Comparison of Methods for Examining Change in Everyday Competence

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This study was designed to address the relationship of traditional and SEM-defined cut score classification methods for several clinical measures routinely administered to detect early cognitive impairment with change on the Everyday Problems Test for Cognitively Challenged Elderly (EPCCE), a measure of everyday competence. Everyday competence has been found to relate to executive functioning and completion of complex daily tasks and is considered an indicator of early cognitive decline (Willis et al., 1998). This study investigated whether traditional cut scores accurately indicate cognitive impairment or whether an alternative cut score approach may be more reliable. Having an accurate cut score classification method is important for those called upon to recommend cut score values to be used as evidence of cognitive decline in both research studies and clinical practice. Clarity on the relative effectiveness of these two methods for determining appropriate classifications on clinical measures may also be helpful in determining the level of expected change in everyday competence, as measured by the EPCCE.

This study addressed two main questions. First, we examined the proportion of participants who declined or remained stable on the EPCCE over two occasions relative to their score on several clinical measures. Scores were classified using two methods: a traditional cut score classification method and an alternative, SEM-defined cut score classification method. For example, what proportion of participants who declined or remained stable on the EPCCE scored below the cut score on the MMSE at Time 2? Alternatively, how would these proportions differ using the SEM-defined classification method to examine participants who scored in the non-normal range, within the confidence interval, or normal range on each clinical measure. The second research question examined the proportion of participants who declined or remained stable on the EPCCE over two occasions relative to the proportion of participants who declined or remained stable on the clinical measures over two occasions. In other words, how does change on the EPCCE relate to change on the clinical measures? For example, were participants who declined on the EPCCE more likely to have declined or remained stable on other clinical measures which may not detect early cognitive impairment as accurately?

Method

Participants

The sample for this study included 320 (F=212, M=108) lower SES, community-dwelling, non-demented older adults from rural Southwest Pennsylvania. Participants in the current study were predominantly Caucasian (97%) with a mean age of 77 years (SD=4.24, range 70-92). Thirty-four percent of the participants had less than a high school education (n=108), forty percent received a high school diploma or equivalency (n=129), and twenty-six percent attained education beyond high school (n=83).

This study was part of a larger, ongoing epidemiological study called the Monongahela Valley Independent Elders Survey (MoVIES; Ganguli et al., 1991). The MoVIES sample included adults aged 65 years and older selected by age-stratified, random sampling from voter registration lists of communities in the Monongahela Valley of Southwestern Pennsylvania. This was a rural blue-collar population with relatively low socioeconomic status and education. To be eligible for participation in the study, persons had to be living in the community, be fluent in English, and have at least six years of education (Ganguli et al., 1991). All potential participants who volunteered to take the EPCCE, as part of the MoVIES study, were screened for dementia using the Clinical Dementia Rating Scale (CDR; Hughes, Berg, Danziger, Cohen, & Martin, 1982). Participants who rated 0.5 or higher on the CDR were excluded. After the first administration of the EPCCE, participants were retested within a 23-40 month interval of the initial assessment (Dolan & Willis, 1999).

Procedure

For the MoVIES longitudinal study, all participants were assessed in their homes (Ganguli et al., 1991). The MoVIES protocol included an extensive semi-structured interview followed by the administration of a battery of clinical, neuropsychological measures (Ganguli et al., 1991). Following the standardized protocol, participants were asked if they wanted to complete the EPCCE, a new measure designed to evaluate everyday problem solving. Participants were paid $10 for their participation in the MoVIES study and an additional $10 for taking the EPCCE test measure.

Measures

Five measures were included in this study. The EPCCE was the outcome measure. The remaining four measures were clinical measures selected from the MoVIES neuropsychological battery. The clinical measures used in the MoVIES study had been selected from the expanded Consortium to Establish a Registry for Alzheimer's Disease (CERAD) battery, developed to determine presence of cognitive impairment (Morris et al., 1989; Ganguli et al., 1991).

Everyday Problems Test for Cognitively Challenged Elderly. The Everyday Problems Test for Cognitively Challenged Elderly (EPCCE; Willis, 1993; Willis et al., 1998) is an objective measure of complex cognitive abilities necessary to perform tasks associated with everyday activities. This 32-item measure of everyday competence assesses functioning in each of seven IADL domains (managing medications, meal preparation and nutrition, household management, determination of necessary transportation, telephone use, shopping, and managing finances) through the presentation of 16 printed stimulus materials. A sample item is shown in

Figure 1. These materials represent real-world tasks encountered in daily living, such as an itemized phone bill. After viewing the stimulus material (e.g., phone bill, nutrition label, etc.), participants are asked to answer two questions relating to the information presented for each of the 16 stimulus materials. The items are scored as correct or incorrect, with 32 as the highest possible total score. The number of items per domain varied from four to six.

Mini-Mental Status Examination. The Mini-Mental Status Examination (MMSE; Folstein, Folstein, & McHugh, 1975) is a 30-item test used as a brief, cognitive screening measure to assess orientation to person, place and time, short term and delayed memory recall, ability to follow directions, constructional ability, attention/concentration, and language.

Trails B. Trails B (Reitan & Wolfson, 1985) is more sensitive at detecting cognitive impairment than its counterpart, Trails A (Spreen & Strauss, 1998). Both measure speed, attention, sequencing, mental flexibility, visual search, and motor function. For Trails B, participants are instructed to draw a line connecting numbers with corresponding letters (e.g., 1-A-2-B-3-C, etc.). A practice test is administered prior to the actual test. Although both the practice test and actual test are scored, only the actual test scores were included in this study. Scores on the actual test range from 0-300, determined by the number of seconds to complete the test. Typically, higher scores on the Trails B measure indicate poorer performance.

Verbal Fluency. Verbal Fluency (Benton & Hamsher, 1976) measures verbal production, semantic memory, and language (Morris et al., 1989). Participants are asked to name as many items as possible in 60 seconds within a given category (e.g., words that begin with letter S, P, or animals). Scores represent the total number of words generated.

Word List Memory Recall. Word List Memory Recall (Morris et al., 1989) was assessed by presenting a list of 10 words and then asking the participant to immediately recall as many as possible in 90 seconds. This procedure was followed for three trials, with the words in a different order in each trial. Scores for immediate recall (range=0-10) on Trial 3 were used in this study.

Analysis Plan

The first research question addressed what proportion of participants declined or remained stable on the EPCCE relative to their score on each clinical measure (e.g., the MMSE) at Time 2. Two cut score methods were used to classify test scores at Time 2 on several clinical measures. First, traditional cut score values were used, as they are generally accepted in the literature to assess cognitive impairment (LaRue, 1992; Spreen & Strauss, 1998), and observed scores were classified as indicating non-normal or normal performance. Second, an alternative type of cut score using the standard error of measurement (SEM), which sets a confidence interval around the traditionally accepted cut value, was investigated. Using the SEM for the measures, participants' cut values were classified as being non-normal, within the confidence interval around the cut value, or in the normal range.

For the second research question, additional analyses were computed to determine whether change on the EPCCE varied with change on each clinical measure. The objective was to understand what proportion of participants declined or remained stable on the EPCCE relative to those that declined or remained stable on each of the clinical measures. Such fluctuations could have implications for establishing which cognitive abilities have been preserved and which have declined or remained stable over time.

Traditional cut score method. Participants' scores at Time 2 on each of the four clinical measures were classified into two groups: 1) non-normal (below the cut off value); or 2) normal (above the cut off value). Because higher scores on Trails B indicate poorer performance, the classification was reversed for this measure (i.e., scores above the traditional cut-off value were classified as non-normal and scores below the traditional cut-off value were classified as normal). Values for the traditional cut scores were taken from established norms from clinical literature. For the MMSE, a score of 27 was used as the traditional cut score based on means of comparable samples and diagnostic criteria (Crum, Anthony, Bassett, & Folstein, 1993; Lemsky, Smith, Malec, & Ivnik, 1996; Uhlmann & Larson, 1991). A score of 180 on Trails B was used as the traditional cut score based on samples comparable on age and education (Spreen & Strauss, 1991, 1998). For Verbal Fluency, a score of 10 was used as the traditional cut score, based on norms from samples with education levels similar to our sample (Spreen & Strauss, 1998). For the Word List measure, a score of 7.6 was used as the traditional cut score, based on norms from samples with age and education ranges similar to our sample (Welsh et al., 1994).

SEM-defined cut score method. Participants' scores at Time 2 on each of the four clinical measures were also classified using a method that used the standard error of measurement (SEM) of the test. The SEM was calculated as:

$$s_{t_2}\sqrt{1 - r_{t_1 t_2}}$$

where s_{t2} is the standard deviation of the test scores at Time 1 and r_{tt} is the reliability coefficient of the test (Dudek, 1979; Lord & Novick, 1968). Scores were classified into one of three groups: (1) non-normal (i.e., one SEM below the traditional cut value), (2) within range (i.e., within the confidence interval around the cut value), or (3) normal (i.e., greater than or equal to one SEM above the traditional cut value). Classification of scores on Trails B as normal or non-normal were again reversed, as done for the traditional cut score method.

Change Status. Change on all measures was calculated by subtracting Time 1 scores from Time 2 scores. Participants' change on the EPCCE and the four clinical measures was then classified into one of two groups: (1) those who declined (i.e., the Time 2 score was more than 1

SEP below the Time 1 score); or 2) those who remained stable (i.e., the Time 2 score was not greater than one SEP below the Time 1 score). As is appropriate for calculating the SEM for change scores, the squared reliability coefficient was used in the formula given above in place of r_{tt}; this formula is called the standard error of prediction (SEP; Dudek, 1979; Lord & Novick, 1968; Schaie, 1989).

Results

To test how participants scored on the clinical measures at Time 2 in relation to change on the EPCCE, a series of chi-square tests were performed. Chi-square tests were also performed to test how change on the clinical measures compared with change on the EPCCE. First, we examined the proportion of participants who declined or remained stable on the EPCCE over two occasions relative to their classification on several clinical measures. Further, we investigated how the relationship between Time 2 clinical scores and change on the EPCCE varied when using traditional and SEM-defined cut score classification methods. Second, we examined the proportion of participants who declined or remained stable on the EPCCE over two occasions in relation to the proportion of participants who declined or remained stable on each clinical measure over two occasions. Change scores for each of the measures, as well as the correlations over time, SEM and SEP values can be seen in Table 1.

Change on the EPCCE relative to traditional cut score classification.

Classification of change on the EPCCE was significantly related to the traditional cut score classification of the MMSE ($p < .01$), Trails B ($p < .001$), and Word List ($p < .05$), as shown in Table 2. There was a trend for the Verbal Fluency measure ($p = .06$), though statistical significance was not reached. The proportion of participants in each of the classifications relative to their EPCCE change status is shown in Figure 2.

Change on the EPCCE was correctly predicted by the traditional cut score method for each of these clinical measures for the following proportions of participants: MMSE (63%), Verbal Fluency (61%), Trails B (66%), and Word List (64%). The traditional cut scores on the clinical measures were better at predicting stability on the EPCCE than decline on the EPCCE. Also, the traditional cut scores on the clinical measures had limited utility in predicting those who declined on the EPCCE.

Change on the EPCCE relative to SEM-defined cut score classification.

Classification of change on the EPCCE was significantly related to the SEM-defined classification of scores on the MMSE ($p < .01$), Trails B ($p < .001$), Verbal Fluency ($p < .05$), and Word List ($p < .05$), as shown in Table 2. The proportion of participants in each of the three SEM classifications relative to their EPCCE change status is shown in Figure 3.

Change in the EPCCE was correctly predicted by the SEM classification method for the clinical measures for the following proportions of participants: MMSE (66%), Verbal Fluency (69%), Trails B (68%), and Word List (71%). The SEM-defined classification method for the clinical measures of Verbal Fluency, Trails B, and Word List was somewhat better at predicting change on the EPCCE than the traditional cut score classification method. Also, the SEM classified scores on the clinical measures were better at predicting stability on the EPCCE than decline on the EPCCE. The SEM classification scores on the clinical measures had limited utility in predicting those who declined on the EPCCE.

Comparison of traditional and SEM-defined cut score classification methods.

The SEM classification method resulted in somewhat more consistent classifications (i.e., non-normal on Time 2 clinical measures and decline on EPCCE) than did the traditional cut score method for three of the four clinical measures. Both classification methods were better at predicting stability on the EPCCE than decline on the EPCCE. Both classification methods were much less useful in predicting who declined on the EPCCE. A greater proportion of participants showed reliable decline on the EPCCE than those who showed reliable decline on any of the clinical measures (i.e., MMSE 23%; Verbal Fluency 20%; Trails B 21%; Word List 14%).

Change on the EPCCE relative to change on the clinical measures.

No statistical significance was found for change on the EPCCE relative to change on the clinical measures, as shown in Table 3. The proportion of participants in each change status group on the clinical measures relative to their EPCCE change status is shown in Figure 4. The proportion of participants showing the same change status on both the EPCCE and the clinical measure were: MMSE (60%), Verbal Fluency (63%), Trails B (66%), and Word List (66%). The proportion who declined on both the EPCCE and any one clinical measure was very small (< 6%), as compared to those who declined on the EPCCE (28%) or who declined on the clinical measures (MMSE 23%; Verbal Fluency 20%; Trails B 21%; Word List 14%).

Discussion

In summary, the SEM classification method was generally better than the traditional method at classifying scores relative to change on the EPCCE. However, both methods were better at predicting stability on the EPCCE rather than decline. Also, a greater proportion of participants showed reliable decline on the EPCCE than reliable decline on any of the clinical measures. In response to whether change on the clinical measures varied with change on the EPCCE, we found that the proportion who declined on both the EPCCE and any one clinical measure was very small (<6%), as compared to the proportion who declined on the clinical measures (MMSE 23%; Verbal Fluency 20%, Trails B 21%; and Word List 14%).

Future investigations may involve studying how change on the EPCCE compares with a composite score representing all the clinical measures of the same ability domain. For example, a composite of executive functioning measures (e.g., Trails B, Verbal Fluency, etc.) may better explain change on the EPCCE than clinical measures for multiple abilities. Research by Willis et al. (1998) has found that executive functioning measures account for a significant amount of variance in EPCCE performance above and beyond general cognitive ability. It is also possible that comparing change on the EPCCE with change on clinical measures over non-concurrent time periods may better support findings that the EPCCE is more sensitive for detecting early cognitive impairment than standard clinical measures.

One explanation for why we were unable to predict decline with the EPCCE with either of the two methods was that the participants with questionable cognitive impairment (CDR of 0.5) were excluded from the analyses. The participants in these analyses had all been screened for dementia at fairly conservative level (i.e., had to receive a score of zero on the CDR, indicating no impairment) and thus may not fully represent a community-dwelling population. While some level of cognitive impairment should be screened for, it is likely that some otherwise competent individuals may have been unnecessarily excluded. For example, individuals receiving a score of 0.5 on the CDR are fully capable of self care, fully oriented except for slight difficulty with time relationships, but display slight impairment in memory, judgment and problem solving, and community affairs (Berg, 1988; La Rue, 1992). It is unclear whether addition of these individuals would provide both a more representative sample and a more holistic approach to studying the differences in classification methods in a manner applicable to practicing clinicians.

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Table 1

Statistics for Outcome Measure and Clinical Measures (N = 320)

Test	M Time 1	M Time 2	M Change	Correlation over time	SEP	SEM
EPCCE	21.98	19.77	-2.22	.69***	4.51	---
MMSE	26.71	26.63	-0.08	.64***	1.77	1.59
Trails B	135.30	152.00	16.70	.74***	47.22	39.82
Verbal Fluency	11.76	11.53	-0.23	.67***	3.46	2.60
Word List	8.35	8.15	-0.20	.57***	1.08	1.01

Note. Change = Time 2 - Time 1. SEP = standard error of prediction. SEM = standard error of measurement.

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 2

Level of Change on the EPCCE relative to Traditionally and SEM-defined Classifications of Clinical Measures at Time 2

Measure	Cut Score Group	EPCCE Change Decline (28.13%)	EPCCE Change Stable (71.88%)	Row Percent	χ^2
MMSE[a]	Traditional				9.75**
	Non-normal	14.06	22.50	36.56	
	Normal	14.06	49.38	63.44	
	SEM				9.68**
	Non-normal	9.06	15.31	24.38	
	Within Range	15.31	35.94	51.25	
	Normal	3.75	20.63	24.38	
Trails B[b]	Traditional				11.26***
	Non-normal	12.50	18.13	30.63	
	Normal	15.63	53.75	69.38	
	SEM				15.64***
	Non-normal	8.44	11.88	20.31	
	Within Range	8.75	14.69	23.44	
	Normal	10.94	45.31	56.25	
Verbal Fluency[c]	Traditional				3.42
	Non-normal	11.88	22.50	34.38	
	Normal	16.25	49.38	65.63	
	SEM				7.94*
	Non-normal	8.13	10.94	19.06	
	Within Range	10.94	31.88	42.81	
	Normal	9.06	29.06	38.13	
Word List[d]	Traditional				4.63*
	Non-normal	10.63	18.44	29.06	
	Normal	17.50	53.44	70.94	
	SEM				8.38*
	Non-normal	6.25	7.50	13.75	
	Within Range	10.63	27.19	37.81	
	Normal	11.25	37.19	48.44	

Note. The values presented are percentages of the total sample. EPCCE Change = (Time 2 – Time 1). SEM = standard error of measurement. [a]MMSE cut score = 27. [b]Trails B cut score = 180. [c]Verbal Fluency cut score = 10. [d]Word List cut score = 7.6.*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3

Level of Change on the EPCCE Relative to Level of Change on Each Clinical Measure

Measure	Change Group	EPCCE Change Decline (28.13%)	EPCCE Change Stable (71.88%)	Row Percent	χ^2
MMSE					0.94
	Decline	5.31	17.19	22.50	
	Stable	22.81	54.69	77.50	
Trails B					1.86
	Decline	7.19	13.44	20.63	
	Stable	20.94	58.44	79.38	
Verbal Fluency					3.20
	Decline	3.75	15.94	19.69	
	Stable	24.38	55.94	80.31	
Word List					0.00
	Decline	4.06	10.31	14.38	
	Stable	24.06	61.56	85.63	

Note. The percentages presented are percentages of the total sample. Change on all measures = (Time 2 – Time 1).

Figure 1. Sample item on the EPCCE, as found in real-world instructional pamphlets.

Toaster Cleaning and Safety Instructions

CLEANING INSTRUCTIONS

- Disconnect Toaster
- Wide outside with soft, damp cloth when toaster is cold. Polish with soft, dry cloth.
- Open crumb tray in bottom of toaster and brush out crumbs.
- Any service requiring disassembly other than the above cleaning should be performed by an authorized service station.

ELECTRIC POWER: If electric circuit is overloaded with other appliances, your toaster may not operate properly. When possible, toaster should be operated on a separate electric circuit than other operating appliances.

Questions:

a. Before cleaning the outside of the toaster, what should you do?

b. If your toaster and coffee maker are plugged into the same outlet, why might your toaster not work?

Note. From Test manual for the Everyday Problems Test for Cognitively Challenged Elderly, by S. L. Willis, 1993, University Park, PA: The Pennsylvania State University.

Figure 2. Traditional classification method for Time 2 clinical measures relative to change status on the EPCCE

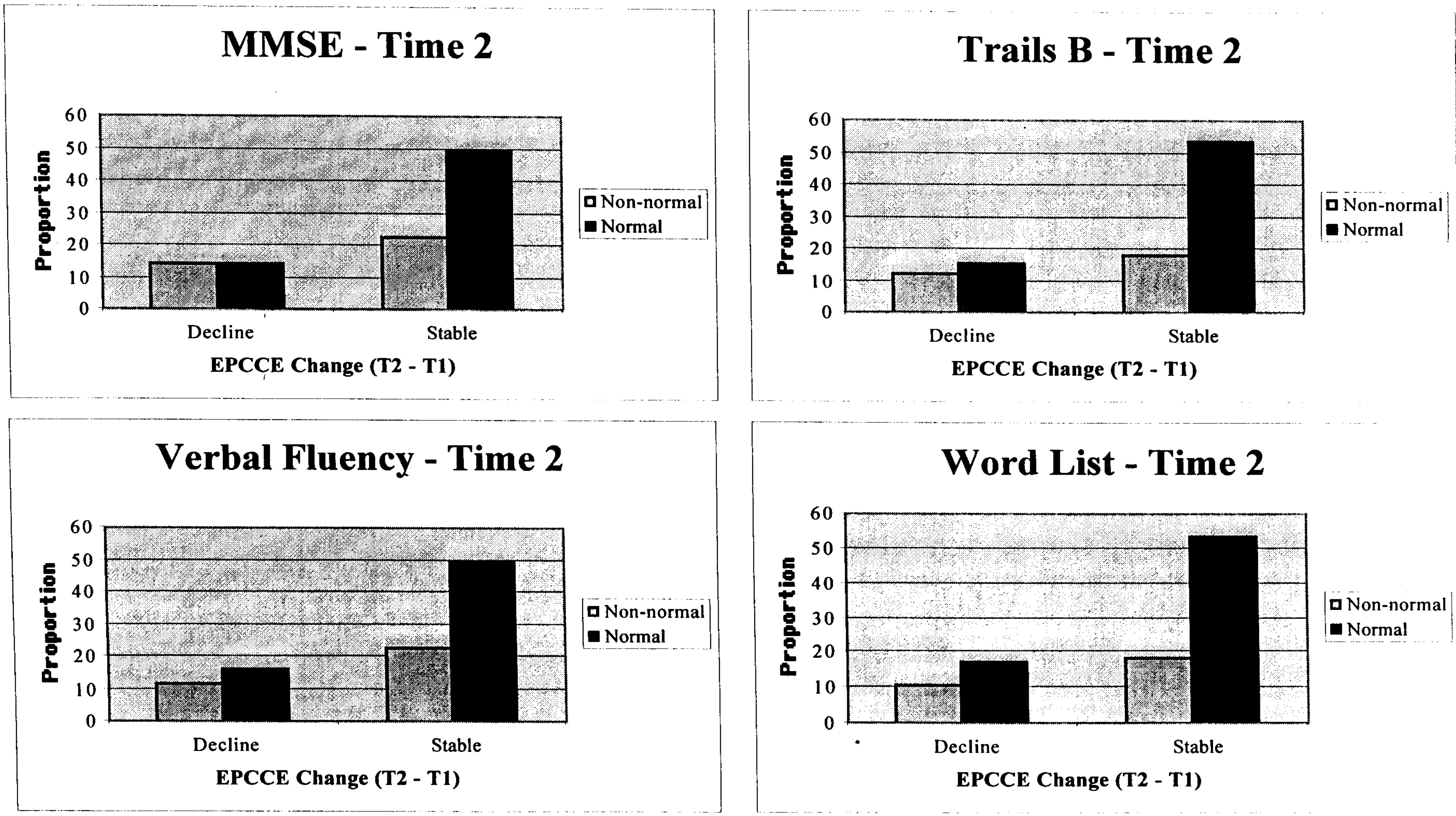

Figure 3. SEM-defined classification method for Time 2 clinical measures relative to change status on the EPCCE

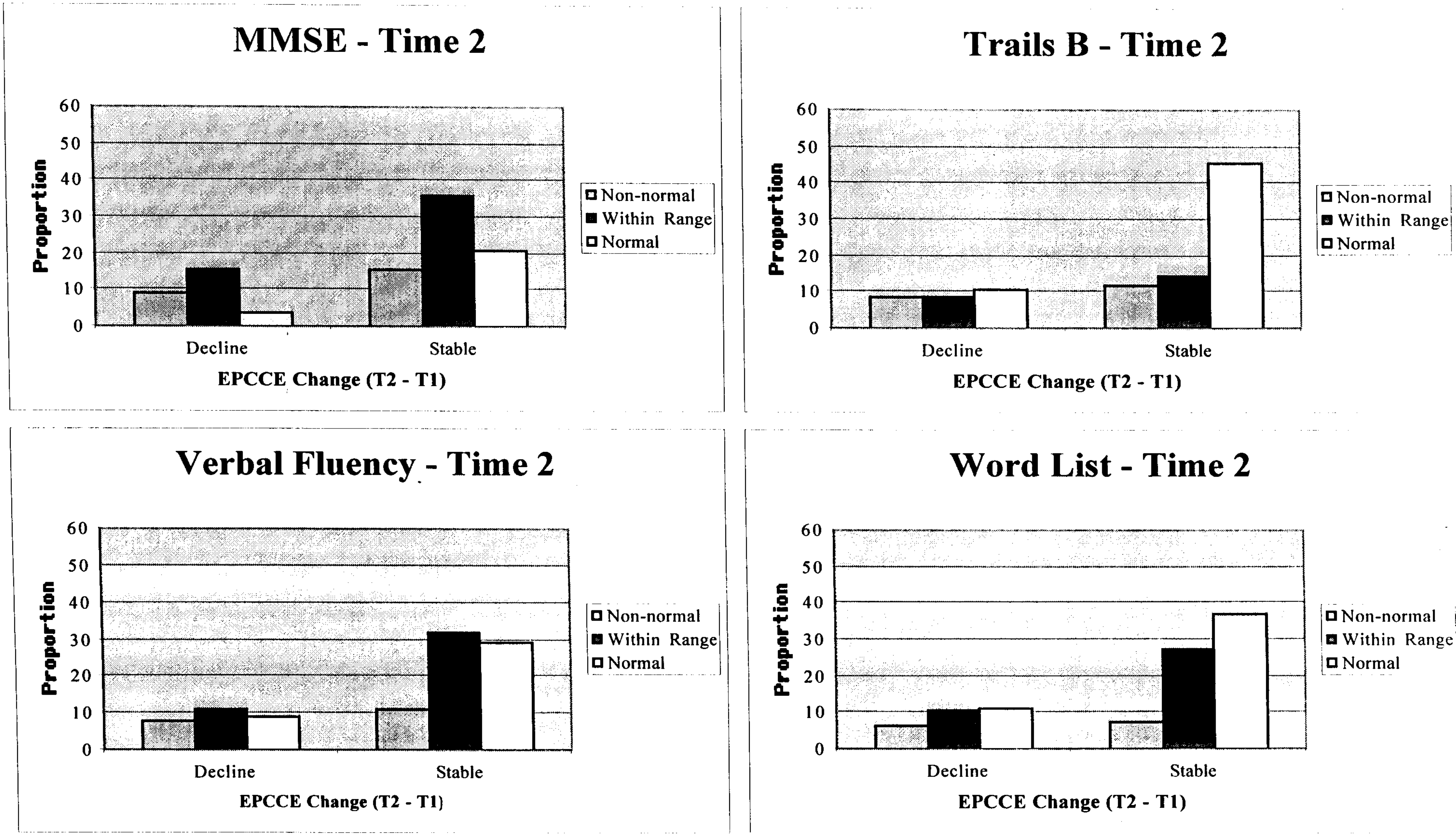

Figure 4. Change status on clinical measures relative to change status on EPCCE