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Evaluating PROMIS(®) Applied Cognition Items In a Sample of Older Adults At Risk for Cognitive Decline

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Abstract

PROMIS(®) Applied Cognition is a short self-assessment of cognitive abilities and concerns that obviates the need for a trained rater and provides online question banks that can be uniformly used across health care providers. This 12-month prospective study of 275 elderly individuals evaluates self-perceptions of cognitive functioning in relation to objective cognition, or assessment by an external rater, and compares PROMIS® Applied Cognition Abilities and Concerns subsets with commonly used “legacy” instruments. PROMIS® correlated with objective legacy measures (the Mini-Mental State Examination [MMSE] and Saint Louis University Mental Status [SLUMS] examination), depression (measured with the Geriatric Depression Scale [GDS]), anxiety, and activities of daily living. PROMIS® and MMSE correlations remained after controlling for depression and anxiety. PROMIS® associated more strongly than MMSE with depression, highlighting the relationship between subjective cognitive deficit and depression. One-year changes in PROMIS® correlated with one-year changes in MMSE and GDS. The PROMIS® Abilities subset more strongly correlated with objective cognition, whereas the Concerns subset more strongly correlated with depression and activities of daily living. PROMIS® seems to be a reasonable prescreening tool to identify patients with cognitive decline or psychological distress.

Keywords

Geriatric assessment; Dementia; Mild cognitive impairment; Self report; Depression; Anxiety; Activities of daily living

1. Introduction

Brief cognitive screening tools have been developed to identify patients who need more comprehensive neuropsychological evaluation. The Mini-Mental State Examination (MMSE) is one of the most widely used “legacy” screening instruments. However, trained raters must score the MMSE, and with the recent removal of the MMSE from the public domain, many care providers have considered a wide array of alternative measures (Carnero-Pardo, 2014; Nieuwenhuis-Mark, 2010; Newman and Feldman, 2011). The Saint Louis University Mental Status (SLUMS) (Tariq et al., 2006) is another popular cognitive screening instrument. However, use of different cognitive screening instruments makes comparison between research studies challenging (Stewart et al., 2011), and it is difficult to know which measures minimize patient burden while maximizing information and precision. The National Institutes of Health (NIH)-funded Patient-Reported Outcomes Measurement Information System (PROMIS)®, featuring publicly available short self-report forms developed using item-response theory, obviates the need for a trained rater and provides large, online question banks that could be uniformly used across health care providers (Riley et al., 2011).

The PROMIS® Applied Cognition items assess an individual’s perception of his or her cognitive status over the past week with a subset evaluating cognitive abilities and a subset evaluating cognitive concerns (Lai et al., 2014). Unlike the MMSE, which is externally administered, PROMIS® is inherently subjective, assessing patients’ distress about their cognitive functioning, which is useful information for clinicians (Lai et al., 2014). Saffer et al. (2015) found modest correlations between the Abilities subset questions and depression and anxiety in a sample of medical outpatients. However, this psychological aspect of subjective cognition measures may confound the accuracy of these instruments in assessing individuals’ cognitive functioning (Lai et al., 2009).

To address this concern, we evaluated the relationship between the PROMIS® Applied Cognition items and objective cognitive measures in a population of older individuals at risk for cognitive decline and with varying degrees of cognitive impairment, a population in which this measure had not previously been evaluated. We also compared the performance of the Abilities and Concerns subsets. Our large, longitudinal data set enabled us to evaluate changes over time in subjective and objective cognition.

2. Methods

2.1. Subjects

We recruited our sample ($n=275$ who completed PROMIS® Applied Cognition at baseline) primarily from a neurology and geriatrics outpatient clinic and various community settings in Ohio. A small number of participants were recruited during a five- to eight day-long stay at an in-patient geropsychiatric unit of an academic medical center. The mean age in our sample was 78.4 years (standard deviation [SD] 5.7) (Table 1). Our sample comprised 71.6% women, 80.0% Caucasian participants, 64.7% participants with more than a high school education, and 82.8% non-depressed participants according to GDS scoring categories (Yesavage et al., 1982). Our sample had a mean MMSE score of 27.6 (median 28.0, SD 2.5).

We administered follow-up assessments after one year with a retention rate of 92%. All study procedures were approved by the local Institutional Review Board. Participants were recruited between May 2011 and September 2013.

Inclusion criteria were broad and exclusion criteria minimal to facilitate generalization of study results to community-dwelling and primary care populations. Eligible participants were: 1) age 70 years or older; 2) experiencing mild/moderate dementia, MCI, or no cognitive impairment, as defined by an MMSE score of 16 or higher; 3) able to read and speak in English; and 4) able to provide informed consent at the time of the baseline interview. If subjects with cognitive impairment were unable to summarize study procedures after undergoing the consent process, a care partner also signed the consent form. Individuals were excluded if they had: 1) a life expectancy of less than 12 months; 2) planned a nursing home placement or a move from the greater Cleveland area within 12 months of the initial interview; 3) active substance abuse or dependence problems; or 4) a severe, uncontrolled mental disorder that would prevent completion of the study instruments.

2.2. Measures

- a. **PROMIS® Applied Cognition:** PROMIS® Applied Cognition is a 16-item measure evaluating self-impressions of cognitive function “in the past 7 days” in areas such as mental acuity, concentration, and memory (Lai et al., 2014). The measure includes a positively worded Abilities subset and a negatively worded Concerns subset. Because the subsets have opposite directionalities, we reverse coded the Concerns subset. Thus, higher scores indicate better cognitive function. Previous studies have demonstrated internal consistency reliability of greater than 0.90 for both subsets, and the Abilities subset negatively correlated with anxiety and depression (Saffer et al., 2015; Becker et al., 2014).
- b. **Objective cognitive assessment instruments:** We used the MMSE and SLUMS examination as objective cognitive instruments. The MMSE is a 12-item cognitive screening tool with 26 question subparts that assesses an individual’s orientation to time and place, registration of words, attention and calculation, recall of words, and visual construction (Tombaugh and McIntyre, 1992). The SLUMS is an 11-item screening tool with 17 total question subparts to assess cognitive ability in adults. SLUMS items can be divided into three categories: orientation, reasoning, and memory (Cao et al., 2012).
- c. **Geriatric Depression Scale (GDS):** The GDS is a 30-item self-report scale that assesses depression in older individuals. The test features yes/no responses, which require less cognitive ability compared to Likert scales (Yesavage et al., 1982). The GDS has demonstrated strong psychometric properties such as robust internal consistency (Cronbach’s $\alpha = 0.91$), split-half reliability of 0.94, and a test-retest correlation of 0.85 over one month (Parmalee et al., 1989).
- d. **Instrumental Activities of Daily Living, self-rated (IADLS):** The IADLS scale consists of 9 multiple-point ratings assessing self-impressions of money management, shopping, travel, telephoning, medication use, housekeeping, meal preparation, handy work, and laundry (Lawton et al., 1982). The IADLS

correlates with clinicians' direct observation of activities of daily living in patients at home and has shown sensitivity to change between middle age and old age (Schmitter-Edgecombe et al., 2011).

- e. **Montgomery-Asberg Depression Scale (MADRS):** To assess anxiety, we used the "inner tension" rating from the MADRS. Leading questions for the clinical inner tension rating on MADRS include "Have you felt tense or edgy in the last week? Have you felt anxious or nervous?" The individual's answers to these questions inform the clinician's rating between 0—"Placid. Only fleeting inner tension"—and 6—"Unrelenting dread or anguish. Overwhelming panic" (Willians and Kobak, 2008).

2.3. Data Analysis

We estimated the Cronbach's alpha of PROMIS® Applied Cognition items and assessed test-retest reliability by computing a Spearman correlation between the total PROMIS® raw score at baseline and the total score at the one-year time point. We characterized the demographics, depression status, and cognitive status of our sample. We performed Spearman correlations between PROMIS® raw scores and GDS, MMSE, SLUMS, IADLS, and the "inner tension" item from the Montgomery-Asberg Depression Scale (MADRS). To determine whether item-response theory could improve the accuracy of PROMIS®, we performed Spearman Correlations between PROMIS® raw scores and the output scores we generated using item-level calibrations. To access the item-level calibrations, we entered an input file of participants' scores on each item into the PROMIS® Assessment Center Scoring Service, which automatically generated an output file that contained T-scores for the total score on PROMIS®. PROMIS® investigators generated these item-level calibrations from a sample of cancer patients with a mean age of 60.6 years (SD 11.8) (Lai et al., 2014). Due to differences in age and health status between our sample and the cancer sample, we performed all analyses using raw scores rather than item-level calibrations. Spearman correlations were also performed for one-year changes over time in PROMIS® and changes over time in GDS, MMSE, and IADLS.

To examine the association of PROMIS® Applied Cognition to objective cognitive function when controlling for depression and anxiety, we performed regression analysis between MMSE (dependent variable) and PROMIS®, GDS, and MADRS "inner tension" item (independent variables). We also assessed the relationship of PROMIS® with GDS compared to the relationship of MMSE with GDS. We correlated MMSE and PROMIS® with GDS and, using a linear regression model, jointly modeled their association as independent variables with GDS as the dependent variable.

To contrast the PROMIS® Abilities and Concerns subsets, we performed Spearman correlations between each subset and GDS, MMSE, and IADLS. We then carried out regressions of GDS, MMSE, or IADLS (dependent variable) on the Abilities and Concerns subsets (as separate independent variables).

Given our interest in evaluating a range of associations with PROMIS®, we adopted a two-sided Type I error level of 0.05 for all hypothesis tests.

3. Results

PROMIS® Applied Cognition had a Cronbach's alpha of 0.94 at baseline, while the Spearman correlation reflecting test-retest reliability was 0.60. The Abilities subset had a Cronbach's alpha of 0.95 and a test-retest reliability of 0.52. The Concerns subset had a Cronbach's alpha of 0.93 and a test-retest reliability of 0.64.

PROMIS® raw score significantly correlated with GDS, MMSE, SLUMS, and IADLS (Table 2). Pearson correlations generally produced results similar to Spearman correlations. The PROMIS® T-scores generated by item-level calibration demonstrated a correlation of 0.99 with the raw scores. Changes over time in PROMIS® significantly correlated with changes over time in GDS ($\rho=-0.19$, $p=0.003$, $df=260$) and MMSE ($\rho=0.13$, $p=0.028$, $df=267$) but not IADLS ($\rho=0.002$, $p=0.970$, $df=256$). Linear regression of MMSE (dependent variable) on PROMIS®, GDS, and anxiety (independent variables) produced coefficients of $B=0.049$ (S.E. [standard error]=0.013, $p<0.001$) for PROMIS®, $B=-0.012$ (S.E.=0.038, $p=0.760$) for GDS, and $B=0.092$ (S.E.=0.181, $p=0.613$) for anxiety.

We next assessed the relationship of GDS with PROMIS® and MMSE. Whereas PROMIS® significantly inversely correlated with GDS (Table 2), the relationship between MMSE and GDS did not reach significance ($\rho=-0.11$, $p=0.070$, $df=272$). When GDS was regressed on PROMIS® and MMSE, PROMIS® was significant ($B=-0.154$, S.E.=0.023, $p<0.001$), but MMSE was not ($B=-0.006$, S.E.=0.114, $p=0.956$).

Both the Abilities and Concerns subsets correlated with GDS, MMSE, and IADLS (Table 3). Regression with the Abilities and Concerns subsets as independent variables illustrated that the Concerns subset more strongly associated with baseline GDS and IADLS, while the Abilities subset more strongly associated with baseline MMSE (Table 4).

4. Discussion

The self-report measure PROMIS® Applied Cognition was significantly correlated with the MMSE and SLUMS, two measures of cognitive performance. This relationship with objective cognition remained after controlling for depression and anxiety. Further, one-year changes over time in PROMIS® Applied Cognition were associated with changes over time in the MMSE. Some have argued that individuals' personal definitions of cognitive health may decrease the objective accuracy of subjective cognitive measures. Because longitudinal analyses use intra-individual difference values, these analyses remove the influence of differing individual definitions of cognitive function at baseline (Zimprich et al., 2003). Our results suggest that the self-rated PROMIS® Applied Cognition tool may be sensitive to actual cognitive decline over time in elderly community-dwelling people.

Previous correlations of measures of perceived cognitive function with objective neuropsychological tests have been inconsistent (Von Ah and Tallman, 2015; Lenehan et al., 2012; Lai et al., 2009; Zimprich et al., 2003). However, cognitive complaints—even in the absence of objective cognitive impairment—have been associated with gray matter changes similar to those found in people with objective mild cognitive impairment (MCI) (Saykin et al., 2006). Thus, subjective and objective cognitive decline may have a common neural

basis. Our correlational results may suggest that the rigorous development process of PROMIS® Applied Cognition has produced items that successfully detect this neurodegenerative process. However, the correlation between subjective and objective cognition was only moderate, which could reflect residual influence of psychological states on subjective measures (Lai et al., 2009) or the inherent difference in format between self-report and performance-based measures. Our multivariate analysis illustrates that PROMIS® may be more influenced than the MMSE by depression. Additionally, some people with dementia are unaware of their memory deficits (Markova et al., 2014), which could skew the results of subjective cognitive measures. Use of appropriate item-level calibrations could strengthen the correlation between PROMIS® Applied Cognition and objective cognitive measures.

We support the finding by Saffer et al. (2015) of a modest inverse correlation between the Abilities subset and depression, and we also demonstrated associations between PROMIS® Applied Cognition as a whole and depression and anxiety. PROMIS® Applied Cognition correlated more strongly than the MMSE with depression, and changes over time in PROMIS® scores correlated with changes over time in depression. Thus, PROMIS® may better reflect patients' psychological state than the MMSE. Though some view this association between subjective cognitive measures and depression as a limitation, others posit that this association is clinically useful as an indication of patients' distress (Saffer et al., 2015; Lai et al., 2014). Moreover, Caqueo-Úrizar et al. (2015) found that subjective cognition correlated more strongly than objective cognition with quality of life.

Though PROMIS® Applied Cognition correlated significantly with activities of daily living at baseline, changes over time in these measures did not correlate significantly. Since MCI is not traditionally associated with major abnormalities in activities of daily living, perhaps subtler changes in cognition that may occur over one year would not be reflected by the IADLS (Winblad et al., 2004; Petersen et al., 1999).

The Concerns subset correlated more strongly with depression and activities of daily living, whereas the Abilities subset correlated more strongly with objective cognitive status. To our knowledge, we are the first to evaluate the clinical relationships of PROMIS® Applied Cognition subsets. Other research has supported the idea that perceived cognitive abilities may be more objective and less vulnerable to influence from psychological states than perceived cognitive concerns (Von Ah and Tallman, 2015; Lai et al., 2014). Prior studies have proposed that the negatively worded Concerns subset corresponds to negatively worded psychological measures (i.e., depression)—perhaps due to negatively framed questions resonating with people experiencing negative affect (Von Ah and Tallman, 2015; Mora et al., 2007; Becker et al., 2014). Though IADLS items are positively worded, some answer options are negatively worded (i.e., “completely unable to use the telephone”). It could be that seeing these answer options that infer disability biases people with negative affect to select these answers, potentially explaining the relationship between the Concerns subset and IADLS.

PROMIS® Applied Cognition and its subsets had excellent internal consistency reliabilities. The somewhat lower test-retest reliabilities may be attributable in part to the cognitive mobility of this study population (Howland et al., 2016).

Our study had some limitations. For one, few participants had depression. A wider range of depression levels would have been preferable to evaluate the correlation between depression and PROMIS®. In addition, our sample had little ethnic or racial diversity and relatively high levels of education, which may prevent generalization of our results to ethnic minorities or less educated populations. Further, the reliability of individual MADRS items has not been established, which limits conclusions that can be drawn from the analyses involving the “inner tension” MADRS item. Finally, item-level calibrations were not available for our sample of older adults at risk for cognitive decline. Instead we calculated raw scores, which may have been less accurate.

PROMIS® Applied Cognition assesses both cognition and psychological states in less than five minutes. Because both the Abilities and Concerns subsets had important associations, clinicians may benefit from administering both, especially given that shorter versions of these subsets may have acceptable internal consistency reliabilities (Saffer et al., 2015). Clinicians may benefit from using PROMIS® Applied Cognition as a brief, easy-to-administer prescreening to determine whether patients should be further evaluated for cognitive decline or psychological distress.

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Table 1

Baseline demographic and clinical characteristics for the baseline sample of participants who completed PROMIS® Applied Cognition

	Percentage (frequency) or mean (SD) for the baseline sample (N=275)
Age (years)	78.4 (5.7)
Gender	
Female	71.6% (197)
Male	28.4% (78)
Education level	
No high school diploma	10.2% (28)
High school diploma	25.1% (69)
Some college	23.3% (64)
College degree	22.9% (63)
Graduate degree	18.5% (51)
Race	
Caucasian	80.0% (220)
African-American	17.5% (48)
Other	2.5% (7)
GDS category	
No depression	82.8% (222)
Mild depression	16.0% (43)
Severe depression	1.1% (3)
Average MMSE score	27.6 (2.5)
Average SLUMS score	22.3 (4.7)
Average PROMIS® Applied Cognition score	59.6 (12.2)
Average PROMIS® Applied Cognition Abilities subset score	28.8 (7.6)
Average PROMIS® Applied Cognition Concerns subset score	30.7 (6.6)

Table 2

Spearman correlations for PROMIS® Applied Cognition and GDS, MADRS “inner tension,” MMSE, SLUMS and IADLS at baseline

	PROMIS® Applied Cognition
GDS	−0.42 ** ($p<0.001$)
MADRS “inner tension”	−0.22 ** ($p<0.001$)
MMSE	0.24 ** ($p<0.001$)
SLUMS	0.35 ** ($p<0.001$)
IADLS	0.24 ** ($p<0.001$)

GDS = Geriatric Depression Scale; MADRS = Montgomery Asberg Depression Rating Scale; MMSE = Mini-Mental State Examination; SLUMS = Saint Louis University Mental Status examination; IADLS = self-report Instrumental Activities of Daily Living Scale.

¹The Concerns subset was reverse scored.

* = significant at $p<0.01$

** = significant at $p<0.001$

Table 3

Spearman correlations for PROMIS® Applied Cognition Abilities and Concerns subsets and GDS, MMSE, and IADLS

	Abilities subset	Concerns ^I subset
GDS	-0.31 ** ($p<0.001$)	-0.49 ** ($p<0.001$)
MMSE	0.24 ** ($p<0.001$)	0.22 ** ($p<0.001$)
IADLS	0.20 ** ($p<0.001$)	0.28 ** ($p<0.001$)

GDS = Geriatric Depression Scale; MMSE = Mini-Mental State Examination; IADLS = self-report Instrumental Activities of Daily Living Scale.

^IThe Concerns subset was reverse scored.

* = significant at $p<0.01$

** = significant at $p<0.001$

Table 4

Linear regression of GDS, MMSE, and IADLS on PROMIS® Applied Cognition Abilities and Concerns subsets

Abilities subset			Concerns [†] subset			
<i>B</i>	S.E.	<i>p</i> -value	<i>B</i>	S.E.	<i>p</i> -value	
GDS	-0.062	0.041	<i>p</i> =0.129	-0.265**	0.047	<i>p</i> <0.001
MMSE	0.065*	0.022	<i>p</i> =0.003	0.031	0.031	<i>p</i> =0.220
IADLS	0.027	0.021	<i>p</i> =0.189	0.071*	0.024	<i>p</i> =0.004

B = beta coefficient from regression analysis; S.E. = standard error; GDS = Geriatric Depression Scale; MMSE = Mini-Mental State Examination; IADLS = self-report Instrumental Activities of Daily Living Scale.

[†]The Concerns subset was reverse scored.

* = significant at *p*<0.01

** = significant at *p*<0.001