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Development and Validation of the State-Trait Inventory of Cognitive Fatigue in Community-Dwelling Older Adults

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Abstract

Objective—To develop and validate a subjective measure of cognitive fatigue—the State-Trait Inventory of Cognitive Fatigue (STI-CF)—in community-dwelling older adults.

Design—Scale development and test construction.

Setting—Community-dwelling older adults enrolled in a longitudinal cohort aging study.

Participants—Participants (N=175) were healthy, English-speaking, community-dwelling adults, age 65 and above.

Interventions—Not applicable.

Main Outcome Measures—STI-CF total, cognitive fatigue, motivation, mental effort, and boredom summation scores for both state and trait forms.

Results—Principal component analysis yielded the expected four components for both state and trait forms: cognitive fatigue, mental effort, motivation, and boredom. All components had good reliability. There was good convergent validity as measured by the strong positive relationship between cognitive fatigue and a subjective measure of general fatigue, even after controlling for depressive symptoms. Greater subjective cognitive fatigue was associated with worse performance on measures thought to be more sensitive to aspects of executive functioning.

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¹This study was conducted when the corresponding author was a student at the Ferkauf Graduate School of Psychology; but this author is currently a post-doctoral fellow in the Brain Injury Research Center, Department of rehabilitation Medicine at the Icahn School of Medicine at Mount Sinai.

Conflict of Interest: This material has not been presented elsewhere. There is no conflict of interest between any of the authors, or any organizations of which the authors are associated with

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Conclusions—The current study developed and established the psychometric properties of a new instrument for the subjective measurement of cognitive fatigue for use in community-dwelling older adults. The STI-CF's relatively brief administration time (less than 10 minutes; $M = 5.6$, $SD = 2.9$) and strong psychometric properties support its utility in both research and clinical settings. Future studies should establish the psychometric properties of this scale in other populations and examine its predictive utility for relevant clinical outcomes.

Keywords

cognitive fatigue; aging; validation studies; questionnaires

Subjective fatigue has been proposed to be a physiologic warning signal of impending disease events (1–3) and is predictive of future disability outcomes, including depression (4), frailty (1, 5), mobility disability (6), loss of functional independence (7, 8), and mortality (9).

Cognitive fatigue has been attributed to dysfunction in the prefrontal-basal ganglia circuitry (10, 11). Changes within these regions such as atrophy (12) and reduced cerebral glucose metabolism (13) have been associated with both subjective fatigue (12, 13) and age-related neurological and cognitive changes in older adults (14–20). Given fatigue's high prevalence, association with disability and cognitive decline, and putative link to brain regions that are sensitive to the aging process, it is important to develop a scale for cognitive fatigue that can be easily incorporated into rehabilitation and medical facilities, as well as clinical trials and longitudinal studies.

The State-Trait Inventory for Cognitive Fatigue (STI-CF) has several unique features. First, it is limited to the measurement of cognitive fatigue, defined as the executive failure to maintain and optimize performance over acute but sustained cognitive effort (21, 22). The addition of an executive failure captures self-control, which is limited in capacity and subject to fatigue-like decline (23). This has been demonstrated by two types of objective measurements of cognitive fatigue: those where the central executive load is increased or maximized (24–26) and those marked by increased reaction time or response variability (22, 27–30) for tasks that are not necessarily more difficult (31). Each subscale asks about individuals' experiences during “challenging mental tasks” or “repetitive and monotonous tasks” in order to capture both aspects of cognitive fatigue.

Second, both state and trait forms were developed to account for intra- and inter- individual variability, potentially making the scale more useful for longitudinal studies and experimental manipulation. To maintain balance between retaining stability and controlling for momentary fluctuation (32, 33) and to remain consistent with the literature on state-trait (32) and previous fatigue inventories (34–37), trait items were worded “in general” with the qualifier of “for the past 6 months” and state items were worded “right now.” Most state and trait items were designed in parallel in order to capture the same underlying experience. For example, the motivation state item “I am interested in the task at hand,” has a similar trait item “I can find a way to stay motivated for most tasks I am completing.”

Finally, unlike previous inventories, the STI-CF captures the closely related constructs of mental effort, motivation, and boredom that influence individuals' experience of fatigue. *Mental Effort:* Studies have shown improvements in objective measures of cognitive performance in spite of reports of increased subjective fatigue (38–40), and neuroimaging studies have demonstrated increased activity in areas associated with fatigue coupled with performance that remains the same or even improves (41–44), interpreted as increased mental effort. Examples of effort items include “I am putting forth as much effort as I am able” (state) and “I always put forth as much effort as I am able” (trait). *Motivation:* Consistent with these neuroimaging findings, cognitive fatigue has been linked with areas of the cortico-striatal network that are involved with reward-guiding behavior (45), possibly due to a dopamine imbalance in this network (46). Additionally, research has demonstrated improved performance on a previously fatiguing task when rewards are offered (47, 48), supporting the role of motivation in individuals' experience of cognitive fatigue (45). *Boredom:* In contrast, an inverted-U-shaped function of “under-arousal” has been proposed relating boredom to cognitive fatigue. As opposed to effortful processing resulting in the experience of “overload,” this theory suggests that there may be an “underload” or vigilance decrement during tasks that are less challenging, resulting in the subjective experience of “boredom” (49). Examples of boredom items include “I am feeling restless and fidgety” (state) and “I am often bored” (trait).

While there have been previous attempts to create subjective measures of fatigue and cognitive fatigue, most of these scales are limited. They lack adequate psychometric validation; fail to capture the construct of cognitive fatigue as it has been more precisely defined; do not include the constructs closely related to cognitive fatigue described in more detail above; and have not been validated in older adults. The current study aimed to develop and determine the reliability, validity, and factor structure of the STI-CF in community-dwelling older adults.

Methods

Participants

Community-dwelling older adults were recruited from a longitudinal cohort study entitled “Central Control of Mobility in Aging” (CCMA), a cohort study designed to determine cognitive and brain predictors of mobility. Details concerning procedures for this study have been reported (50, 51). Briefly, a structured telephone interview was administered to assess eligibility. Exclusion criteria were an inability to speak English or ambulate independently; significant loss of vision or hearing; current or history of neurological or psychiatric disorders; or recent/anticipated medical procedures that could affect mobility. Eligible participants were scheduled for two three-hour visits where they received neuropsychological, cognitive, psychological, and mobility assessments, as well as a structured neurological examination. Written informed consents were obtained in-person and approved by Institutional Review Board. A total of 175 participants, aged 65 and older, were included in the study. Analyses were based on the STI-CF administered at the first study visit, before any experimental procedures commenced, to control for variability due to the time of administration or study activities. As this study involved minimal risk, there is no

reason to believe that there would be additional fatigue or anxiety while waiting for procedures.

Measures

STI-CF—The STI-CF is a 32-item subjective measure of cognitive fatigue. A review of the literature was undertaken and a pool of items was formed, with changes made and items created based on feedback from participants in a previous aging study. A Likert rating scale was used as the literature indicates that this is a more precise method of measurement (35, 52, 53). An 11-point rating, with response options between 0 and 10, was chosen as it is thought to be more sensitive and closer to the interval level of scaling and normality (54). While the STI-CF was designed for flexible administration, the inventory was administered by study personnel, ensuring comprehension and completion.

BFI—The Brief Fatigue Inventory (BFI) is a 9-item, 11-point rating scale that assesses subjective fatigue during the past 24 hours (55). A recent study validating the scale in older adults found that it had a bi-dimensional factor structure (fatigue severity and fatigue interference) with good reliability (56). The STI-CF was hypothesized to have a positive but weak relationship with the BFI since the scales measure different aspects of fatigue.

GDS—The Geriatric Depression Scale (GDS) consists of 30 yes/no response items designed to screen for depression in the geriatric population. Its reliability and validity have been established (57). As co-morbid but separate constructs (58), the STI-CF and GDS were hypothesized to have a weak positive relationship.

Health Variables and Questionnaires—Participants' report of physician diagnosed medical conditions (i.e., diabetes, heart failure, hypertension, angina, myocardial infarction, depression, stroke, Parkinson's disease, chronic obstructive lung disease, and arthritis) were used to calculate an illness comorbidity score (0–10) (59). Given the relationship of fatigue to disability and health decline (1–3, 5, 60, 61), the STI-CF was expected to be positively related to greater disease burden.

TMT—The Trail Making Test was used to measure executive control (57). Error scores on TMT-B have been shown to differentiate individuals with mild cognitive impairment and dementia (57, 62–64) and ratio and subtraction scoring methods for the difference between Parts A and B have been shown to be more sensitive to the executive demands of TMT-B (64–66). Given the increasing evidence of a relationship between cognitive fatigue and tasks of executive control, higher scores on the STI-CF were hypothesized to have strong positive relationships with errors, ratio, and subtraction scores for the TMT.

RBANS—The RBANS was developed to identify and characterize cognitive decline in older adults (57, 67). The total score was used to describe the overall level of cognitive functioning in the sample. Since the battery consists of tests that vary in terms of their sensitivity to fatigue, no significant relationships were expected between the total score for this battery and the STI-CF.

Statistical Analysis

Motivation and mental effort subscales were reverse scored to ensure consistent valence. P-P plots and histograms were analyzed to check for overall normality.

Construct validity was evaluated using a principal component analysis (PCA) with an oblique (promax) rotation since the subscales are comprised of constructs thought to be related to cognitive fatigue. The minimum eigenvalue for extraction was set at 1. Minimum component loading for inclusion of an item in a subscale was set at 0.4 (68, 69). Values above 0.5 for communalities were considered adequate (69). The resulting correlation matrix was examined to ensure that all variables were sufficiently related ($r \geq 0.3$), but not so highly related ($r \geq 0.9$) to suggest multicollinearity. The Kaiser-Meyer-Olkin measure of sampling adequacy, Bartlett's test of sphericity, and determinants were assessed prior to analysis to ensure the adequacy for PCA.

Reliability was assessed and compared for the four subscales using Cronbach's α as a measure of internal consistency, checking whether any item would increase the Cronbach's α coefficient if deleted, and examining correlation coefficients between items (Cronbach's $\alpha \geq 0.7$ was considered acceptable). The correlation of each item to the total scale was also considered, with 0.3 set as the minimal acceptable standard (68, 69).

Pearson correlation coefficients were calculated to examine the relationship between the separate summation scores of the STI-CF with related subjective and neuropsychological outcome measures. Partial correlation coefficients were examined to investigate the relationships when controlling for the potential shared variance of depression. Significance level α was set at 0.05; all p values were two-tailed. Scatter plots were run to ensure there was a linear relationship between variables prior to any analysis.

Statistical analyses were performed using SPSS version 22 (IBM, Somers, NY).

Results

Demographic characteristics are summarized in Table 1. The means of the individual items on the STI-CF subscales ranged from 0.69 to 2.73, standard deviations ranged from 0.25 to 3.44, and scores for all individual items ranged from 0 to 10. For the summed scale scores, means ranged from 3.17 to 9.65 and standard deviations ranged from 6.31 to 11.96.

Construct Validity, presented in Tables 2 and 3, was established using PCA with an oblique (promax) rotation with the default Kaiser's criterion of eigenvalue ≥ 1 for component extraction. The minimum loading level was set to 0.4. The Kaiser-Meyer-Olkin measure of sampling adequacy, $KMO = 0.825$ for the state scale and $.844$ for the trait scale, was well above the acceptable limit of 0.5 (68). Bartlett's test of sphericity, $\chi^2(120) = 2200.035$, $p < .001$ for the state and $\chi^2(120) = 2047.064$, $p < .001$ for the trait scale indicated that correlations between items were sufficiently high to run a PCA.

PCA yielded the four expected subscales for both the state and trait inventories. The scree plot had a clear inflection at the fifth component. All components had eigenvalues over

Kaiser's criterion of 1 and, in combination, explained 78.16% of the variance for the state items and 75.67% for the trait items. Correlations on the component correlation matrix ranged from .072 to .491 for the state subscales and from .369 to .618 for the trait subscales, which indicates correlated but distinct components. Tables 2 and 3 show the factor loadings after rotation. Loadings for all subscales were high, ranging from .648 to .953 for the state items and .650 to .971 for the trait items. The rotated sums of squared loadings indicated that all subscales contributed roughly equally to the total scale.

All subscales demonstrated good reliability. Cronbach's α ranged from .851 to .928 for the state subscales and from .848 to .905 for the trait subscales. The corrected item-total-correlation ranged from .515 to .871 for the state items and from .758 to .857 for the trait items. The communalities and correlation matrices for both state and trait forms indicated that all items were sufficiently related ($r \geq 0.3$), but not so highly related ($r \geq 0.9$) to suggest multicollinearity.

STI-CF relationships to outcome measures are presented in tables 4 and 5. The STI-CF had significant relationships with the BFI. For the state subscales, cognitive fatigue and boredom yielded a significant positive relationship with the BFI interference and total subscales, with stronger relationships between the BFI subscales to cognitive fatigue than boredom. The BFI severity subscale was significantly associated only with cognitive fatigue. There were also significant positive relationships with all subscales and the GDS. Cognitive fatigue had the lowest association with the GDS and was the only subscale that remained significantly associated with BFI severity, interference, and total after controlling for depression using partial correlations.

For the trait subscales, the cognitive fatigue subscale had a significant positive relationship to BFI interference and total, but not severity. Though not significant, there was a trend for a significant positive association between the cognitive fatigue subscale and BFI interference after controlling for depression.

There were several consistent significant relationships between the STI-CF and relevant health-related variables: Health comorbidities were significantly related to the boredom subscale of the STI-CF (State) and the motivation subscale of the STI-CF (Trait). There were also significant relationships between the STI-CF and tests that measure aspects of executive functioning. For the state subscales, errors on TMT-B had significant positive associations with motivation, subtraction for TMT (B-A) had significant positive associations with mental effort, and the ratio of TMT (B/A) had significant positive associations with motivation and mental effort. For the trait subscales, there was a significant negative relationship between time to complete TMT-B and motivation and significant positive relationships for errors on TMT-B to cognitive fatigue and boredom. There were no significant associations between the STI-CF and TMT-A or other neuropsychological measures that are not thought to be related to executive control.

Discussion

This study validated the STI-CF, a newly developed measure of cognitive fatigue, for use in older adults. Principal component analyses demonstrated good construct validity, with items for both state and trait forms loading on the predicted components. All subscales demonstrated good reliability. Associations with a brief subjective measure that captures the state nature of general fatigue suggested good convergent validity.

Fatigue can be categorized into primary and secondary fatigue, with the former defined by factors that initiate disease and the latter defined by factors that exacerbate and perpetuate fatigue, such as depression, pain, and sleepiness (58, 70). The low correlations between the STI-CF and depression suggest that the STI-CF may more closely measure primary fatigue rather than the confounds of depression.

The limited capacity framework of cognitive fatigue suggests that fatigue results from the increased effort required to complete complex tasks due to limited resources (71). There were strong positive relationships between subscales of the STI-CF (particularly for mental effort and motivation) with error, ratio, and subtraction scores on the TMT, which are thought to be more sensitive to aspects of executive functioning that require maximizing attentional demands and rearranging resources, supporting the limited capacity framework for cognitive fatigue. Coupled with a lack of a relationship with neuropsychological measures that are not related to this construct, this provides further evidence that fatigue and executive control may be related (29, 56, 72) and that the STI-CF may be a useful measure for examining this relationship.

The relationship between the STI-CF to scoring methods on the TMT-B that are thought to be more sensitive to neurological impairment and global disease status (57) lend further support to the notion that general fatigue and cognitive fatigue may be an early sign of subsequent health and cognitive decline in this age cohort. Whether or not the STI-CF could complement existing measures to predict cognitive changes and outcomes as well as its potential utility for tracking rehabilitation progress, especially in the early stages of impairment, should be examined in future research.

Study Limitations

As the STI-CF was related to measures of divided attention and executive control that have been shown to differentiate older adults experiencing cognitive decline, longitudinal studies exploring predictive validity are needed to establish whether the STI-CF can predict functional and cognitive outcomes in older adults over time.

Despite significant associations with relevant outcome variables, many of the relationships were weak, likely due to the present sample consisting of relatively healthy older adults who reported fewer fatigue symptoms. These relationships may be stronger with a more cognitively diverse older adult sample. As the BFI is a measure of general fatigue severity and impact, rather than a measure of cognitive fatigue, the relationship between these constructs was expected to be relatively weak. It is also notable that the STI-CF had stronger positive relationships with neuropsychological outcome measures involving divided

attention and executive control that are hypothesized to be more closely related to cognitive, as opposed to general, fatigue.

Further investigation is needed to extend these findings to a more diverse sample of older adults who experience more health concerns, such as those in clinical settings and residential care facilities, as well as additional populations who experience cognitive fatigue, such as individuals with neurodegenerative diseases, multiple sclerosis, and traumatic brain injury.

Conclusions

Cognitive fatigue remains poorly understood and defined, particularly in older adults. The STI-CF offers a more nuanced subjective measurement of this construct. The current study yielded strong psychometric properties in a community-dwelling older adult cohort. The STI-CF had significant relationships in the expected direction with various health and cognitive outcome variables. The STI-CF is the first subjective inventory established and validated for the measurement of cognitive fatigue in older adults.

Future studies should determine its predictive validity and expand validation studies of the STI-CF to less healthy older adults and additional groups that experience cognitive fatigue. Given its separate state and trait forms, allowing the measurement of change over time, studies examining the STI-CF at various time points may help to establish this as a useful measure in longitudinal and clinical trials.

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List of Abbreviations

CCMA	Central Control of Mobility in Aging Study
GDS	Geriatric Depression Scale
PCA	Principal component analysis
RBANS	Repeatable Battery for the Assessment of Neuropsychological Status
STI-CF	State-Trait Inventory of Cognitive Fatigue
TMT	Trail Making Test
TMT B/A	Ratio of TMT-B to TMT-A
TMT B-A	Subtraction of TMT-A from TMT-B

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Table 1

Demographic Characteristics (N = 175)

Variable	N (%)	M ± SD (range)
Age (y)		77.35 ± 6.911 (66–96)
Sex		
Females	98 (56 %)	
Males	77 (44 %)	
Education (years)		14.98 ± 3.28 (5–28)
GDS		4.71 ± 3.72 (0–19)
GHS		
0	78 (44.6 %)	
1	57 (32.6 %)	
2	33 (18.9 %)	
3	6 (3.4 %)	
6	1 (0.6 %)	
Subjective Measures		
BFI Total		11.58 ± 11.70 (0–52)
BFI Severity		7.50 ± 5.97 (0–25)
BFI Interference		4.08 ± 7.43 (0–35)
Geriatric Depression Scale (GDS)		
RBANS Total Score		94.96 ± 10.86 (70–123)

Abbreviations: Geriatric Depression Scale (GDS), Global Health Status (GHS), Brief Fatigue Inventory (BFI), Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)

Table 2

Principal component analysis of the State Trait Inventory for Cognitive Fatigue (STI-CF): State Subscale Rotated oblique (promax) solution

Items (Component)				
	Cognitive Fatigue	Mental Effort	Motivation	Boredom
CF Question 3 (.901)	ME Question 1 (.953)	MO Question 4 (.926)	BO Question 4 (.942)	
CF Question 2 (.896)	ME Question 3 (.926)	MO Question 3 (.880)	BO Question 3 (.881)	
CF Question 1 (.863)	ME Question 2 (.921)	MO Question 1 (.839)	BO Question 2 (.879)	
CF Question 4 (.824)	ME Question 4 (.760)	MO Question 2 (.834)	BO Question 1 (.648)	
Rotated sums of squared loadings	3.789	4.429	4.813	4.479

Abbreviations: CF = Cognitive Fatigue, ME = Mental Effort, MO = Motivation, BO = Boredom

Table 3

Principal component analysis of the State Trait Inventory for Cognitive Fatigue (STI-CF): Trait Subscale Rotated oblique (promax) solution

Items (Component)				
	Cognitive Fatigue	Mental Effort	Motivation	Boredom
CF Question 1 (.883)	ME Question 3 (.971)	MO Question 3 (.958)	BO Question 4 (.944)	
CF Question 3 (.871)	ME Question 1 (.882)	MO Question 1 (.830)	BO Question 2 (.854)	
CF Question 4 (.764)	ME Question 4 (.820)	MO Question 4 (.813)	BO Question 1 (.834)	
CF Question 2 (.739)	ME Question 2 (.650)	MO Question 2 (.730)	BO Question 3 (.730)	
Rotated Sums of squared loadings	4.376	5.191	5.420	4.575

Abbreviations: CF = Cognitive Fatigue, ME = Mental Effort, MO = Motivation, BO = Boredom

Table 4

Correlations of STL-CF State Summation Scores and Outcome Measures

		STL-CF State Summation Scores			
		Cognitive Fatigue	Mental Effort	Motivation	Boredom
		STL-CF Total			
Demographic					
Age	Pearson	-.072 (.357)	-.056 (.470)	-.054 (.489)	-.013 (.866)
	Sig. (2-tailed)				
Education	Pearson	-.143 (.062)	0.041 (.598)	-.109 (.155)	.001 (.986)
	Sig. (2-tailed)				
Gender	Spearman	.048 (.532)	-.130 (.089)	-.192* (.011)	-.040 (.600)
	Sig. (2-tailed)				
GHS	Pearson	.102 (.179)	.032 (.679)	.040 (.603)	.172* (.023)
	Sig. (2-tailed)				
RBANS Total	Pearson	-.034 (.663)	.081 (.301)	.004 (.956)	-.139 (.074)
	Sig. (2-tailed)				
Subjective Measures					
BFI Severity	Pearson	.239 [†] (.002)	.001 (.991)	.026 (.745)	.120 (.125)
	Sig. (2-tailed)				
BFI Interference	Pearson	.271 [†] ($<.001$)	.092 (.239)	.087 (.267)	.129* (.012)
	Sig. (2-tailed)				
BFI Total	Pearson	.295 [†] ($<.001$)	.059 (.451)	.069 (.383)	.198* (.011)
	Sig. (2-tailed)				
GDS	Pearson	.160* (.040)	.177* (.023)	.184* (.018)	.205 [†] (.008)
	Sig. (2-tailed)				
Trail Making Test					
TMT A (Time)	Pearson	-.029 (.709)	-.016 (.836)	-.058 (.456)	-.051 (.516)
	Sig. (2-tailed)				
TMT A (Errors)	Pearson	-.044 (.577)	.128 (.100)	.051 (.516)	.064 (.411)
	Sig. (2-tailed)				
TMT B (Time)	Pearson	-.030 (.777)	-.069 (.411)	.078 (.290)	-.033 (.290)
	Sig. (2-tailed)				

STI-CF State Summation Scores						
		Cognitive Fatigue	Mental Effort	Motivation	Boredom	STI-CF Total
TMT B (Errors)	Sig. (2-tailed)	(.706)	(.379)	(.325)	(.673)	(.702)
	Pearson	-.039	.147	.371[†]	.034	.183[*]
TMT Time (B-A)	Sig. (2-tailed)	(.624)	(.062)	(<.001)	(.670)	(.020)
	Pearson	.010	.126	.154[*]	.025	.121
TMT Time (B/A)	Sig. (2-tailed)	(.900)	(.105)	(.049)	(.748)	(.123)
	Pearson	-.031	.164[*]	.188[*]	.056	.145
	Sig. (2-tailed)	(.697)	(.036)	(.016)	(.475)	(.063)

Note: Pearson correlation values are reported. Values in parentheses are P values

Abbreviations: GHS = Global Health Status; GDS = Geriatric Depression Scale; RBANS = The Repeatable Battery for the Assessment of Neuropsychological Status; TMT A = Trail Making Test (Part A);

TMT B = Trail Making Test (Part B)

^{*} P < 0.05

[†] P < 0.01[†]

Table 5

Correlations of STL-CF Trait Summation Scores and Outcome Measures

	STL-CF Trait Summation Scores				
	Cognitive Fatigue	Mental Effort	Motivation	Boredom	STL-CF Total
Demographic					
Age	Pearson Sig. (2-tailed)	-.036 (.643)	-.043 (.586)	-.064 (.412)	.010 (.894)
Education	Pearson Sig. (2-tailed)	-.170* (.026)	-.002 (.978)	.014 (.853)	-.193* (.012)
Gender	Spearman Sig. (2-tailed)	.020 (.792)	-.082 (.284)	-.096 (.210)	-.181* (.018)
GHS	Pearson Sig. (2-tailed)	.050 (.511)	.199 [†] (.008)	.096 (.209)	.217 [†] (.004)
RBANS Total	Pearson Sig. (2-tailed)	.025 (.745)	-.015 (.847)	.059 (.448)	-.061 (.433)
Subjective Measures					
BFI Severity	Pearson Sig. (2-tailed)	.109 (.165)	.073 (.354)	.150* (.055)	.249 [†] (.001)
BFI Interference	Pearson Sig. (2-tailed)	.256 [†] (.001)	.056 (.474)	.085 (.278)	.229 [†] (.003)
BFI Total	Pearson Sig. (2-tailed)	.219** (.005)	.073 (.353)	.132 (.093)	.274 [†] (.001)
GDS	Pearson Sig. (2-tailed)	.332 [†] (.001)	.178* (.022)	.264 [†] (.001)	.324 [†] (.001)
Trail Making Test					
TMT A (Time)	Pearson Sig. (2-tailed)	.038 (.541)	.009 (.912)	.022 (.779)	.023 (.773)
TMT A (Errors)	Pearson Sig. (2-tailed)	-.027 (.731)	.122 (.118)	.109 (.164)	.125 (.109)
TMT B (Time)	Pearson	.069	-.149	-.155*	.128

STI-CF Trait Summation Scores					
		Cognitive Fatigue	Mental Effort	Motivation	Boredom
TMT B (Errors)	Sig. (2-tailed)	(.383)	(.058)	(.048)	(.104)
	Pearson	.316[†]	-.014	-.039	.261[†]
TMT Time (Subtraction)	Sig. (2-tailed)	(<.001)	(.863)	(.619)	(.001)
	Pearson	-.012	-.055	-.030	.061
TMT Time Ratio (B/A)	Sig. (2-tailed)	(.878)	(.482)	(.700)	(.438)
	Pearson	-.002	-.091	-.080	.028
	Sig. (2-tailed)	(.976)	(.244)	(.305)	(.720)
					(.566)

Note: Pearson correlation values are reported. Values in parentheses are P values

Abbreviations: GHS = Global Health Status; GDS = Geriatric Depression Scale; RBANS = The Repeatable Battery for the Assessment of Neuropsychological Status; TMT A = Trail Making Test (Part A); TMT B = Trail Making Test (Part B)

* P < 0.05

[†] P < 0.01