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Development of a subjective cognitive decline questionnaire using item response theory: A pilot study

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Abstract

Introduction: Subjective cognitive decline (SCD) may indicate unhealthy cognitive changes, but no standardized SCD measurement exists. This pilot study aimed to identify reliable SCD questions.
Methods: A total of 112 cognitively normal (NC; 76 ± 8 years; 63% female), 43 mild cognitive impairment (MCI; 77 ± 7 years; 51% female), and 33 diagnostically ambiguous participants (79 ± 9 years; 58% female) were recruited from a research registry and completed 57 self-report SCD questions. Psychometric methods were used for item reduction.
Results: Factor analytic models assessed unidimensionality of the latent trait (SCD); 19 items were removed with extreme response distribution or trait-fit. Item response theory (IRT) provided information about question utility; 17 items with low information were dropped. Post hoc simulation using computerized adaptive test (CAT) modeling selected the most commonly used items (n = 9 of 21 items) that represented the latent trait well (r = 0.94) and differentiated NC from MCI participants (F [1, 146] = 8.9, P = .003).
Discussion: IRT and CAT modeling identified nine reliable SCD items. This pilot study is a first step toward refining SCD assessment in older adults. Replication of these findings and validation with Alzheimer's disease biomarkers will be an important next step for the creation of a SCD screener.

Keywords: Subjective cognitive decline; Item response theory; Factor analysis; Computerized adaptive testing; Psychometrics; Mild cognitive impairment

1. Introduction

Emerging evidence suggests that subjective cognitive decline (SCD), or a self-reported concern regarding a change in cognition, may represent a clinically relevant change in cognitive health, such as early Alzheimer's disease (AD) or unhealthy brain aging [1]. Recent work has linked SCD with markers of AD pathology, including smaller medial temporal lobe volumes on magnetic resonance imaging [2], amyloid burden quantified by positron emission tomography [3], and postmortem neuropathology [4]. SCD predicts cognitive decline [5,6], incident mild cognitive impairment (MCI) [7], and incident dementia [7,8] in nondemented older adults.

Not all studies to date support SCD as a marker of brain health [9–11] and there are several explanations for such variability. First, SCD is prevalent among older adults regardless of cognitive status [12]. Current SCD assessment methods lack specificity with as many as 95% of elders endorsing cognitive changes [13]. Such poor specificity prevents effective identification of individuals at risk for cognitive decline. Another explanation for discrepant SCD findings in the literature is the lack of standardized definition and the variable methods used to assess SCD. SCD

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measurement can vary based on the number of questions used (i.e., a single question [14] vs. multiple questions [15]) or based on the referent for defining decline (i.e., compared with one's own past abilities [16], compared with one's peers [17], or functional ability [18]). Given the variability in assessment methods, it is not surprising that different SCD questions have diverse associations with markers of brain health [19].

The longstanding absence of a standard SCD definition has brought about inconsistent utilization of SCD methods in both research and clinical practice. Furthermore, the lack of operationalization for SCD is in stark contrast to other markers of early AD pathology. First, accepted standards now exist for classifying elders as "amyloid positive" using either in vivo amyloid imaging [20] or amyloid-β_{42} values quantified by cerebral spinal fluid [21]. Similarly, there are standard structural neuroimaging markers of AD pathology, such as medial temporal lobe atrophy [22], and Food and Drug Administration-approved software is available to empirically define atrophy consistent with AD in clinical practice [23]. Finally, there is consensus on how to assess and define cognitive impairment in AD and MCI (i.e., impairment in a standard set of domains, such as memory, language, and executive functioning, is demarcated as 1.5 standard deviations below the normative mean) [24].

In light of growing support that SCD is a marker of unhealthy brain aging (e.g., SCD is a criterion for the MCI diagnosis [24]), efforts are underway to establish a standard method for defining SCD [25] to strengthen its utility in early AD detection. One proposed definition for SCD includes the following criteria: (1) self-experienced decline in cognitive capacity compared with a previous state and (2) normal objective cognitive functioning in the absence of MCI, dementia, or another symptom-explaining etiology. Although these criteria were defined for research purposes, a measure that has been validated and detects a threshold of SCD implicating a pathologic process would have broad implications. Clinically, such a tool would offer a quick and cost-effective screener for adults aged >65 years that triggers a more indepth cognitive assessment (e.g., administration of Montreal Cognitive Assessment or specialty referral for a memory loss workup). In research settings, such a screener could provide an efficient means for enriching research studies with prodromal AD individuals. To alleviate patient and clinician burden when administering the tool, a shortened questionnaire maintaining maximal precision in measuring SCD is desirable.

With a proposed criteria for SCD defined, the present study aimed to enhance ongoing efforts and operationalize the assessment of SCD by identifying questions that most reliably capture SCD. We use in succession a series of psychometric modeling techniques commonly used for data reduction (i.e., factor analysis [26]), item response theory (IRT) [27], and adaptive testing (i.e., computerized adaptive testing [CAT] [28]) to select a small but reliable subset of SCD items from a larger question bank. We hypothesized that the combination of these statistical modeling efforts would yield a subset of 5–10 items, which could be piloted as a short SCD questionnaire or screener. This study represents an important contribution to ongoing efforts to create a brief and efficient SCD tool and will support further endeavors to define and standardize SCD in cognitive aging.

2. Methods

Participants were recruited from the Boston University Alzheimer's Disease Center Registry. As previously described [29], this cohort includes adults aged ≥65 years who undergo a standard evaluation annually, including clinical interview, medical history, neurologic examination, and neuropsychological evaluation as part of the National Alzheimer's Coordinating Center uniform data set [30]. The study was approved by our institutional review board.

The present study recruited 266 individuals free of dementia (i.e., diagnosed as cognitively normal [NC], MCI, or ambiguous) at their last annual visit before January 12, 2010. Cognitive diagnoses are based on a multidisciplinary consensus team using information from the comprehensive standard evaluation. NC was defined by (1) clinical dementia rating (CDR) [31] = 0 (no dementia); (2) no deficits in activities of daily living directly attributable to cognitive impairment; (3) no evidence of cognitive impairment defined as performance on neuropsychological tests within 1.5 standard deviations of the age-adjusted normative mean [32] on tests assessing language, attention, memory, and executive functioning; and (4) no cognitive complaint. MCI was based on Peterson et al. [33] criteria and defined as (1) CDR ≤0.5 (reflecting at most mild impairment), (2) relatively spared activities of daily living, (3) objective cognitive impairment in at least one cognitive domain (i.e., performances >1.5 standard deviations of the age-adjusted normative mean) or a significant decline over time on the neuropsychological evaluation, (4) report of a cognitive change by the participant or informant (i.e., endorsement of cognitive change as assessed by a brief questionnaire) or as observed by a clinician, and (5) absence of dementia. Of note, the subjective cognitive change questions used for consensus diagnostic purposes were not included in the current scale development activities. Individuals were classified as ambiguous if they were free of dementia but did not meet all criteria for either NC or MCI (i.e., cognitive impairment but no complaint or significant report of cognitive change but normal objective neuropsychological performance).

Between January 6, 2011 and January 12, 2011, all 266 nondemented participants were mailed a 57-item SCD questionnaire, of which 191 participants completed and returned. The 57 SCD items were derived from publically available tools assessing memory changes, including the everyday cognition questionnaire [18], memory functioning questionnaire [34], and individual SCD questions drawn from the literature [12]. Response options were dichotomous (yes/no) for 43 questions and Likert scale (i.e., always,