-being of this possession”). Respondents rate from 1 to 7 the extent to which they experienced each thought when attempting to discard an object within the past week. The SCI has demonstrated good internal consistency and convergent and discriminant validity (Steketee et al., 2003). Internal consistency estimates were acceptable in the present sample (attachment α = 0.97, memory α = 0.88, control α = 0.79, responsibility α = 0.87).

Depression, anxiety, and stress-related symptoms are common in HD (Frost et al., 2011; Wheaton et al., 2008), and can contribute independently to impaired cognitive function (Beaudreau and O'Hara, 2008; Rock et al., 2014; Sandi, 2013). Thus, we measured these affective symptoms using the *Depression Anxiety Stress Scales* (DASS; Lovibond and Lovibond, 1995), a 42-item self-report measure assessing three domains of negative emotion: depression, anxiety, and stress/

tension. Each item is rated on a 4-point scale assessing symptom frequency over the past week. Subscales of the DASS show high internal consistency (α = 0.89 −0.96) and good discriminant and divergent validity (Brown et al., 1997). In the present study, the depression (DASS-D, α = 0.96), anxiety (DASS-A, α = 0.91) and stress (DASS-S, α = 0.95) subscales showed excellent internal consistency.

Because OCD symptoms can co-occur with HD (Frost et al., 2011) and are associated with cognitive impairment (Shin et al., 2014), we measured OCD symptoms using the *Obsessive Compulsive Inventory-Revised* (OCI-R; Foa et al., 2002), an 18-item self-report measure assessing six obsessive-compulsive symptom domains: checking, obsessions, mental neutralizing, ordering, washing, and hoarding. Each item is rated on a 5-point Likert-type scale ranging from 0 (not at all) to 4 (extremely) indicating the degree to which participants are distressed or bothered by OCD symptoms within the past month. The hoarding subscale of the OCI-R was excluded in the current study and the OCI-R total score therefore consists of the remaining five domains (15 items). This revised OCI-R showed high internal consistency (α = 0.88) in the current study.

Self-reported inattentiveness was assessed using the inattention subscale of the *ADHD Symptom Scale* (ADHDSS; Barkley and Murphy, 1998) a 9-item self-report scale. Scores on this scale can range from 0–27, with higher scores indicating greater inattentiveness. The ADHDSS readily discriminates ADHD patients from community control participants (Barkley et al., 2002) and shows adequate inter-rater reliability between patients and their parents and spouses (Barkley and Murphy, 1998). The ADHDSS subscales have shown excellent internal consistency in previous studies of individuals with HD (Frost et al., 2011; Hartl et al., 2005). Scale data from the present sample demonstrated excellent internal consistency (α = 0.94).

Other self-reported cognitive impairments were assessed using the *Cognitive Failures Questionnaire* (CFQ; Broadbent et al., 1982), a 25 item self-report measure assessing the patient's perception of his or her overall cognitive status. Items are responded to on a 5-point scale and the CFQ is comprised of four reliable subscales (Wallace et al., 2002): Memory (α = 0.89 in the present sample), Distractibility (α = 0.89 in the present sample), Blunders (α = 0.84 in the present sample), and Memory for Names (α = 0.71 in the present sample).

2.3. Procedure

All study procedures were approved by the Hospital Institutional Review Board and all participants provided written informed consent prior to any study procedures. The present study was conducted as part of a clinical trial for HD, and the HD group (recruited from the clinic flow, newspaper advertisements, community lectures, and flyers in the community) was seeking treatment as part of the clinical trial. The HC group was recruited via newspaper advertisements and flyers in the community and received monetary compensation for participating. Participants met with a doctoral-level psychologist or supervised post-doctoral fellow, trained in the use of the DIAMOND and HRS-I, to determine whether they met diagnostic criteria for enrollment. They then completed, on a subsequent day, a battery of self-report measures, including the SI-R, SCI, DASS, OCI-R, CFQ, and ADHDSS. Further aspects of the clinical trial will be described elsewhere.

2.4. Data analytic strategy

Cognitive functioning scores were compared for HD and HC participants using a series of univariate general linear models (GLMs), with and without the DASS subscales and OCI-R as covariates. Effect sizes of partial eta-squared (η_p^2), for which values of 0.01, 0.06, and 0.14 are conventionally considered to reflect small, medium, and large effects, respectively (Richardson, 2011), were calculated. Examining the HD group separately, we then used Pearson correlations (*r*) between the cognitive scales and the SI-R total and subscale scores; Spearman's correlations (ρ), controlling for age, the DASS subscales, and the OCI-R, were also used. All analyses were conducted using SPSS v. 19.

Table 1
Sample characteristics.

	HD	HC	χ^2	*t*
Female [N(%)]	70 (84.3%)	34 (73.9%)	2.06	
Age [M(SD)]	54.08 (9.29)	53.33 (7.15)		0.48
Hispanic [N(%)]	3 (3.6%)	4 (8.7%)	1.49	
Nonwhite [N(%)]	7 (8.4%)	10 (21.7%)	4.58	
SI-R total [M(SD)]	61.43 (11.03)	8.67 (6.68)		29.54**
HRS-I total [M(SD)]	27.23 (4.50)	0.36 (0.77)		39.72**
DASS-D [M(SD)]	9.71 (8.40)	0.93 (2.55)		6.90**
DASS-A [M(SD)]	5.84 (6.55)	0.78 (2.01)		5.09**
DASS-S [M(SD)]	13.20 (8.48)	2.78 (3.84)		7.88**
OCI-R†	12.59 (8.77)	3.28 (4.99)		6.62**
Comorbid obsessive-compulsive disorder [N(%)]	10 (12.0%)	0 (0.0%)		5.88*
Comorbid depressive disorder [N (%)]	45 (54.9%)	0 (0.0%)		38.25**
Comorbid anxiety disorder	24 (29.3%)	0 (0.0%)		16.24**

HD = Hoarding disorder group. HC = Healthy control group. SI-R = Saving Inventory-Revised. HRS-I = Hoarding Rating Scale-Interview. DASS-D = Depression Anxiety Stress Scales, Depression subscale. DASS-A = Depression Anxiety Stress Scales, Anxiety subscale. DASS-S = Depression Anxiety Stress Scales, Stress subscale.

* $p < 0.05$.

** $p < 0.01$.

† Excluding the hoarding items.

3. Results

3.1. Sample characteristics

As shown in Table 1, the sample was predominantly non-Hispanic White and female, and had an average age of 53.8 years (*SD* = 8.6). There were no significant differences between the HD and HC groups in terms of age, sex, race, or ethnicity. As expected, the HD group scored significantly higher than did the HC group on hoarding severity, depression, anxiety, stress, and OCD symptom severity.

3.2. Self-Reported cognitive impairment in hoarding vs. Healthy participants

The self-reported cognitive impairments on the CFQ and ADHDSS for the HD and HC groups is shown in Table 2. The HD group scored significantly higher (more self-reported impairment) on all CFQ scales and the ADHDSS Inattention scale, with large effect sizes.

Table 2
Self-reported cognitive impairment in hoarding vs. healthy participants (Top) and in hoarding vs. healthy participants when controlling for OCD symptoms, depression, anxiety, and stress (Bottom).

	HD	HC	*F*	η_p^2
CFQ memory	11.81 (5.64)	4.93 (3.52)	56.01**	0.31
CFQ distractibility	18.95 (5.87)	9.85 (7.79)	80.76**	0.39
CFQ blunders	11.02 (4.88)	5.65 (3.38)	43.94**	0.26
CFQ names	4.80 (1.86)	3.22 (1.86)	21.30**	0.14
ADHDSS inattention	10.95 (6.83)	1.63 (2.94)	77.65**	0.38
CFQ memory	10.53 (5.23)	7.23 (5.57)	8.76**	0.07
CFQ distractibility	17.66 (5.87)	12.18 (6.25)	19.21**	0.14
CFQ blunders	9.86 (4.54)	7.76 (4.84)	4.67*	0.04
CFQ names	4.45 (2.06)	3.84 (2.20)	1.90	0.02
ADHDSS inattention	9.37 (5.85)	4.49 (6.23)	15.30**	0.11

HD = Hoarding disorder group. HC = Healthy control group. CFQ = Cognitive failures questionnaire. ADHDSS = ADHD symptom scale.

* $p < 0.05$.

** $p < 0.01$.

Table 3
Correlations, among patients with hoarding disorder, between scores on cognitive measures and the saving inventory-revised (SI-R) (Top; showing Pearson's r), and when controlling for age, OCD symptoms, depression, anxiety, and stress (Bottom, showing Spearman's ρ).

	SI-R			
	Total	Clutter	Saving	Acquiring
CFQ memory	0.15	−0.01	0.02	0.30**
CFQ distractibility	0.25*	0.02	0.23*	0.32**
CFQ blunders	0.13	−0.01	0.07	0.23*
CFQ names	0.12	−0.02	0.05	0.23*
ADHDSS inattention	0.33**	0.17	0.24*	0.33**
CFQ memory	0.08	−0.04	−0.05	0.23*
CFQ distractibility	0.14	−0.02	0.13	0.20
CFQ blunders	0.03	−0.07	−0.01	0.14
CFQ names	0.02	−0.04	−0.05	0.11
ADHDSS inattention	0.27*	0.14	0.20	0.26*

* $p < 0.05$.
** $p < 0.01$.

To check for important covariates, we calculated Person's correlation coefficients between the CFQ/ADHDSS and the DASS/OCI-R. All correlations were significant ($p < 0.05$, with r values ranging from 0.37–0.60). It was therefore concluded that the DASS subscales and the OCI-R would be necessary to include as covariates in subsequent analyses. When controlling for the DASS subscales and OCI-R score (see Table 2, bottom, showing estimated marginal means), all CFQ subscales (with the exception of CFQ Names) remained significantly elevated in HD participants. The ADHDSS inattention subscale also remained significantly elevated in HD participants.

3.3. Relationship between hoarding symptom severity and self-reported cognitive impairment in hoarding patients

Table 3 shows the correlations between scores on the cognitive measures (CFQ subscales and ADHDSS inattention subscale) and the SI-R in the HD group. The SI-R clutter subscale, which is the functional outcome of hoarding behaviors rather than a specific behavior, did not correlate significantly with any of the cognitive measure subscales. However, the behavioral aspects of HD (saving and acquiring subscales of the SI-R) correlated significantly with the cognitive measures. The SI-R acquiring subscale was significantly correlated with all CFQ subscales as well as the ADHDSS Inattention scale. The SI-R saving subscale was significantly correlated only with CFQ Distractibility and the ADHDSS Inattention scale. The SI-R total score was significantly correlated with the CFQ distractibility subscale and ADHDSS Inattention scale.

When controlling for age, OCD symptoms, depression, anxiety, and stress, the SI-R acquiring subscale remained significantly correlated with the CFQ memory subscale and the ADHDSS inattention scale. The SI-R saving subscale was no longer significantly correlated with any cognitive measures and the SI-R total score remained significantly correlated with the ADHDSS Inattention scale.

As shown in Table 4, the SCI memory scale (reflecting a desire to save things in order to avoid forgetting) was significantly correlated with CFQ memory, distractibility, blunders, and names. The other SCI subscales showed few significant correlations with self-reported cognitive dysfunction. When controlling for age, OCD symptoms, depression, anxiety, and stress, SCI memory remained significantly associated with CFQ distractibility, blunders, and names, as well as ADHDSS inattention. The association with CFQ-memory was marginal ($p = 0.06$). None of the other SCI subscales remained associated with subjective cognitive functioning (CFQ or ADHDSS-Inattention).

Table 4
Correlations, among patients with hoarding disorder, between saving cognitions inventory-revised subscale scores (Top; showing Pearson's r), and when controlling for age, OCD symptoms, depression, anxiety, and stress (Bottom, showing Spearman's ρ).

	Saving cognitions inventory			
	Memory	Control	Responsibility	Emotional
CFQ memory	0.32**	−0.05	0.05	0.09
CFQ distractibility	0.38**	0.01	0.15	0.28**
CFQ blunders	0.38**	0.21	0.23*	0.16
CFQ names	0.37**	0.10	0.18	0.11
ADHDSS inattention	0.33	−0.02	−0.28	0.21
CFQ memory	0.21	−0.15	−0.07	−0.04
CFQ distractibility	0.31**	−0.06	0.08	0.16
CFQ blunders	0.28*	0.15	0.11	0.03
CFQ names	0.27*	0.03	0.08	−0.02
ADHDSS inattention	0.33**	−0.05	0.13	0.07

* $p < 0.05$.
** $p < 0.01$.

4. Discussion

Current models of HD emphasizing the role of decision-making deficits (Frost and Hartl, 1996), and clinical observations of tangentiality and low insight (Tolin et al., 2012), raise the possibility of cognitive impairment in this population. Neuropsychological testing has yielded mixed results, but an overall impression of impaired function, most robustly seen in sustained attention, is emerging (Woody et al., 2014). The results of this study suggest the presence of substantial subjective cognitive impairment in patients with HD. The largest effects (compared to HCs) were in the domains of distractibility and inattention, which is consistent with findings of impaired attention in neuropsychological tests (Grisham et al., 2007; Tolin et al., 2011). Compared to HCs, HD patients also reported significantly greater impairments in memory, a finding that has some corroboration from neuropsychological testing (Ayers et al., 2013; Dozier et al., 2016; Mackin et al., 2016), though results have been mixed.

The present results extend those of prior studies (Moshier et al., 2016; Samuels et al., 2017) by demonstrating that the subjective cognitive impairment observed in HD cannot be attributed solely to the severity of affective or OCD symptoms. This is an important distinction, because both OCD and depression are common in HD (Frost et al., 2011), and the presence of these comorbid conditions is associated with greater impairment, including cognitive dysfunction (Grisham et al., 2005; Mackin et al., 2011).

Among patients with HD, the degree of subjective cognitive impairment was significantly correlated with severity of HD symptoms. We did not find that cognitive impairment was associated with clutter. Clutter is an environmental consequence of behavior, rather than a specific behavior, and thus may be less sensitive to predictive analyses. Importantly, however, the core *behavioral* features of HD (saving and acquiring) were significantly associated with subjective deficits in attention and memory. When controlling for affective and OCD symptoms, the picture becomes less clear; impaired cognitive functioning remained associated with acquiring but was no longer related to saving. Thus, it is possible that although the differences in subjective cognitive function between HD and HC participants is specific to hoarding, within HD patients, the severity of cognitive dysfunction is at least partially related to comorbid symptoms. An alternative explanation is that certain comorbid symptoms (particularly depression, anxiety and stress) are maintained by severe hoarding, and therefore covarying for these symptoms obscured a true relationship between hoarding and cognitive impairment. Indeed, in one study, the presence of comorbid ADHD symptoms in hoarding was typically associated with co-occurring depression (Hall et al., 2013).

It has been established that individuals with HD may save

possessions due to memory-related concerns (Steketee et al., 2003). For example, a patient may feel a need to save an object in order to remember the event with which it is associated; another might perceive a need to keep possessions in sight in order to avoid forgetting them. Thus, low memory confidence may be a maintaining factor in hoarding-related behaviors (Hartl et al., 2004). The present results indicate that memory-related maladaptive beliefs are most evident among those who perceive themselves to be more cognitively impaired. As discussed below, the distinction between cognitive impairment and metacognitive beliefs has important implications for treatment development.

Several limitations of the present study should be noted. The most important of these is the absence of corroborating neuropsychological testing. Without such objective evidence, the present results can only inform about *subjective* cognitive impairment, which does not always comport with objective test results (Moshier et al., 2016; Potvin et al., 2016). This could reflect a systematic under-estimation of cognitive ability in individuals with HD, or it could indicate a more subtle dysfunction than can be easily detected using traditional tests. In either case, however, subjective cognitive impairment may still be an important driver of hoarding-related behaviors, as demonstrated here by the relationships among subjective impairment, memory-related beliefs, and saving and acquiring behavior. Furthermore, it is worth considering the possibility that subjective cognitive function captures subtle dysfunction that is not easily tested using performance-based tasks. As noted by Samuels et al. (2017), subjective impairment complements the outcomes of neuropsychological testing studies with more "ecologically valid" evaluations of functioning in everyday life (Chaytor and Schmitter-Edgecombe, 2003; Potvin et al., 2016). While neuropsychological tests may measure cognitive function during a particular task, they do not necessarily capture the multiple cognitive and emotional processes that influence complex behavior. Second, this was a treatment-seeking sample of HD patients, which may not represent the entire range of HD severity and cognitive deficits. Many HD patients do not seek treatment voluntarily (Frost et al., 2010), and there may be important differences between treatment-seeking HD patients and those who seek treatment involuntarily or never present for treatment in the first place. Third, because these data were collected as part of an ongoing clinical trial using fMRI, we had somewhat strict inclusion criteria (e.g., medication restrictions, at least moderate HD severity, right-handedness) that may not be representative of all treatment-seeking HD patients. Finally, the sample was largely White and female, which likely does not reflect the entire HD population (Samuels et al., 2008). It will be important to replicate these findings in more diverse samples of individuals with HD.

It has been established that subjective cognitive impairment is not unique to HD. Patients with major depressive disorder (Srisurapanont et al., 2017), OCD (Moritz et al., 2006), and anxiety disorders (Hill et al., 2016) all report impaired cognitive function, even though such dysfunction is not always evident on neuropsychological tests (e.g., Srisurapanont et al., 2017). Consistent with those findings, in the present sample, subjective cognitive impairment correlated significantly with depression, anxiety, stress, and non-hoarding OCD symptoms. However, the fact that the relationship between HD and subjective cognitive impairment remained significant even when controlling for those comorbid symptoms suggests the presence of a unique relationship between hoarding and subjective cognitive impairment. Additional research using a clinical control group (e.g., patients with OCD but without hoarding) would be informative.

The presence of, and distinction between, true vs. perceived cognitive impairment in HD is an important area for future studies and has direct clinical implications. To the extent that HD is associated with objective cognitive dysfunction, cognitive remediation strategies might be considered. One example is that of Ayers et al. (2014) who employed a combination of standard cognitive-behavioral therapy (CBT) with a compensatory cognitive remediation program (Twamley et al., 2012). An alternative example is that of DiMauro et al. (2014) who sought to improve cognitive functioning using computerized drill-and-practice strategies. To the extent that HD is more strongly associated with underestimation of one's own cognitive capacity, CBT might be employed that uses cognitive restructuring and behavioral experiments to improve confidence in patients' cognitive abilities. It is quite possible that some HD patients will be characterized by true cognitive impairment, some with poor cognitive confidence, some with both, and some with neither, making patient-treatment matching an important priority.

Funding

Funded by NIMH grant R01 MH101163.

Acknowledgement

The authors thank Marla Genova and James Ransom for their assistance with data collection. Clinicaltrials.gov identifier NCT01956344.

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