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Development and Initial Validation of a Brief Self-Report Measure of Cognitive Dysfunction in Fibromyalgia

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Abstract

Pain is often the focus of research and clinical care in fibromyalgia (FM); however, cognitive dysfunction is also a common, distressing, and disabling symptom in FM. Current efforts to address this problem are limited by lack of a comprehensive, valid measure of subjective cognitive dysfunction in FM that is easily interpretable, accessible, and brief. The purpose of this study was to leverage cognitive functioning item banks that were developed as part of the Patient Reported Outcomes Measurement Information System (PROMIS[®]) to devise a 10-item short form measure of cognitive functioning for use in FM. In Study 1, a nationwide (US) sample of 1035 adults with FM (age range: 18–82, 95.2% female) completed two cognitive item pools. Factor analyses and item response theory (IRT) analyses were used to identify dimensionality and optimally-performing items. A recommended 10-item measure, called the Multidimensional Inventory of Subjective Cognitive Impairment (MISCI) was created. In Study 2, 232 adults with FM completed the MISCI as well as a legacy measure of cognitive functioning that is used in FM clinical trials, the Multiple Ability Self-Report Questionnaire (MASQ). The MISCI showed excellent internal reliability, low ceiling/floor effects, and good convergent validity with the MASQ ($r = -.82$).

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Perspective—This paper presents the Multidimensional Inventory of Subjective Cognitive Impairment (MISCI), a 10-item measure of cognitive dysfunction in fibromyalgia, developed through classical test theory and item response theory. This brief but comprehensive measure shows evidence of excellent construct validity through large correlations with a lengthy legacy measure of cognitive functioning.

Keywords

fibromyalgia; cognitive functioning; self-report; PROMIS; MISCI

Introduction

In addition to chronic widespread pain, cognitive dysfunction has emerged as one of the most highly prevalent, distressing, and disabling FM symptoms.^{26, 29} This “dyscognition” can indicate objective cognitive difficulty, as has been reflected in diminished performance on tests of memory^{16, 21, 27, 32, 33, 40}, verbal fluency^{4, 22, 32, 33}, attention and concentration¹⁶, and executive functioning⁵. Dyscognition can also refer to subjective cognitive problems, often called “fibrofog,” which includes perceived problems with memory, managing activities/schedule, verbal expression, focus/concentration, and generally experiencing life in a haze^{2, 15, 25}. Fibrofog is related to distress about one’s condition and problems maintaining relationships, working, communicating, driving, organizing/planning, and initiating activities of daily life^{2, 15}. In fact, patients rate fibrofog among the top five most important and troubling FM symptoms^{7, 29}.

Unfortunately, no self-report measure of multi-faceted cognitive functioning has been developed for FM³⁹. The Mental Clutter Scale²⁸, was developed to assess the narrow construct of “mental foggiess” in FM, but does not assess facets of cognition such as memory, language, or concentration. The Multiple Ability Self-Report Questionnaire (MASQ)³⁸, developed for use in medical populations, has been used to characterize fibrofog⁴⁷ and is commonly used to assess cognitive dysfunction in FM clinical trials^{3, 13, 30}. The MASQ has 38 items and assesses language, visual/perceptual ability, verbal memory, visual memory, and attention. Estimates suggest it takes 10 minutes to complete the MASQ⁴⁶. Brevity and accessibility are especially important in a complex condition like FM, where it is often necessary to assess a wide range of symptoms and functional domains. Consequently, a comprehensive measure of dyscognition in FM that is briefer than the MASQ is highly desirable for both clinical and research applications.

The development of brief and accessible patient-reported outcomes measures is the goal of the two federally-funded initiatives, the Patient Reported Outcomes Measurement Information System (PROMIS®), designed to be “generic,” or universally-relevant, and the Quality of Life in Neurological Disorders (Neuro-QOL), designed to be generic within neurological conditions. PROMIS® and Neuro-QOL (PROMIS®/NQ) share a common rigorous methodology combining classical test theory and item response theory (IRT) to develop contemporary measures of physical, mental, and social outcomes. PROMIS® has two cognition item banks: Applied Cognition-Abilities and Applied Cognition-General

Concerns^{11, 12}, and Neuro-QOL also has two banks: Applied Cognition-General Concerns and Applied Cognition-Executive Functioning.

PROMIS[®] and Neuro-QOL share many overlapping items, are scored on a T-score metric (Mean = 50, SD = 10), and scores are comparable across the two measurement systems. Measures are available as either computer-adaptive tests (CAT) or short forms. The standard PROMIS[®]/NQ short-forms do not provide broad content coverage across all cognitive domains relevant to individuals with FM. For example, the PROMIS[®] Applied Cognition – General Concerns Short Form 8a primarily contains items that assess attention and general mental clarity but does not contain items that assess memory or language abilities. Fortunately, PROMIS[®]/NQ allow for creation of custom short-forms by selecting a static set of available items from the item banks.

This paper describes two studies. The aim of Study 1 was to develop a brief but comprehensive short-form measure of subjective cognitive dysfunction in FM by conducting factor analyses and IRT analyses in the PROMIS[®]/NQ cognitive functioning items to identify a) the inherent dimension in the cognition items and b) items that provide optimal information in adults with FM. The aim of Study 2 was to evaluate the construct validity, internal consistency and distribution characteristics (e.g. floor and ceiling effects) of the newly created cognition short-form and compare it to standard PROMIS[®] short-forms in terms of validity and reliability.

Patients and Methods

Study 1: Factor Analysis/IRT

Participants—Participants were 1035 adults who reported a diagnosis of FM and who were members of the National Fibromyalgia Association (NFA), a patient advocacy organization. Most of the participants were female and Caucasian. The average age of the sample was 48.70 years (minimum-maximum = 18–82 years). All 50 states in the United States of America were represented in the sample. In terms of educational achievement, only 13.2% of the sample had a 12th grade education/equivalent or lower, whereas most people had attended some college or received a post-secondary degree. Additional participant demographics are described in the upper half of Table 1.

Study Procedures—This study constitutes the cognitive arm of a larger study (N= 4265) that examined multiple PROMIS[®]/NQ item pools (e.g. pain interference, sleep disturbance, fatigue) in adults with FM. The Institutional Review Board at the University of Michigan approved all aspects of the study before it was initiated. Participants were recruited through an advertisement in the monthly NFA newsletter, which was distributed to approximately 70,000 NFA members. The advertisement described the study and provided a URL (website) link to the study site (PROMIS Assessment CenterSM). Interested individuals who entered the study website first viewed an informed consent page and could indicate consent electronically. After enrolling in the study, participants were given a unique Assessment CenterSM login ID and password. After completing a basic demographic form, each participant completed only one of the two cognitive item pools, Form A (n = 520) or Form B (n = 515), to minimize participant burden. Participants also completed items from the

alternate Form (to serve as bridging items between the forms) as well as several items from other item banks (e.g. fatigue). Each participant was compensated \$10 for participation. Data was securely stored by Assessment CenterSM until it was downloaded by study investigators in Microsoft Excel format for data analysis. All data were collected between April 2009 and May 2010.

Measures—At the time the current study was initiated, PROMIS[®] was in the process of developing and evaluating two large items banks to assess cognitive functioning: the Cancer PROMIS Supplement (CaPS) Initiative and the NeuroQOL^{44, 45}. Currently, PROMIS[®] offers two item banks for the assessment of Applied Cognition: Cognitive Abilities (33 items) and General Concerns (34 items^{10, 18, 19} that were based on the CaPS and NeuroQOL items banks. Given that this study predated the currently refined PROMIS[®] Applied Cognition banks, the entire CaPS and NeuroQOL item banks were administered and evaluated in our sample even though some of these items were subsequently eliminated from the current version of PROMIS[®]/NQ. Form A contained 78-items consisting of items that assessed perceived cognitive functioning and contained 42 negative statements (e.g. “I had trouble forming thoughts”) and 36 positive statements (e.g. “I have been able to think clearly”). Each item began with a common item stem, “In the past 7 days,” to provide a time frame for respondents to rate the frequency of each item on a 5-point response scale (never, rarely, sometimes, often, very often). Form B contained 88-items consisting of items that assessed applied cognitive dysfunction and had 42 items rated on a 5-point scale that indicated degree of difficulty completing each item (i.e., none, a little, somewhat, a lot, cannot do; e.g., “how much difficulty do you currently have reading simple material?”). The remaining 46 items had a common item stem “In the past 7 days” with a 5-point response scale indicating frequency of the item (never, rarely, sometimes, often, always; e.g., “I made simple mistakes more easily”).

Data Analyses

Factor Analysis: Factor structure was examined separately for the two cognitive item banks (Form A/Form B) by means of full-information item factor analysis³⁶ using a computer program for conducting ordinal factor analysis, ORDFAC³⁵. Previous research has indicated that full-information item factor analysis produces slightly more accurate results and allows for greater clarity in the identification of the number of factors than does factor analysis of polychoric correlation matrices³⁶. The Akaike Information Criterion (AIC¹) and the Bayesian Information Criterion (BIC³⁷) were used to compare model fit to the data, with emphasis on BIC values, given that this is the more conservative of the two criteria. For both criteria, the model with the lowest value was chosen.

Item Response Theory Analyses: Samejima’s graded response model (GRM³⁴) was used to fit the item responses to each uni-dimensional cognitive functioning subscale that was identified through factor analysis. This is the same modeling approach used by PROMIS[®]/NQ in the calibration of their item banks. Fit of the GRM entails determining the slope parameter, which details the steepness of the item characteristic curves (ICC’s) for the various categories, and the threshold parameters, which gives the intersections of the ICC’s for adjacent categories. All models were fit using MULTILOG 7⁴³. Estimation of the item/

test polyserial correlations was accomplished using the R-statistical package²³. Item information function and polyserial correlations were used to guide selection of the items that best assessed each cognitive domain.

Results (Study 1)

Factor Analysis: For Form A, the Chi-Squared, BIC, and AIC criteria all indicated a five factor model (Table 2). The factors consisted of items concerning mental confusion (factor 1), mental acuity (factor 2), memory (factor 3), spoken language (factor 4), and how one's cognitive functioning is perceived by others (factor 5). Because the fifth factor had only 4 items that did not relate to cognitive functioning, this factor was dropped, resulting in four factors on Form A that define measureable dimensions of cognitive functioning. For Form B, all criteria indicated a five factor model (Table 2). The factors consisted of items related to mental confusion (factor 1), visual/spatial/symbolic interpretation (factor 2), spoken language (factor 3), memory (factor 4) and planning and organization (factor 5). Across both forms, results of factor analyses indicated 5 distinct cognitive functioning domains. These were: 1) Mental Clarity; 2) Memory; 3) Language; 4) Symbolic reasoning; and 5) Organization. The first factor was created by combining mental acuity and mental confusion into a single factor given that they represent positive and negative poles of mental clarity.

IRT Results: Key to the IRT analyses was determining the items that were most informative for measuring a particular dimension (i.e., steeper slopes lead to higher item information functions (IIF's)). Secondly, highly informative items were evaluated relative to each other such that breadth of content was maximized along with high IIF's

Creation of a 10-item short form: Three main criteria were considered in selecting the items for the FM cognition short form. First, it was important to select items that demonstrated excellent, or "high discrimination" IRT parameters; because the short form was designed to have few items, it was important that each item provide a great deal of information. Second, it was important that the short form have adequate content coverage. For this study, we sought to create a short form that would assess a broad range of domains of cognitive functioning. To attain good content coverage, we considered the results of the factor analysis from a clinical perspective on which domains of cognitive functioning would be most important to assess in FM. The Mental Clarity, Memory, and Language factors were considered clinically important domains of cognitive functioning. Items from the Symbolic and Organization factors were combined into a single domain, because clinically, these items reflected the broad domain of cognitive functioning called executive functioning. Because attention and concentration problems are commonly reported by persons with FM, it was determined that items reflecting this cognitive domain should be included in the short form. Therefore, in terms of content coverage, we selected candidate short form items that represented the following five cognitive domains: 1) Mental Clarity, 2) Memory, 3) Language, 4) Executive Functioning, and 5) Attention/Concentration. With the goal of developing a 10-item short form, 2 items from each domain were selected. Third, it was important to select items that were, at the time of this publication, part of the current PROMIS[®]/NQ cognitive item banks. This was an important criterion because these items would be freely and easily accessible through the Assessment CenterSM website, met strict

psychometric and interpretability criteria, and could allow for comparison to PROMIS[®]/NQ measures in future work.

Pragmatic considerations were also taken into account in the creation of the short form. For example, there are three possible response sets for the PROMIS[®]/NQ items: “Never – Very Often”, “Not at all – Very Much”, and “None – Cannot Do”. The vast majority of candidate items used the first two response sets. To produce a simpler short form, with a maximum of two response option sets, we did not consider items that used the last response set (“None – Cannot Do”). In selecting items for the short form, we also made efforts to avoid item redundancy. Therefore, in cases where two very similar items showed excellent IRT parameters, one item was chosen over the other based on better empirical findings and/or item wording that was simpler or more general.

Overview of 10-item Multidimensional Inventory of Subjective Cognitive Impairment

(MISCI): The items and response options for the 10-item FM cognition short form, named the Multidimensional Inventory of Subjective Cognitive Impairment (MISCI), are found in Table 3. The first 6 items are positively worded and reflect perceived cognitive abilities and the last 4 items are negatively worded and reflect perceived cognitive difficulties. There are two items from each cognitive domain, listed in the following order: mental clarity, memory, attention/concentration, executive functioning, and language. The same scoring metric is used for both response scales; however, the scores on items 7–10 must be reverse-coded prior to summing the responses to generate the total score due to the negative wording of these items. The possible raw score range is 10–50, with higher scores indicating better perceived cognitive functioning (i.e., lower impairment). So as to be compatible with the PROMIS[®]/NQ metric, two sets of T-score scale conversions were calculated and are shown in Table 4. The study sample T-score conversion values are based on IRT-parameters from this study; therefore, T-scores derived from this conversion would provide for comparison with the Study 1 sample (N = 1035). The PROMIS[®] equivalent T-score conversion values are based on IRT-parameters from PROMIS[®]; therefore, T-scores derived from this conversion would provide for comparison to the PROMIS[®] normative sample.

Study 2: MISCI Validity and Reliability

Participants—This study was an analysis of the cognitive arm of a larger study (N=1,506) that assessed the reliability and validity of original and newly re-calibrated PROMIS[®]/NQ items banks across multiple domains of patient reported health status. Participants were all members of the NFA and reported FM diagnoses. Of this larger sample, 232 adults completed the cognitive arm and were included in the data analysis for Study 2.

Demographic and descriptive data for key study variables are described in the lower half of Table 1. Participants in the cognitive arm were predominately female and Caucasian. Gender, age, and race were the only demographic variables collected in this study. Scores in this sample on the Multiple Ability Self-Report Questionnaire (MASQ), a measure of cognitive dysfunction that is described in more detail in the Measures section, are somewhat higher (indicating more dysfunction) than have been found in previous studies. For example, average total MASQ scores across four previous studies ranged from 90.6 – 96.2^{3, 24, 30, 47}. The sample average on the Fibromyalgia Impact Questionnaire Revised (FIQ-R), a measure

of FM severity that is described in more detail in the Measures section, is consistent with the average score for people with FM on the FIQ-R (average = 63), according to FIQ-R FM severity interpretation guidelines and findings from previous research^{6, 17}.

Study Procedures—The Institutional Review Board at the University of Michigan approved all aspects of the study before it was initiated. A description of the study was posted on the NFA website and an email announcement from the NFA was sent to members inviting them to participate. Interested individuals were able to access the study specific website through a secure URL link to the Assessment CenterSM. After accessing the website, individuals were prompted to read and complete an electronic informed consent. Once individuals consented electronically, they were given a login and password. After login, participants submitted their name and address for the sole purpose of payment and this information was unlinked to the research data. Participants completed a de-identified sociodemographic form identical to the one used in Study 1. Next they were randomly assigned to one of six study arms each consisting of one of the following patient self-report batteries: pain, fatigue, physical function, mood, sleep, and cognition. Each participant was administered between 70–140 items, with an average administration time of 30–40 minutes. Data were collected between May and June 2012. Participants were compensated \$10 dollars for their participation.

Measures—Participants provided basic demographic information (e.g. age, race, sex), and completed the CaPS and NeuroQol item banks (described in detail above), which were used to calculate scores for the MISCI, PROMIS Cognition-Abilities short form 8a, and PROMIS Cognition – General Concerns short form 8a, as well as two legacy measures.

Multidimensional Inventory of Subjective Cognitive Impairment (MISCI)—The items on the newly developed 10-item MISCI were administered. The items that were used to calculate MISCI scores were drawn from items that were either administered as PROMIS®-calibrated CATs or short forms. The raw scores for each of the 10 items were summed to produce a total sum score for the MISCI.

Legacy Measures—Two “legacy” measures, commonly used as outcome measures in FM research, were used to support the validity of the newly-developed 10-item short form. The Multiple Ability Self-Report Questionnaire (MASQ) is a 38-item self-report measure that assesses perceived difficulties in five cognitive domains: language ability (8 items), visual-perceptual ability (6 items), verbal memory (8 items), visual memory (8 items), and attention/concentration (8 items)³⁸. Items on the MASQ reflect the degree to which the respondent has difficulty with cognitive tasks, rated on a Likert scale from 1 = Never to 5 = Always. Items within a subscale are summed for subscale scores and the total score reflects the sum of all 38 items. Possible scores range from 38–190 and higher scores indicate more cognitive problems/difficulty. Cronbach’s alpha for the full MASQ scale = 0.94 (38 items) in this sample, suggesting good internal reliability. The MASQ was used to establish convergent validity. The Fibromyalgia Impact Questionnaire Revised (FIQ-R)^{5, 8} has 9 items that assess physical functioning (first domain), 2 items that assess overall impact (second domain), and 10 items that assess symptoms (e.g., pain, fatigue, stiffness; third

domain), for a total of 21 items. One item in the symptom domain, “please rate your level of memory problems,” assesses cognitive dysfunction. All items share a common response scale from 0 – 10, with higher numbers reflecting greater severity. The measure is scored by summing the responses for each of the three domains (function, overall, and symptoms) and normalizing the scores by dividing domain one by 3, leaving domain two unchanged, and dividing domain three by 2. The total score reflects the sum of the resulting normalized domain scores. In this sample, Cronbach’s alpha = 0.94 (21 items). The FIQ-R was used to establish discriminant/divergent validity (e.g. correlations between the MISCI and the FIQ-R were not expected to be as large as with the MASQ).

Data Analyses—Zero-order correlations between the newly created FM cognition short-form, the PROMIS® Cognitive - Abilities short-form 8a, the PROMIS® Cognitive - General Concerns short-form 8a, the subscale and total scores for the MASQ and FIQ-R, and the FIQ-R memory item were used to examine construct validity. Correlations 0.6 or greater were considered good evidence of convergent validity and smaller correlations with FIQ-R scores relative to MASQ scores was considered evidence of divergent validity⁹. Steiger’s t-tests³¹ were conducted to test whether the correlations between the MISCI and the MASQ total score were significantly different from the correlation between the PROMIS® standard short-forms and the MASQ criterion. Internal consistency reliability was examined through calculation of Cronbach’s alpha statistic (criterion = 0.70). Data distribution characteristics, including mean, standard deviation (SD), skew, kurtosis, and percentage of cases with the lowest and highest possible values (i.e. floor and ceiling effects) were calculated.

Validity Results—Correlational results are depicted in Table 5. The MISCI showed medium to large significant correlations with the MASQ subscale scores; the largest correlation was with the MASQ total score. Similarly, both PROMIS® standard short forms showed medium to large correlations with the MASQ subscale and total scores. This suggests good convergent validity of the MISCI as well as for the existing standard PROMIS® short-forms. The MASQ/MISCI correlation was significantly higher than both the MASQ/PROMIS® Cognitive Abilities correlation, $Z = 4.40, p < 0.01$, and the MASQ/PROMIS® Cognitive General Concerns, $Z = 5.31, p < .01$. Interestingly, the correlations between the MISCI and both the PROMIS® Cognitive Abilities short form and the PROMIS® Cognitive Concerns short form were significantly larger than the correlation between the two PROMIS® short-forms ($Z = 7.48, p < .01$; $Z = 5.00, p < .01$, respectively). Although all of the short-forms correlated significantly with the FIQ-R subscales and total score, these correlations were generally smaller magnitude than the correlations with the MASQ, suggesting that these measures of cognition are not highly redundant with measures of general FM symptom burden, functional status, or FM disease severity. The relatively higher correlation between the MISCI and the single FIQ-R “memory problem” item compared to the FIQ-R subscale scores and total score further supports this conclusion.

Reliability and Data Distribution Results—The MISCI and the PROMIS® short-forms demonstrated good internal consistency reliability. The MISCI Cronbach’s alpha = 0.95. The 8-item PROMIS® Cognitive –Abilities short form 8a Cronbach’s alpha = 0.96 and the 8-item PROMIS® Cognitive- General Concerns short form 8a Cronbach’s alpha = 0.96.

In this sample, the average MISCI score was 25.94 (SD=9.52; median = 26.00). Skew (0.34) and kurtosis (-0.62) values indicate a reasonably normal distribution of MISCI scores. Floor and ceiling effects were quite low, with only 6 (2.6%) cases with a raw score of 10 and no cases with a raw score of 50 (1 case had a raw score of 49).

Discussion

The aim of this study was to utilize classical test theory and IRT to develop and validate a brief but comprehensive short-form measure of cognitive functioning for use in FM. Such a measure is sorely needed by clinicians and researchers alike, who currently either choose not to assess cognitive problems or, if they do, subject patients to considerable burden in order to gain adequate breadth covering the cognitive dysfunction domain (e.g., using the MASQ).

The 10-item Multidimensional Inventory of Subjective Cognitive Impairment (MISCI) was developed, guided by empirical indicators such as item information functions and factor analytic results, as well as knowledge of relevant cognitive domains (based upon clinical experience and existing research findings). The resulting questionnaire has items that reflect abilities or concerns with memory, verbal language ability, general mental clarity, attention/concentration, and executive functioning. In contrast the PROMIS[®] Cognition – General Concerns short form 8a does not have any items that assess memory or language functioning, and the PROMIS[®] Cognition – Abilities short form 8a does not have any items that assess language functioning. Both of these PROMIS[®] short forms contain just one item each that could be considered an executive functioning item (i.e., item IDs PC47_2 for Abilities and PC42 for General Concerns). We believe that these omissions from the PROMIS[®] forms are significant and could limit the adequacy of these measures to assess perceived cognitive functioning in FM, given that complaints about verbal communication and managing daily activities and schedules are characteristic of fibrofog and are known deficits on objective testing with individuals with FM^{4, 5, 22, 32, 33}. Indeed, in qualitative studies that allow the patients themselves to define the scope of cognitive problems in FM, the range of cognitive complaints is quite broad^{2, 14}, including: problems with reaction/response time, disorientation, and acuity/confusion, which are covered by the two MISCI mental acuity items; problem solving, reasoning and planning skills, (MISCI executive functioning items); problems with word finding and self-expression, (MISCI language items); forgetfulness, learning, and memory, (MISCI memory items); and attention and concentration (MISCI attention/concentration items).

The MISCI demonstrated excellent psychometric properties. Internal consistency was very good. Convergent validity of the MISCI was supported by large correlations with the MASQ subscale and total scores. This suggests that the MISCI is highly redundant with the MASQ, but is much shorter (i.e., 28 fewer items). The 8-item PROMIS[®] generic short forms also performed well in this sample. Both measures demonstrated good internal reliability and large correlations with the MASQ total score. The fact that both PROMIS[®] short forms predominantly contain items that reflected mental clarity and attention (with few or no items for memory, language, and executive functioning) is reflected in the somewhat higher correlations of the generic PROMIS[®] short forms with the MASQ attention subscale compared to the MASQ language and memory subscales.

The PROMIS[®]/NQ are designed so that anyone can construct a customized short form by selecting any number of items that they deem desirable for their population of interest. Use of the MISCI is recommended with individuals with FM because we have demonstrated that this grouping of PROMIS[®]/NQ items has solid psychometric properties across two samples of adults with FM, including good internal reliability and low floor/ceiling effects, and has good content coverage. Consistent use of the MISCI by other FM researchers will allow for comparison of cognitive functioning scores across studies. Additionally, because it is possible to convert the raw scores of the MISCI to T-scores that are comparable to this study sample (N = 1035) as well as the PROMIS[®] normative sample, clinicians and researchers can compare the score for any given patient or participant sample to others with FM (using this study sample T-scores) or the general US population (using the PROMIS[®] T-scores). Although further research is needed to provide a more complete understanding of the psychometric properties and clinical utility of the MISCI, based on this preliminary evidence, clinicians and researchers alike can incorporate the MISCI into their assessment battery. The MISCI is entirely comprised of PROMIS[®]/NQ items, which are recommended for use once validated in a given population.

Subjective cognitive dysfunction in FM, fibrofog, is a major contributor to distress about the severity of one's condition²⁶ and is related to problems coping with symptoms and higher health care utilization⁴⁸. However, there is a lack of clarity about how much subjective cognitive dysfunction relates to objective cognitive difficulty. For instance, several FM studies have found that perceived cognitive functioning is related to neurocognitive test performance^{20, 21, 42}. However, one study found no associations between subjective cognitive functioning and neurocognitive test performance after controlling for fatigue, pain and depression⁴¹. Furthermore, there is some evidence that, compared to control subjects without FM, the self-report of cognitive dysfunction is disproportionate to objective difficulty on cognitive testing²¹. Future research that examines the correspondence of MISCI scores with neurocognitive test scores, and the impact of various symptoms on that association, would be useful in determining the extent to which objective cognitive ability is assessed with the MISCI. Longitudinal studies that examine the extent to which individuals are able to perceive changes in cognitive ability from their own typical level of functioning would be particularly useful.

Study Strengths and Limitations

There are a number of notable strengths to this study including the large and geographically diverse samples, use of both IRT and classical test theory, and consideration of clinical and pragmatic issues in MISCI item selection. The sample was limited by the fact that participants self-reported their FM diagnosis, although this approach is consistent with the overall PROMIS[®] methodology, which utilized self-report of diagnosis in the normative sample. All participants in both studies were NFA members which makes it more likely that the self-reported diagnostic status was accurate than if we had recruited from the general community. In the demographic questionnaire for Study 1, only 13 (1.5%) of participants responded 'no' to the question, "Have you been diagnosed with FM?" Furthermore, as described in the Methods/Participants section for Study 2, the average FIQ-R score for this sample is the same as the normative average for individuals with FM¹⁷. Further examination

of frequencies of FIQ-R total scores in this sample indicate that, only 2 participants (0.9%) scored in the normal range, 55 (23.7%) were in the mild FM range, 50 (21.5%) were in the moderate FM range, 71 (30.6%) were in the severe FM range, and 54 (23.3%) were in the extreme FM range. Although the FIQ-R is not a proxy for an FM diagnosis, the fact that over 75% of the people in Study 2 reported FM severity in the moderate to extreme range, along with the other available data, suggests that relatively few people in the studies would not meet criteria for FM.

The sample was also quite homogeneous in terms of sex and race, which limits our ability to generalize the findings to males or racial/ethnic minorities; however the sociodemographics of this study are similar to the sociodemographics for fibromyalgia more generally⁴⁹. Still, future research is needed with more diverse samples that include larger proportions of males and racial and ethnic minorities to determine if the psychometric properties of the MISCI hold up across subgroups of people with FM. This study provides support for internal consistency and convergent validity but further examination of other types of validity, sensitivity to change (i.e ability to measure change regardless of clinical meaningfulness) responsiveness to change/minimally important difference (i.e ability to measure clinically meaningful changes), test-retest reliability, and other measurement characteristics are needed to understand the complete psychometric qualities of this measure.

Conclusion

This study developed and supported the validity of the Multidimensional Inventory of Subjective Cognitive Impairment (MISCI), a brief and more comprehensive short form measure of cognitive functioning in a sample of individuals with FM. The MISCI showed excellent internal consistency reliability and evidence of convergent validity through large correlations with a legacy measure of cognition, the MASQ. Such a brief and comprehensive measure that covers the domains of relevance identified in studies of both objective and subjective dyscognition in FM has been needed by clinicians and clinical trialists for a long time.

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- A brief measure of perceived cognitive function in fibromyalgia was developed.
- It is the Multidimensional Inventory of Subjective Cognitive Impairment (MISCI)
- The 10-item MISCI demonstrated excellent internal consistency reliability.
- The MISCI is normally distributed and has low rates of ceiling and floor effects.
- The MISCI showed good construct validity in correlations with legacy measures.

Table 1

Participant descriptive data for Study 1 and Study 2.

	N	%	Mean	SD	Min-Max
Study 1 (N = 1035)					
Age			48.70	11.18	18–82
Time since FM diagnosis (years)			10.93	9.40	1–63
Sex (Female)	846	95.2			
Race					
White	594	57.4			
Black/African Am	19	1.8			
Asian	5	.5			
American Indian	5	.5			
Pacific Islander	1	.1			
Other/Not Provided	411	39.7			
Education					
< 12 th grade education	12	1.3			
High school grad/GED	123	11.9			
Some college	420	40.6			
College degree (BA/BS)	226	21.8			
Advanced degree (MA, PhD)	109	10.5			
No response/Not provided	145	14.0			
Study 2 (N = 232)					
Age			51.37	9.92	27–82
Sex (Female)	225	97.0			
Race					
White	203	87.5			
Black/African Am	7	3.0			
Asian	1	0.4			
American Indian	3	1.2			

	N	%	Mean	SD	Min-Max
Pacific Islander	1	0.4			
Other/Not Provided	17	7.3			
MASQ (possible range)					
Language (8–40)			21.75	4.75	10–33
Visual-Perceptual (6–30)			16.19	4.47	6–29
Verbal Memory (8–40)			24.09	5.13	10–39
Visual-Spatial Memory (8–40)			20.54	5.11	9–35
Attention/Concentration (8–40)			23.79	5.28	9–36
Total (38–190)			106.38	20.78	56–167
FIQ-R (possible range)					
Physical Functioning (0–30)			17.73	6.90	0–30
Overall Impact (0–20)			12.54	5.16	0–20
Symptoms (0–50)			33.19	8.22	10–48.50
Total (0–100)			63.46	18.69	10–97.83

Note. GED = General Educational Development (GED), high school equivalency test; MASQ = Multiple Abilities Self-Report Questionnaire; FIQ-R = Fibromyalgia Impact Questionnaire-Revised.

Table 2

Cognitive functioning item factor analysis model comparisons for Form A and Form B

Form A					
Model	Log-Lik	Chi-Sq	DF	AIC	BIC
1 Factor	-46828	93656	84	93824	93914
2 Factor	-45262	90525	83	90859	91037
3 Factor	-44621	89242	82	89740	90007
4 Factor	-43986	87973	81	88633	88986
5 Factor	-43607	87214	80	88034	88473

Form B					
Model	Log-Lik	Chi-Sq	DF	AIC	BIC
1 Factor	-55583	111165	94	111353	111455
2 Factor	-54349	108697	93	109071	109274
3 Factor	-53534	107067	92	107625	107928
4 Factor	-53064	106128	91	106868	107269
5 Factor	-52733	105467	90	106387	106885

Note. Log-Lik = Log Likelihood; Chi-Sq = Chi-Squared; AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion

Table 3

The Multidimensional Inventory of Subjective Cognitive Impairment (MISCI)

#	Item Name	In the past 7 days...	Not at all	A little bit	Somewhat	Quite a bit	Very much
1	PC-CaPS3	I have been able to think clearly without extra effort.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2	PC43_2	My mind has been as sharp as usual.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
3	PC-CaPS14	I have been able to remember things as easily as usual without extra effort.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4	PC-CaPS9	I have been able to learn new things easily, like telephone numbers or instructions.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
5	PC-CaPS4	My ability to concentrate has been good.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6	PC29_2	I have been able to pay attention and keep track of what I was doing without extra effort.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
In the past 7 days...							
7	PC42	I have had trouble shifting back and forth between different activities that require thinking.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8	NQCOG86	I had trouble planning out the steps of a task.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9	PC38	I have had to work harder than usual to express myself clearly.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
10	PC16	I have had trouble finding the right word(s) to express myself.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Note. Item Name indicates the name used to identify the item within PROMIS®/NQ item banks, currently available at www.assessmentcenter.net

Table 4

Multidimensional Inventory of Subjective Cognitive Impairment (MISCI) raw score (sum of all item scores) and equivalent T-scores for this Study 1 (n = 1035) sample and PROMIS®.

MISCI raw score	FM Study Sample T-Score	PROMIS® Equivalent T-Score
10	30	31
11	34	36
12	36	39
13	37	39
14	38	41
15	39	41
16	40	42
17	41	43
18	42	43
19	43	43
20	44	44
21	45	44
22	46	44
23	47	45
24	48	45
25	49	45
26	50	46
27	51	46
28	52	46
29	53	46
30	54	47
31	55	47
32	56	47
33	57	47
34	58	48
35	59	48
36	60	49
37	61	49
38	62	49
39	63	50
40	64	50
41	65	50
42	67	51
43	68	51
44	69	52
45	70	53
46	71	53
47	72	53

MISCI raw score	FM Study Sample T-Score	PROMIS® Equivalent T-Score
48	73	55
49	74	57
50	75	61

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Table 5

Pearson r bivariate correlations ($N = 232$) between the Multidimensional Inventory of Subjective Cognitive Impairment (MISCI), PROMIS® Cognition–Abilities short-form 8a, PROMIS® Cognition-General Concerns short-form 8a, and sub-scale and total scores of the MASQ and FIQ-R.

	MISCI	PROMIS® - Cognition Abilities	PROMIS® - Cognition Concerns
MISCI	-	.94	.91
PROMIS® Cognition - Abilities	-	-	.86
MASQ Language scale	-.72	-.66	-.63
MASQ Visual/Perceptual scale	-.57	-.52	-.48
MASQ Verbal Memory scale	-.72	-.69	-.67
MASQ Visual Memory scale	-.63	-.58	-.55
MASQ Attention scale	-.76	-.76	-.71
MASQ TOTAL	-.82	-.76	-.73
FIQ-R Physical Function scale	-.60	-.55	-.53
FIQ-R Overall Impact scale	-.60	-.57	-.57
FIQ-R Symptoms scale	-.64	-.62	-.57
FIQ-R memory item [*]	-.70	-.69	-.64
FIQ-R TOTAL	-.67	-.64	-.61

Note. All correlations significant at $p < 0.001$; MASQ = Multiple Abilities Self-Report Questionnaire; FIQ-R = Fibromyalgia Impact Questionnaire-Revised;

^{*} Single item “please rate your level of memory problems”.