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Title of Thesis: "Development of a brief self-report measure of work-related cognitive limitations in breast cancer survivors"

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1/7/2013

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ABSTRACT

Title of Thesis: Development of a brief self-report measure of work-related cognitive limitations in breast cancer survivors

Alicia Ottati, M.A., 2012

Thesis Directed by: Michael Feuerstein, PhD, MPH

Professor , Medical and Clinical Psychology and Preventive Medicine and Biometrics

Objective: To develop a brief, reliable self-report measure of work-related cognitive limitations using a cross-validation method and to assess the correlation of that measure with an established self-report measure of generic cognitive limitations in cancer survivors.

Method: A pooled dataset of working (e.g., managerial, sales, services, professional/technical, clerical) breast cancer survivors (n = 228) completed a self-report measure of work-related cognitive limitations, the Cognitive Symptom Checklist-Work-59 (CSC-W59). A cross-validation technique was employed such that the pooled participants were randomized into two separate groups in order to conduct exploratory factor analysis (EFA) of the CSC-W59 with one group and validate the results of the EFA with the other group. A subset of this pooled dataset (breast cancer survivors, n = 133) also completed a self-report measure of generic cognitive limitations, the Functional Assessment of Cancer Therapy-Cognition (FACT-Cog) which measures such dimensions as subjectively perceived cognitive impairment, other's perception of cognitive impairment, and effects of cognitive impairment on quality of functioning.

Results: The EFA of the 59 items in the CSC-W59 on randomized group 1 (n = 114) resulted in the identification of 21 items with a consistent factor loading of .4 or higher on three separate subscales (Memory, Executive Function, and Task Completion). The consistency of the factor structure on these 21 items was validated on randomized group 2 ($n = 114$) which demonstrated the same 21 items loading at .4 or higher on the same three subscales. These findings resulted in a brief 21-item, self-report measure referred to as the Cognitive Symptom Checklist-Work-21 (CSC-W21). The CSC-W21 demonstrates good internal reliability ($\alpha = .88$) and accounts for 68% of the variance in a measure of generic cognitive function ($\rho < .001$) suggesting the CSC-W21 captures some commonalities of limitations in global cognition. Construct validity of the CSC-W21 is supported by significant positive correlations with cancer stage, job stress, and affective states. The CSC-W21 also demonstrates high face validity with regard to the more distinct construct of work-related cognitive limitations.

Conclusion: Brief, internally reliable, valid self-report measures such as the CSC-W21 may be used to quickly assess work-related cognitive problems for breast cancer survivors at work. Such a measure may be less burdensome than lengthier self-report or neuropsychological measures of cognitive problems. The CSC-W21 appears most applicable to those breast cancer survivors working in jobs which require knowledge-based cognitive tasks; however, validation of the CSC-W21 with other populations and job types is warranted.

Development of a brief self-report measure of work-related cognitive limitations

in breast cancer survivors

by

Alicia Ottati

Thesis submitted to the Faculty of the

Department of Medical and Clinical Psychology Program of the

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in partial fulfillment of the

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Introduction

Of the 12.5 million cancer survivors in the United States, over 2.7 million are women who are living with a history of breast cancer (SEER, 2012). Many breast cancer survivors return to work following treatment. In general, work can be a necessity to ensure income and secure health insurance in the United States, while also providing a sense of purpose, stability, and security (Amir, Wilson, Hennings, & Young, 2012; Main, Nowels, Cavender, Etschmaier, & Steiner, 2005; Rasmussen & Elverdam, 2008; Steiner et al., 2008). For some cancer survivors, work can also represent a return to normalcy, indicate a marker of health, and provide an additional support system (Ferrell & Hassey Dow, 1997; Rasmussen & Elverdam, 2008).

Despite these positive aspects of work, cancer survivorship has been significantly associated with unemployment rates (Syse, Tretli, & Kravdal, 2008). A meta-analysis revealed that cancer survivors were more likely than healthy controls to be out of work (pooled RR = 1.37, 95% CI = 1.21 to 1.55) and unemployment rates were higher for breast cancer survivors than a non-cancer comparison group (pooled RR = 1.28, 95% CI = 1.11 to 1.49) (de Boer, Taskila, Ojajarvi, van Dijk, & Verbeek, 2009). Incidence of return to work can also be affected and varies by type of cancer, physical symptoms, and functional limitations (e.g., difficulties lifting heavy loads or problems concentrating for long periods of time) (Bradley, Bednarek, & Neumark, 2002; Steiner, Cavender, Main, & Bradley, 2004). In a review of studies on work and post-diagnosis/post-treatment cancer survivors, the average return to work rate ranged from 72%-93% for breast cancer survivors post-diagnosis (Spelten, Sprangers, & Verbeek, 2002). More recent research shows return-to-work rates for breast cancer survivors ranging from 59%-82% (Bouknight, Bradley, & Luo, 2006; Drolet et al., 2005; Fantoni et al., 2010; Johnsson et al., 2009; Roelen, Koopmans, Groothoff, van der Klink, & Bultmann, 2011). However, compared to non-cancer comparison groups, working breast cancer survivors reported significantly higher levels of work limitations, higher levels of cancer-related symptoms and job stress, as well as poorer work outcomes across many symptom burden measures such as anxiety, depressive symptoms, fatigue, pain, and cognitive problems (Calvio, Peugeot, Bruns, Todd, & Feuerstein, 2010; Hansen, Feuerstein, Calvio, & Olsen, 2008; Todd, Feuerstein, & Feuerstein, 2011). Additionally, a subset of breast cancer survivors who do return to work or continue working despite diagnosis and treatment report difficulties with cognitive functioning that can have a negative impact on their work ability, productivity, and sustainability (Boykoff, Moieni, & Subramanian, 2009; Munir, Burrows, Yarker, Kalawsky, & Bains, 2010; Von Ah, Habermann, Carpenter, & Schneider, 2012; Wefel, Lenzi, Theriault, Davis, & Meyers, 2004).

Cognitive Challenges in the Context of Work

Cognitive demands are required in many different types of work (Lysaght, Shaw, Almas, Jogia, & Larmour-Trode, 2008), are especially important in today's knowledge-based work (Johnson, Mermin, & Resseger, 2007), and work settings that require cognitive function. A large-scale study of work task disability in breast and prostate cancer survivors found over 95% of breast cancer survivors reported having occupations that required cognitive tasks (e.g., data analysis) (Oberst, Bradley, Gardiner, Schenk, & Given, 2010).

Cognitive Limitations in Breast Cancer Survivors

Many breast cancer survivors report difficulties with their cognitive functioning following cancer treatment, including chemotherapy and adjuvant chemotherapy (Boykoff et al., 2009; Breckenridge, Bruns, Todd, & Feuerstein, 2012; Downie, Mar Fan, Houede-Tchen, Yi, & Tannock, 2006; Janelsins et al., 2011; Shilling, Jenkins, Morris, Deutsch, & Bloomfield, 2005). For some breast cancer survivors, cognitive limitations are reported as their most difficult post-treatment symptom (Boykoff et al., 2009).

Cognitive limitations associated with breast cancer survivorship often present as subtle variations in cognitive domains such as working memory, long-term memory, attention, learning, executive function, and/or concentration (Bender et al., 2006; Jenkins et al., 2006; Quesnel, Savard, & Ivers, 2009; Shilling et al., 2005; Wefel et al., 2004; Wefel, Saleeba, Buzdar, & Meyers, 2010). However, cognitive limitations observed and reported can depend on the study design, the measurements used to assess cognitive function, and the definition of cognitive impairment adopted by the study (Falleti, Sanfilippo, Maruff, Weih, & Phillips, 2005; Hutchinson, Hosking, Kichenadasse, Mattiske, & Wilson, 2012; Matsuda et al., 2005). Furthermore, cognitive limitations can be exacerbated by affective states such as psychological stress (Jenkins et al., 2006; Shilling & Jenkins, 2007) and common cancer-related symptoms such as fatigue and depression (Munir et al., 2011; Todd et al., 2011).

Longitudinal studies of post-treatment breast cancer survivors including baseline neuropsychological assessments reported ranges of participants demonstrating observed cognitive decline from 20%-65% in the following domains: attention, learning, and processing speed (Wefel et al., 2004); concentration and attention (Shilling et al., 2005); concentration and memory (Jenkins et al., 2006); and, learning/memory, executive function, and processing speed (Wefel et al., 2010). By contrast, longitudinal studies of post-treatment breast cancer survivors which also included baseline assessments of self-reported cognitive problems demonstrated ranges of participants reporting cognitive problems from 45%-83% in the following domains: memory (Shilling et al., 2005); memory and concentration (Jenkins et al., 2006); memory, concentration, and attention (Shilling & Jenkins, 2007).

Regardless of whether cancer-related cognitive limitations are acute, chronic, or mild to severe, cognitive impairment can have adverse consequences on work in breast cancer survivors. Wefel and colleagues (2004) found that breast cancer survivors with cognitive limitations as indicated by a reliable change index reported more difficulties in ability to work on one question of a self-report measure of quality of life than those survivors without cognitive changes. Moreover, a qualitative study of breast cancer survivors reported that 70% of their participants (n = 74) endorsed cognitive impairment at 1-year post-treatment (Boykoff et al., 2009). These cognitive problems were associated with diminished focusing ability, slower processing speed, and memory problems which reportedly had adverse effects on job performance, work retention, possibility of promotion, ability to re-enter the workforce, and financial stability. Similar findings were observed in another qualitative study where all participating breast cancer survivors (n = 13) reported changes in their cognitive functioning such as diminished concentration, inability to think clearly, and confusion following chemotherapeutic treatment (Munir et al., 2010). These cognitive changes detrimentally influenced survivors' confidence in their ability to return to work and negatively impacted their job performance. The most common problem reported by a sample of breast cancer survivors with post-treatment symptoms (i.e., fatigue, depressed mood, memory and attention problems) was difficulty remembering tasks at work (Munir et al., 2011). These self-reports were further supported by two studies of cancer survivors and work using a self-report measure of work-related cognitive function which found significantly higher cognitive limitations in occupationally active breast cancer survivors as compared to a non-cancer comparison group (Calvio et al., 2010; Hansen et al., 2008). The research by Calvio and colleagues (2010) also demonstrated that the cognitive limitations endorsed in this study included three domains correlated to work function: Working Memory, Executive Function, and Attention.

Assessment of Cognitive Function

Many assessments which evaluate cognitive functioning are currently available, although existing assessments can produce discrepant findings between neuropsychological measures and self-report measures of cognitive problems (Jenkins et al., 2006; Shilling & Jenkins, 2007; Shilling et al., 2005). Neuropsychological assessments are often used in cancer survivor cognition research because they are considered objective, sensitive, brief, and repeatable (Wefel et al., 2004). However, critics contend that neuropsychological measures may not be as sensitive as subjective self-report to the mild cognitive declines experienced by cancer survivors, have low ecological validity, and are unable to provide a situation- or task-specific assessment of cognitive limitations (Ferguson, Cassel, & Dawson, 2010; Pullens, De Vries, & Roukema, 2010; Tannock, Ahles, Ganz, & Van Dam, 2004). Specifically, cognitive impairments experienced by some cancer survivors may be role-specific (e.g., functional job tasks) and therefore too task dependent to be accurately detected by more generic neuropsychological tools (Ferguson et al., 2010; Pullens et al., 2010). Additionally, for those cancer survivors who exhibited high premorbid cognitive function, post-treatment cognitive problems may be apparent to the individual (relative to his or her previous level of functioning) but reflect as normal cognitive ability on neuropsychological tests—suggesting a need to adjust for premorbid ability (Ferguson et al., 2010; Jenkins et al., 2006; Shilling & Jenkins, 2007). For example, in a study comparing neuropsychological assessment to self-reported cognitive problems in breast cancer survivors, Shilling and Jenkins (2007) observed the absence of cognitive impairments (as defined by a reliable decline on at least two cognitive measures) on a standardized neuropsychological test battery but found patient self-reported memory (83%) and concentration (78%) problems at 6 months post-treatment. Furthermore, neuropsychological measures examine cognitive function at a specific time point and in a particular setting whereas self-report tends to query cognitive abilities over time and in a variety of settings (Tannock et al., 2004). In an effort to address the limitations of current neuropsychological measures, many cancer survivorship studies have incorporated self-report assessments in addition to neuropsychological measures to evaluate cognitive function (Bender et al., 2006; Biglia et al., 2012; Hermelink et al., 2007; Quesnel et al., 2009; Shilling & Jenkins, 2007; Shilling et al., 2005) but even these studies included subjective measures to assess global cognitive functioning and may lack the sensitivity and specificity to evaluate work-related cognitive limitations.

Although neuropsychological measures are still considered the gold standard assessment of cognitive impairment (Vardy, Rourke, & Tannock, 2007; Wagner, Sweet, Butt, Lai, & Cella, 2009), recent research suggests that these measures may assess a different aspect of cognition than that assessed by self-report measures. One study of cognitive performance examined healthy older adults who performed within the normal range of functioning on neuropsychological tests but reported significant difficulties with cognitive functioning in the context of memory complaints (Saykin et al., 2006). This cognitive complaint group showed rates of decreased gray matter density on whole brain MRIs which was comparable to (i.e., not statistically significantly different) the gray matter density of older adults with observable cognitive problems. However, the MRIs of both the cognitive complaint group and the observed cognitive problems group showed significantly less gray matter than those MRIs of healthy controls with no cognitive complaints ($\rho \leq .001$) (Saykin et al., 2006).

Ferguson and colleagues (2007) conducted a structural and functional MRI study of a pair of monozygotic twins, one of which had received chemotherapy for breast cancer and was participating in an intervention study to improve memory dysfunction following chemotherapy. Despite the fact that both twins had performed comparably on neuropsychological assessments indicating the absence of cognitive impairment, the twin who had received chemotherapy scored three standard deviations higher than healthy controls on the total score of a self-report measure of cognitive limitations (language, visual-perceptual ability, visual memory, spatial memory, attention-concentration subscales) while the twin with no history of cancer scored within normal limits on the same measure. Furthermore, pronounced structural and functional differences were observed on imaging of the twins' brains. The findings indicated greater levels of brain activity in the twin who had received chemotherapy during a task of working memory, possibly suggesting a greater cognitive effort on the part of the twin who had received chemotherapy in order to compensate for her perceived cognitive difficulties. Despite these functional differences, both twins performed similarly on the task. Additionally, a study by Calvio and colleagues (2010) reported on the correlation between neuropsychological tests and subjective reports of work-related cognitive problems in breast cancer survivors and a non-cancer comparison group. Results of this study found that work productivity in breast cancer survivors was correlated only with the measures of self-report, whereas only the neuropsychological measures were related to work productivity in the non-cancer comparison group. While these findings may have been due to methodological approach or construct differences in report measures, they are consistent with earlier studies indicating little consistency between self-report and neuropsychological measures (Hutchinson et al., 2012; Pullens et al., 2010). As a whole, these findings suggest that neuropsychological and self-report measures may be assessing two different but important aspects of cognitive functioning. These differences should not preclude the use of one type of measure in favor of the other, but rather underscores the multidimensional aspects of cognition.

Assessment of Work-Related Cognitive Function

Despite the differences noted, cognitive measures which are presently available, whether neuropsychological or subjective, are time-intensive for both the provider and the patient. Additionally, there is no brief measure of work-related cognitive limitations for breast cancer survivors actively employed in work settings that require cognitive function. A work-specific measure of cognitive failure was developed by Wallace and Chen (2005). However, the measure was validated on workers without a history of cancer and was primarily correlated with safety-related outcomes and behaviors in the workplace (e.g., number of accidents, workplace safety compliance). While there are self-report measures of cognitive limitations that have been developed specifically for cancer survivors such as the Functional Assessment of Cancer Therapy – Cognition (FACT-Cog) (Wagner et al., 2009) and the European Organization for Research and Treatment of Cancer QLQ-C30 – Cognitive scale (EORTC-QLQ-C30) (Aaronson et al., 1993), these measures focus on the global facets of cognitive functioning. Currently, there is no brief measure of work-related cognitive limitations for breast cancer survivors actively employed in work settings that require cognitive function.

The original 100-item Cognitive Symptom Checklist (CSC) is a generic self-report measure designed for use as a simple initial screen for cognitive problems experienced in a range of functional tasks. A factor analysis of the 100-item CSC was conducted by Feuerstein and colleagues (2007) which resulted in a modified version of the CSC, known as the Cognitive Symptom Checklist-Work-59 (CSC-W59). The CSC-W59 is a measure containing 59 items for use in the context of work-related cognitive limitations. The factor structure, reliability, and validity (higher scores related to poorer work productivity) of the CSC-W59 have been reported elsewhere (Calvio, Feuerstein, Hansen, & Luff, 2009). The CSC-W59 has been used in prior studies to assess the presence of work-related cognitive problems reported by breast cancer survivors employed for at least one year and ranging from 1 to 10 years post-treatment or 1 to 27 years post-diagnosis (Calvio et al., 2010; Hansen et al., 2008; Todd et al., 2011). Although the CSC-W59 was reduced from 100 items, the measurement burden is still relatively high and it is unlikely such a lengthy measure would be used in epidemiological, workplace, or clinical studies. This indicated a need to explore whether the CSC-W59 could be reduced and a short version could be developed with measurement properties equivalent to the longer version of the CSC-W59. The present study focused on using exploratory factor analysis (EFA) to reduce the CSC-W59 to a more usable, brief self-report measure of cognitive limitations at work.

Method

Participants

A merged dataset was established from previously collected data of two studies of working breast cancer survivors (Calvio et al., 2010; Hansen et al., 2008). Study 1 recruited 149 female breast cancer survivors. Study 2 participants consisted of 100 female breast cancer survivors.

Study 1 inclusion criteria required that participants be female, aged 18-65, working full time at the time of the assessment, and have internet access. Breast cancer survivors were included if they had completed primary anticancer treatment between 1 and 10 years prior to the study and had received a diagnosis of Stage I-III cancer. Volunteers diagnosed with or reporting dementia, brain injury, adult attention deficit hyperactivity disorder, epilepsy, drug or alcohol abuse, or metastatic cancer were excluded from participating in Study 1 (no diagnostic data was available for analysis from the excluded participants). Inclusion criteria for Study 2 required participants be female, between the age of 20-70, and have access to the internet. Breast cancer survivors were included if they reported working full-time or part-time for at least one year prior to the study, had completed primary treatment, and had received a Stage I-III diagnosis of cancer.

Procedures

Both studies recruited participants through advertisements and leaflets disseminated to cancer centers, primary care clinics, support groups, hospital bulletin boards, newspapers, and websites. Both studies also utilized online surveys to collect data from participants. After answering screening material and questionnaires online, eligible participants were directed to a main website to complete informed consent. Participants then received web-based instructions regarding completion of each study's measures. All participants provided demographic information, health history, work history, and job information. Breast cancer survivors also reported on medical variables such as tumor location, stage, and type of primary treatment.

Data Analysis

The aim of the current study was to develop an abbreviated measure of self-reported cognitive limitations at work. Therefore, EFA was conducted on all 59-items of the CSC-W59 which was administered in both Study 1 and Study 2. The full 100-item CSC was not administered to participants in either of the original studies and therefore could not be subjected to an EFA procedure in the current analysis. A cross-validation technique was employed by pooling the breast cancer survivor data from Study 1 and Study 2 (yielding a total sample size of 243 participants) and then randomizing the merged dataset into two separate groups. As a result, the present study conducted EFA on the 59 items of the CSC-W59 using one half of the merged dataset to determine the underlying structure of an abbreviated measure of work-related cognitive limitations and compared the results of that analysis to EFA conducted on the other half of the merged dataset. Therefore, we utilized a two-pronged criterion for deciding which items were retained from the EFA in the final measure: (1) items with a factor loading of $\geq .4$, and (2) items which loaded at $\geq .4$ on the same factors in both randomized groups (i.e., group 1 and group 2). In order to be included in the final measure, items were required to meet both portions of the criterion. This two-pronged approach is more rigorous and designed to maximize the generalizability of the retained items (Preacher, Zhang, Kim, & Mels, in press). Additional correlational analysis was performed using only the data from Study 1 to examine the relationship between the abbreviated (21-item) measure of work-related cognitive limitations resulting from the EFA and a self-report measure of generic cognitive deficits which is widely used in cancer survivors (FACT-Cog) (Wagner, Cella, & Doninger, 2003; Wagner et al., 2009). Although both studies utilized the same 59-item self-report measure of work-related cognitive limitations (CSC-W59), only Study 1 included the FACT-Cog and therefore this generic measure could not be analyzed with the pooled sample.

Sample size

Summarized research on subject size in EFA indicates the majority of studies used case-to-variable ratios in the range of 2.1 to 5.1 (Costello & Osborne, 2005). The present study used a sample size (n = 114) which yields a 1.9:1 ratio of cases-to-variables. However, a measure of sampling adequacy, the Kaiser-Meyer-Olkin (KMO) value (Kaiser, 1970, 1974), was .76 for randomized group 1 (n = 114) and .72 for randomized group 2 (n = 114) which is well above the recommended level of .6 (Garson, 2012; Tabachnick & Fidell, 2007).

Measures

Demographics, Medical History, and Work Status. Participants were asked to provide information about demographics, medical history, and work status. Demographic information included age, race, level of education, and marital status. Breast cancer survivors provided information regarding their medical history which consisted of location and stage of tumor as well as type of anticancer treatment received. Occupational information included type of job, length of time at current job, and the perceived job stress experienced at the present job.

Symptom Burden. Participants in Study 1 (Calvio et al., 2010) completed measures of symptom burden to include self-reported pain within the last week, feelings of physical fatigue during the past week, as well as anxiety and depressive symptoms measured by the Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983). The HADS is a 14-item measure with two subscales measuring anxiety (A-scale; 7-items) and depression (D-scale; 7-items). The HADS has demonstrated acceptable reliability in anxiety and depression screening for breast cancer survivors (Alexander, Palmer, & Stone, 2010).

Cognitive Symptom Checklist-Work-59 (CSC-W59)

The original 100-item CSC was designed as a checklist to identify individuals' self-reported problem areas of cognitive functioning across five general domains: attention/concentration, memory, visual processing, language, and executive function (O'Hara, Harrell, Bellingrath, & Lisicia, 1993). This original measure was comprised of 100 short items indicating whether the patient believes the item is a problem/not a problem (e.g., "I have difficulty staying focused in places where there are many sights and sounds"). No subscales were identified in the original measure.

The 100-item CSC captured many cognitive functions and was developed to provide an office-based screener of generic cognitive impairment. Once out of print and no longer being used for its original purpose, the administration of the full 100-item CSC was revised to provide a measure of self-reported cognitive limitations in the context of work for a study of work and cancer survivors (Feuerstein et al., 2007). Using EFA to identify those items from the full 100-item CSC which were most correlated with work-related cognitive problems, Feuerstein and colleagues (2007) subsequently reduced the 100 items of the full scale to a shorter version of the CSC. They chose varimax rotation to interpret the EFA and a factor loading of $\geq .4$ was selected as the inclusion cut-off such that any items with factor loadings at .4 or above were retained in the final measure. The EFA inclusion criteria identified 59 of the 100 items for retention. These 59 items reflected a range of work-related cognitive limitations in three distinct cognitive domains. Each of the domains demonstrated high internal consistency: Working Memory (Cronbach $\alpha = .93$), Executive Function (Cronbach $\alpha = .91$), and Attention (Cronbach $\alpha = .86$). Higher scores on the CSC-W59 indicate a greater number of work-related cognitive limitations. The CSC-W59 measure is available in Appendix A with each factor subscale indicated next to the individual items that comprise that particular domain.

The CSC-W59 appears to be a promising measure of work-related cognitive limitations and was directly related to a measure of work productivity, the Work Limitations Questionnaire (WLQ) (Lerner et al., 2001). Specifically, higher scores on the CSC-W59 correlated with higher (worse) scores on the work output scale of the WLQ in a sample of working breast cancer survivors (Calvio et al., 2010) supporting its validity as it relates to perceived work output.

Functional Assessment of Cancer Therapy – Cognition, Version 2 (FACT-Cog). The FACT-Cog (Wagner et al., 2003; Wagner et al., 2009) is a 50-item self-report measure designed to evaluate the cognitive problems of cancer survivors. The full scale measure asks participants to rank the frequency of a broad range of cognitive functioning over the past seven days using a 5-point Likert scale (0 = never; 4 = several times a day). Internal consistency of the FACT-Cog was evaluated on 101 cancer survivors, demonstrating an internal reliability range from $\alpha = .97$ (total scale score) to $\alpha = .58$ (concentration subscale) (Jacobs, Jacobsen, Booth-Jones, Wagner, & Anasetti, 2007). The present study utilized the following three subscales of the FACT-Cog comprising 29 total items: Perceived Cognitive Impairment (PCI; 20 items), Cognitive Impairments Quality of Function (CIQOF; 4 items), and Other's Perception of Impairment (5 items). Higher scores on both the PCI and CIQOF subscales are indicative of poorer cognitive performance, while lower scores on the "Other's Perception of Impairment" subscale indicates poor cognitive performance as noticed by others. A high sum total score of these three measures indicates poorer cognitive performance.

Results

The merged dataset resulted in 243 breast cancer survivor participants for the present study. Fifteen participants failed to complete at least one full measure and were excluded from the analysis resulting in a final sample of 228 participants retained in the dataset. Chi-square and independent sample t-test analyses demonstrated no significant differences for completers and non-completers on age ($t(223) = -.06$, $\rho = .95$), education level ($\chi^2 = .52$, df = 4, $\rho = .97$), marital status ($\chi^2 = .71$, df = 2, $\rho = .70$), race ($\chi^2 = .75$, df = 3, $\rho = .86$), type of job ($\chi^2 = 4.31$, df = 4, $\rho = .37$), or number of months at current job ($t(233) = .22$, $\rho = .83$).

The merged sample (n = 228) was subjected to an EFA cross-validation technique in which the pooled participants were randomized into two separate groups so that EFA could be completed using one group and validated with the other group. All breast cancer survivors were randomly assigned to either group 1 or group 2 using the SPSS random number generator (SPSS, version 20). This split-half randomization resulted in an overall sample of size of 114 participants in group 1 and 114 participants in group 2.

Participant demographic, occupational, and medical characteristics of each randomized group in the merged sample are presented in Table 1. Chi-square analyses and independent sample t-tests indicated that the randomized groups did not differ significantly on any of the demographic variables examined. Regarding medical variables, group 1 had more breast cancer survivors who indicated receipt of other anticancer treatment as compared to group 2 and this difference was statistically significant ($\chi^2 = 4.12$, df = 1, $p < .05$). No significant differences were observed on any other medical variables between the two groups.

Table 1. Participant Demographic, Occupational, and Medical Characteristics of Merged Dataset (n = 228)

Characteristic	Group 1 (n = 114)		Group 2 (n = 114)	
	N	%	n	%
Cancer History				
Breast cancer survivor	114	100%	114	100%
Age[1]	M = 46.55 (SD = 9.44)		M = 47.19 (SD = 9.25)	
Race				
White	101	88.6%	101	88.6%
Black	5	4.4%	9	7.9%
Asian	5	4.4%	3	2.6%
Other	3	2.6%	1	0.9%
Relationship status				
Single	14	12.3%	18	15.8%
Married or cohabitating	82	71.9%	81	71.1%
Separated, divorced, or widowed	17	14.9%	15	13.2%
Missing respondents	1	0.9%	0	0.0%
Education				
High school or less	9	7.9%	10	8.8%
Some college	24	21.1%	13	11.4%
Associate's or bachelor's degree	36	31.6%	36	31.6%
Some graduate school	11	9.6%	9	7.9%
Graduate degree	34	29.8%	46	40.4%
Occupation				
Managerial	39	34.2%	33	28.9%
Sales	11	9.6%	6	5.3%
Services	6	5.3%	3	2.6%
Professional or technical	44	38.6%	57	50.0%
Clerical	11	9.6%	15	13.2%
Missing respondents	3	2.6%	0	0.0%
Time at current job[2] (in months)	M = 117.17 (SD = 89.81)		M = 95.33 (SD = 89.24)	
Tumor location				
Right breast	54	47.4%	54	47.4%
Left breast	57	50.0%	52	45.6%
Both breasts	3	2.6%	6	5.3%
Missing respondents	0	0.0%	2	1.8%
Tumor stage at diagnosis				
Stage I	40	35.1%	47	41.2%
Stage II	48	42.1%	53	46.5%
Stage III	24	21.1%	13	11.4%
Missing respondents	2	1.8%	1	0.9%
Anticancer treatment type				

Chemotherapy	92	80.7%	92	80.7%
Radiation	86	75.4%	76	66.7%
Surgery	110	96.5%	107	93.9%
Other	40	35.1%	23	20.2%

[1]In Group 1, 6 respondents are missing (n = 108); and in Group 2, 6 respondents are missing (n = 108)

[2]In Group 1, 5 respondents are missing (n = 109); and in Group 2, no respondents are missing (n = 114)

Factor Analysis of the CSC-W59

Preliminary analyses were conducted to determine the suitability of the merged dataset for an EFA approach. Each of the 59 items of the CSC-W59 in both group 1 and group 2 demonstrated an inter-item correlation range ($r \geq .3$) with at least one other item in the measure, suggesting acceptable factorability (Tabachnick & Fidell, 2007). Additionally, Bartlett's Test of Sphericity (Bartlett, 1954) was significant for group 1 (χ^2 (1711) = 4072.12, $\rho < .001$) and group 2 (χ^2 (1711) = 3365.86, $\rho < .001$).

Because participants from the merged dataset were randomly assigned to split groups, we were able to employ a cross-validation method by conducting EFA on group 1 ($n = 114$) first and subsequently using the EFA of group 2 ($n = 114$) as a reliability check. Using SPSS version 20 on the merged dataset, all 59 items of the CSC-W59 were subjected to principal components analysis extraction methods, followed by direct oblimin (oblique) rotations to determine the optimal rotation method. The delta parameter for the oblique rotations was set at 0. Based on the work of Feuerstein and colleagues (2007), we chose a factor loading cut-off of $\geq .4$ and opted to use a forced three-factor solution. Using the two-pronged criterion described above, we then compared all three factors in each group (i.e., group 1 and group 2) in order to identify overlapping item numbers with a factor loading of .4 or higher on the respective factor.

We selected the direct oblimin rotation to facilitate interpretation of the factors because oblique rotation assumes a relationship among the factors (Costello & Osborne, 2005; Garson, 2012). In our analysis, most correlations among the three factors were greater than .32, indicating sufficient correlation among the factors to justify an oblique rotation (Tabachnick & Fidell, 2007). The results for the direct oblimin (oblique) rotation method are presented in Table 2 and simplified results of the direct oblimin (oblique) rotation are provided in Table 3.

The three-factor solution explained a total of 38.3% of the total variance in group 1 and 34.9% of the total variance in group 2. In group 1, the three factors contributed 28.6% (Factor 1), 5.4% (Factor 2), and 4.3% (Factor 3) of the variance, respectively. In group 2, the three factors contributed 6.0% (Factor 1), 24.1% (Factor 2), and 4.8% (Factor 3) of the variance, respectively. We examined the pattern matrix for the factor loadings of each CSC-W59 item on the three forced factors and decided to retain all three factors for further analyses. As seen in Table 2 and Table 3, significant loading was demonstrated in both groups for eight items on Factor 1, ten items on Factor 2, and three items on Factor 3 resulting in an overall measure consisting of 21 total items. Although some of the remaining 38 items demonstrated factor loadings $\geq .4$, these items were not retained in the final 21-item measure because they failed to meet the second half of our two-pronged criteria and did not load sufficiently high enough on the same factor in both group 1 and group 2.

Factor Structure of the CSC-W21

In the results of the current factor analysis (Tables 2 and 3), Factor 1 is comprised of eight items, all of which were consistent with the original Memory label proposed by Feuerstein and colleagues (2007) for the CSC-W59. Similarly, the ten items in Factor 2 were consistent with the original Executive Function label of the CSC-W59. Therefore, this nomenclature was retained for these two factors. Factor 3 of the new 21-item measure contained three items, each of which originally loaded on a different factor in the CSC-W59. Upon further examination of the items retained in Factor 3, the Task Completion label appeared to best capture the properties of these three items. Thus, the resulting 21-item measure is comprised of three subscales, Memory, Executive Function, and Task Completion. We refer to the brief, 21-item measure as the *Cognitive Symptom Checklist-Work-21* (CSC-W21) (available at Appendix B; see Table 3 for simplified factor loadings of the CSC-W21).

Reliability of Factor Structure for the CSC-W21

The structure matrix and communalities associated with our oblique rotation are presented in Table 4. The structure matrix indicates the correlation of the identified item with the specific factor (Garson, 2012). Communality is a measure of the amount of variance accounted for in a specific item by all the factors combined (Garson, 2012). With the exception of items 6 (*difficulty remembering the name of a familiar object or person*) and 7 (*difficulty remembering information that is on the tip of my tongue*) on group 1 and items 11 (*difficulty knowing where to look for information to solve a* problem) and 14 (*difficulty using new information to re-evaluate what I know*) on group 2, all communality values were above .3 indicating the extracted factors adequately explained the 21 items retained. Although the factor model explained only 27.3% of the variance in item 6 and 27.2% of the variance in item 7 for group 1, these items were retained in the final CSC-W21 measure because they demonstrated acceptable communality in group 2 (47.9% and 54.4% of the variance, respectively). Similarly, the factor model explained 27.9% of the variance in item 11 and 26.9% of the variance in item 14 for group 2, however, these items were retained in the final measure due to suitable communality in group 1 (48.7% and 38.4% of the variance, respectively). The three resulting factors (Memory, Executive Function, and Task Completion) demonstrated a moderate correlation with each other as seen in Table 5.

Due to the rotation method utilized to interpret our EFA, our initial correlational results reflected a misleading negative relationship for group 2 between the Memory and Executive Function subscales as well as the Task Completion and Executive Function subscales (which are actually positively correlated). This specious negative relationship developed as a result of the oblique rotation implemented in interpreting our EFA. In comparison to the positive factor loadings of items on the CSC-W21 Executive Function subscale in group 2, items which loaded on both the Memory and Task Completion subscales in group 2 all initially demonstrated negative factor loadings in our oblique rotation. As a result, the Executive Function subscale appeared to be negatively correlated with Memory and Task Completion for group 2 only. Although negative factor loadings are typically indicative of an inverse relationship between the items and the factor on which the items load, this interpretation may be erroneous if the rotation method is not taken into account. Specifically, factor rotation involves a process of reorienting the location of the factors within a defined dimensional space (i.e., the factor space) to aid in the interpretability of the results (Russell, 2002). Because orthogonal rotation (e.g., varimax) assumes no correlation between the factors, the factor space is constrained to a smaller area, such that plotted results would appear at right-angle axes to one another (Russell, 2002). In contrast, oblique rotation (e.g., direct oblimin) allows the examination of all four planes in the factor space to explain the variance in the relationship. Thus, in an oblique rotation, the axes can take any position in the factor space and this relaxes the orthogonality constraint by allowing the factors to be correlated (Abdi, 2003). In our study, the oblique rotation method arbitrarily flipped the dichotomous "yes/no" response scale on the Memory and Task Completion items in order to utilize the full factor space and find the optimal rotation to explain the relationship variance for Memory (Factor 1) and Task Completion (Factor 3). As a result, the negative sign in our group 2 oblique factor loadings did not truly indicate an inverse relationship of the items with the subscales but rather is an artifact of the rotation method utilized. This interpretation is supported by an examination of the correlation matrices for both randomized groups in the merged datasets which showed that all 59 items in the CSC-W59 were positively correlated with each other prior to factor analysis or factor rotation. Because the items in the Memory and Task Completion scales were flipped in the oblique rotation and resulted in specious negative factor loadings, these negative loadings resulted in a specious negative correlation between the Executive

Function subscale and the Memory and Task Completion subscales. Therefore, for ease of reporting and interpretation, the direction of the Memory subscale (Factor 1) and the Task Completion subscale (Factor 3) factor loadings (Tables 2 and 3), the Structure Coefficients (Table 4), and the Factor Correlation Matrix (Table 5) was reversed in our reported results to reflect the true correlation of the items with the Executive Function subscale (Factor 2) (i.e., negative items are now reflected as positive, and positive items are now reflected as negative).

Cronbach's alpha was calculated to determine the internal consistency of the CSC-W21 and its associated subscales. The CSC-W21 demonstrated good full scale reliability ($\alpha = .88$). The reliability of the subscales was also moderate to high: Memory subscale ($\alpha = .85$), Executive Function subscale ($\alpha = .84$), and Task Completion subscale ($\alpha = .72$). No significant increase in inter-item reliability would have been accomplished by removing more items from the measure.

Table 2. Pattern Matrix Factor Loading of the CSC-W59 using Oblique Rotation with .4 Cutoff and 3 Fixed Factors

	Group1 (n = 114)			Group 2 (n = 114)		
	Direct Oblimin Rotation Factor			Direct Oblimin Rotation Factor		
*CSC-W59 Item**	Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
Difficulty remembering what I intended to write (52)	**.627**	.029	.132	**.614**	-.021	.131
Difficulty remembering my train of thought as I am speaking (46)	**.607**	.002	.095	**.497**	-.124	.365
Difficulty remembering the content of telephone conversations (39)	**.586**	.405	-.162	**.658**	.089	.053
Difficulty remembering the content of conversations and/or meetings (41)	**.567**	.228	.061	**.546**	.218	.026
Difficulty remembering a word I wish to say (42)	**.529**	-.078	.147	**.635**	-.248	.086
Difficulty remembering the name of a familiar object or person (47)	**.479**	.051	.042	**.719**	-.130	.011
Difficulty remembering information that is "on the tip of my tongue" (51)	**.452**	-.032	.144	**.730**	-.129	.106
Difficulty remembering things someone has asked me to do (38)	**.452**	-.002	.395	**.497**	-.096	.273
Difficulty understanding a system (45)	-.088	**.835**	-.024	-.077	**.599**	.061
Difficulty understanding how a task fits into a plan or system (49)	-.088	**.824**	.031	-.214	**.718**	-.066
Difficulty knowing where to look for information to solve a problem (26)	-.154	**.692**	.147	-.030	**.563**	-.096
Difficulty understanding systems and models (50)	-.197	**.612**	.200	.138	**.675**	-.179
Difficulty figuring out how a decision was reached (53)	.169	**.591**	-.022	.042	**.675**	.049
Difficulty using new information to re-evaluate what I know (27)	.146	**.542**	.015	.004	**.469**	.107
Difficulty considering all aspects of what I hear or see instead of focusing on only one part (55)	.368	**.501**	-.087	.081	**.424**	.271
Difficulty understanding what a problem is when it occurs and clearly stating what the problem is (22)	.029	**.478**	.268	-.090	**.453**	.250
Difficulty following the flow of events (54)	.374	**.451**	-.082	-.152	**.600**	.159
Difficulty understanding graphs or flowcharts (48)	.256	**.430**	-.016	.104	**.708**	-.258
Difficulty completing all steps of a task or activity (18)	.145	.101	**.564**	.009	.214	**.514**
Difficulty staying with a task until completion (14)	.137	.022	**.545**	.139	-.002	**.645**
Difficulty putting steps in order such that the most important steps are done first (20)	.036	.085	**.535**	.108	.286	**.422**
Difficulty focusing on a task when there is a lot of movement happening around me (29)	.745	-.057	.073	-.162	.000	.816
Difficulty focusing on a task when there is a sudden movement around me (25)	.710	-.127	.087	-.243	.166	.730
Difficulty focusing on a task when more than one person is speaking at a time (34)	.697	-.039	.009	.221	-.095	.656
Difficulty staying focused in places where there are many sights and sounds (57)	.667	-.084	.078	.010	-.020	.738
Difficulty focusing on a task when I am in a large area (e.g., in a lobby of a building or large gathering in an auditorium) (59)	.634	.051	-.102	.052	.270	.364

Difficulty planning a speech (12)	.568	.039	-.161	.272	.265	-.007
Difficulty answering questions quickly (2)	.474	.102	.182	.339	.258	.230
Difficulty focusing on a task when there is too much detail or clutter (5)	.461	.295	.145	.122	-.061	.568
Difficulty remembering where my car is parked (24)	.458	.132	-.056	.172	.223	-.058
Difficulty focusing on a task when there is a sudden loud noise (e.g., siren, horn, car alarm) (30)	.428	-.164	.259	.123	-.016	.543
Difficulty understanding what I read without rereading it (7)	.425	-.058	.346	.289	.281	.187
Difficulty doing math in my head (1)	.379	.024	.145	.375	.241	-.026
Difficulty organizing information to be remembered (33)	.349	.227	.345	.186	.334	.364
Difficulty focusing on a task when I feel hot or cold (40)	.341	.029	.267	-.041	.064	.353
Difficulty planning what to discuss when I meet someone (15)	.322	.090	.295	.464	.178	.017
Difficulty following directions to a specific place (16)	.215	.147	.201	.476	.132	-.143
Difficulty focusing on a task when a radio or TV is playing in the background (35)	.207	.125	.141	.118	-.177	.575
Difficulty trying new ideas or actions (11)	.155	.152	.108	.159	.302	.156
Difficulty choosing a solution to a problem from several possible sources (28)	-.031	.528	.228	.079	.273	.288
Difficulty writing to other people in an organized manner (32)	.360	.438	-.312	.179	.290	-.125
Difficulty understanding what I hear the first time I hear it (8)	.240	.400	.166	.357	.304	.140
Difficulty following or retracing steps to solve a problem (36)	.295	.331	.148	.300	.105	.175
Difficulty following step-by-step instructions (19)	.159	.311	.194	-.049	.418	.172
Difficulty seeing and correcting mistakes pointed out to me by others (4)	.035	.117	.108	-.021	.342	.115
Difficulty starting a task or activity on my own (23)	-.052	-.102	.684	.136	.301	.047
Difficulty putting together the materials needed for a task (44)	-.201	.370	.624	-.122	.600	.282
Difficulty setting up a routine or system to approach tasks (21)	-.062	.173	.582	.170	.201	.302
Difficulty remembering to perform daily routines (37)	.022	.091	.571	.126	.133	.112
Difficulty shifting from 1 task or activity to another (17)	.135	.081	.519	.103	.198	.378
Difficulty seeing and correcting mistakes on my own (3)	.219	-.251	.509	.251	.494	.070
Difficulty remembering to keep appointments once they are scheduled (58)	.116	.067	.500	.117	.074	.374
Difficulty seeing mistakes after I have completed the task (10)	.005	.068	.499	.180	.555	.131
Difficulty making decisions (6)	.254	.134	.459	-.089	.398	.399
Difficulty acting on a decision that I made (43)	.190	.073	.388	.068	.244	.214
Difficulty following written instructions (31)	.145	.247	.364	-.031	.429	.128
Difficulty shifting my attention among two or more things (13)	.332	.132	.347	.191	.057	.515
Difficulty seeing mistakes that I make as they occur (9)	.225	.043	.337	.341	.482	.032
Difficulty remembering to schedule appointments (56)	.268	.118	.288	.153	.267	.150

*Item Number from original CSC-W59 denoted in parentheses ( )

Table 3. Simplified Pattern Matrix Factor Loading of the CSC-W59 using Oblique Rotation Resulting in the Three-Factor CSC-W21

	Group 1 (n = 114)			Group 2 (n = 114)		
	Direct Oblimin Rotation Factor			Direct Oblimin Rotation Factor		
CSC-W21 Item	1 Memory	2 Executive Function	3 Task Completion	1 Memory	2 Executive Function	3 Task Completion
1. Difficulty remembering what I intended to write	**.627**			**.614**		
2. Difficulty remembering my train of thought as I am speaking	**.607**			**.497**		
3. Difficulty remembering the content of telephone conversations	**.586**			**.658**		
4. Difficulty remembering the content of conversations and/or meetings	**.567**			**.546**		
5. Difficulty remembering a word I wish to say	**.529**			**.635**		
6. Difficulty remembering the name of a familiar object or person	**.479**			**.719**		
7. Difficulty remembering information that is "on the tip of my tongue"	**.452**			**.730**		
8. Difficulty remembering things someone has asked me to do	**.452**			**.497**		
9. Difficulty understanding a system		**.835**			**.599**	
10. Difficulty understanding how a task fits into a plan or system		**.824**			**.718**	
11. Difficulty knowing where to look for information to solve a problem		**.692**			**.563**	
12. Difficulty understanding systems and models		**.612**			**.675**	
13. Difficulty figuring out how a decision was reached		**.591**			**.675**	
14. Difficulty using new information to re-evaluate what I know		**.542**			**.469**	

15. Difficulty considering all aspects of what I hear or see instead of focusing on only one part		**.501**			**.424**	
16. Difficulty understanding what a problem is when it occurs and clearly stating what the problem is		**.478**			**.453**	
17. Difficulty following the flow of events		**.451**			**.600**	
18. Difficulty understanding graphs or flowcharts		**.430**			**.708**	
19. Difficulty completing all steps of a task or activity			**.564**			**.514**
20. Difficulty staying with a task until completion			**.545**			**.645**
21. Difficulty putting steps in order such that the most important steps are done first			**.535**			**.422**

Table 4. Structure Matrix and Communalities of Oblique Rotation and a Three Factor Solution for the Retained CSC-W21 Items

	Structure Coefficients						Communalities	
	Group 1 (n = 114)			Group 2 (n = 114)			Group 1 (n = 114)	Group 2 (n = 114)
CSC-W21 Item	1 Memory	2 Executive Function	3 Task Completion	1 Memory	2 Executive Function	3 Task Completion		
1. Difficulty remembering what I intended to write	.699	.318	.431	.651	.220	.331	.505	.438
2. Difficulty remembering my train of thought as I am speaking	.651	.271	.375	.582	.166	.488	.431	.447
3. Difficulty remembering the content of telephone conversations	.670	.582	.240	.704	.316	.308	.590	.508
4. Difficulty remembering the content of conversations and/or meetings	.684	.470	.397	.623	.399	.290	.519	.435
5. Difficulty remembering a word I wish to say	.566	.177	.365	.586	-.017	.211	.340	.394
6. Difficulty remembering the name of a familiar object or person	.518	.252	.279	.681	.100	.207	.273	.479
7. Difficulty remembering information that is "on the tip of my tongue"	.506	.192	.342	.725	.139	.306	.272	.544
8. Difficulty remembering things someone has asked me to do	.633	.304	.603	.559	.160	.406	.524	.373
9. Difficulty understanding a system	.228	.792	.208	.132	.597	.253	.636	.363
10. Difficulty understanding how a task fits into a plan or system	.249	.799	.260	-.010	.627	.123	.645	.444
11. Difficulty knowing where to look for information to solve a problem	.185	.680	.303	.115	.519	.100	.487	.279
12. Difficulty understanding systems and models	.135	.601	.310	.290	.653	.114	.403	.461
13. Difficulty figuring out how a decision was reached	.390	.649	.248	.271	.706	.309	.444	.503

14. Difficulty using new information to re-evaluate what I know	.365	.603	.259	.188	.509	.279	.384	.269
15. Difficulty considering all aspects of what I hear or see instead of focusing on only one part	.524	.617	.246	.306	.549	.453	.480	.380
16. Difficulty understanding what a problem is when it occurs and clearly stating what the problem is	.340	.578	.438	.137	.515	.384	.404	.317
17. Difficulty following the flow of events	.513	.571	.238	.090	.610	.327	.430	.405
18. Difficulty understanding graphs or flowcharts	.417	.525	.242	.239	.646	.036	.328	.473
19. Difficulty completing all steps of a task or activity	.445	.342	.664	.251	.405	.595	.474	.395
20. Difficulty staying with a task until completion	.397	.254	.615	.357	.277	.691	.395	.495
21. Difficulty putting steps in order such that the most important steps are done first	.315	.274	.579	.341	.474	.563	.345	.410

Table 5. Factor Correlation Matrix of the Three Factors Comprising the CSC-W21

	Group 1 (n = 114)			Group 2 (n = 114)		
CSC-W21 Factor	Memory	Executive Function	Task Completion	Memory	Executive Function	Task Completion
Memory	1.00	.39	.46	1.00	.32	.34
Executive Function	.39	1.00	.33	.32	1.00	.37
Task Completion	.46	.33	1.00	.34	.37	1.00

Determining Shared Variance between the CSC-W59, CSC-W21, and FACT-Cog

Correlational Analysis. A correlational analysis was conducted on the participant data gathered in Study 1 (Calvio et al., 2010) in order to evaluate the relationship of the CSC-W59 and the CSC-W21 to the FACT-Cog. The merged sample could not be used for this analysis because participants in Study 2 (Hansen et al., 2008) were not administered the FACT-Cog measure. Sixteen participants failed to complete at least one full measure and were excluded from the correlational analysis resulting in a final sample of 133 participants. Chi-square and independent sample t-test analyses demonstrated no significant differences for completers and non-completers on age ($t(129) = .54$, $\rho = .59$), education level ($\chi^2 = 1.15$, df = 4, $\rho = .89$), marital status ($\chi^2 = 1.03$, df = 2, $\rho = .60$), race ($\chi^2 = 1.42$, df = 3, $\rho = .70$), type of job ($\chi^2 = 9.19$, df = 4, $\rho = .06$), or number of months at current job ($t(141) = .72$, $\rho = .48$). Demographic, occupational, symptom, and medical characteristics of the final sample are presented in Table 6.

Table 6. Demographic, Occupational, Symptom, and Medical Characteristics for Correlational Analysis

Characteristic	Breast Cancer Survivors (n = 133)	
	N	%
Age[1]	M = 44.88 (SD = 9.51)	
Race		
White	116	87.2%
Black	8	6.0%
Asian	7	5.3%
Other	2	1.5%
Relationship status		
Single	20	15.0%
Married or cohabitating	100	75.2%
Separated, divorced, or widowed	12	9.0%
Missing respondents	1	0.8%
Education		
High school or less	8	6.0%
Some college	22	16.5%
Associate's or bachelor's degree	41	30.8%
Some graduate school	11	8.3%
Graduate degree	51	38.3%
Occupation		
Managerial	47	35.3%
Sales	7	5.3%
Services	4	3.0%
Professional or technical	58	43.6%
Clerical	14	10.5%
Missing respondents	3	2.3%
Time at current job[2] (in months)	M = 92.45 (SD = 82.85)	
Job stress experienced at current job		
Never	24	18.0%
Seldom	28	21.1%
Sometimes	54	40.6%
Often	25	18.8%
Missing respondents	2	1.5%
Fatigue during the past week		
Yes	116	87.2%
No	17	12.8%
Pain during the past week		
Yes	111	83.5%
No	21	15.8%
Missing respondents	1	0.8%
HADS-Anxiety	M = 7.71 (SD = 3.00)	
HADS-Depression	M = 4.56	

	(SD = 3.32)	
Tumor location		
Right breast	68	51.1%
Left breast	59	44.7%
Both breasts	5	3.8%
Missing respondents	1	0.8%
Tumor stage at diagnosis		
Stage I	47	35.3%
Stage II	62	46.6%
Stage III	22	16.5%
Missing respondents	2	1.5%
Anticancer treatment type		
Chemotherapy	110	82.7%
Radiation	98	73.7%
Surgery	129	97.0%
Other	31	23.3%

[1]Eleven respondents are missing (n = 122)
[2]Three respondents are missing (n = 130)

Preliminary analyses indicated non-normality in the distribution of the measures; therefore, we utilized the nonparametric Spearman's rho to assess the correlation. Results presented in Table 7 indicated that higher scores on both the CSC-W59 and the CSC-W21 (which indicate greater work-related cognitive limitations) were associated with higher scores on the FACT-Cog (which indicate greater global cognitive limitations). Correlations were significant between the CSC-W59 and the FACT-Cog ($r = .71$; n = 133, $\rho < .001$) as well as between the CSC-W21 and the FACT-Cog ($r = .68$; n = 133, $\rho < .001$). Scatterplots of these associations are shown in Figures 1 and 2. Additional correlational analyses were conducted to determine the relationship between the subscales of the CSC-W21 and the FACT-Cog. All three subscales of the CSC-W21 demonstrated correlations with the FACT-Cog which were statistically significant at $\rho < .001$: Memory $r = .59$, Executive Function $r = .48$, and Task Completion $r = .60$ (Table 7). The correlations observed here indicate that both the CSC-W59 and CSC-W21 are capturing some of the commonalities in global cognitive limitations assessed by the FACT-Cog. However, a substantial portion of the variance between these measures remains unexplained.

Table 7. Spearman's Rho Correlational Analysis between CSC-W59, CSC-W21, and FACT-Cog (n = 133)

Scale	FACT-Cog (29 items)
CSC-W59 (Full Scale)	.71**
CSC-W21 (Full Scale)	.68**
CSC-W21: M Subscale (8 items)	.59**
CSC-W21: EF Subscale (10 items)	.48**
CSC-W21: T Subscale (3 items)	.60**

** ρ < .001 level (2-tailed); M=Memory; EF=Executive Function; T=Task

Figure 1. Scatterplot of Relationship between CSC-W59 and FACT-Cog (R^2 Linear = .522)

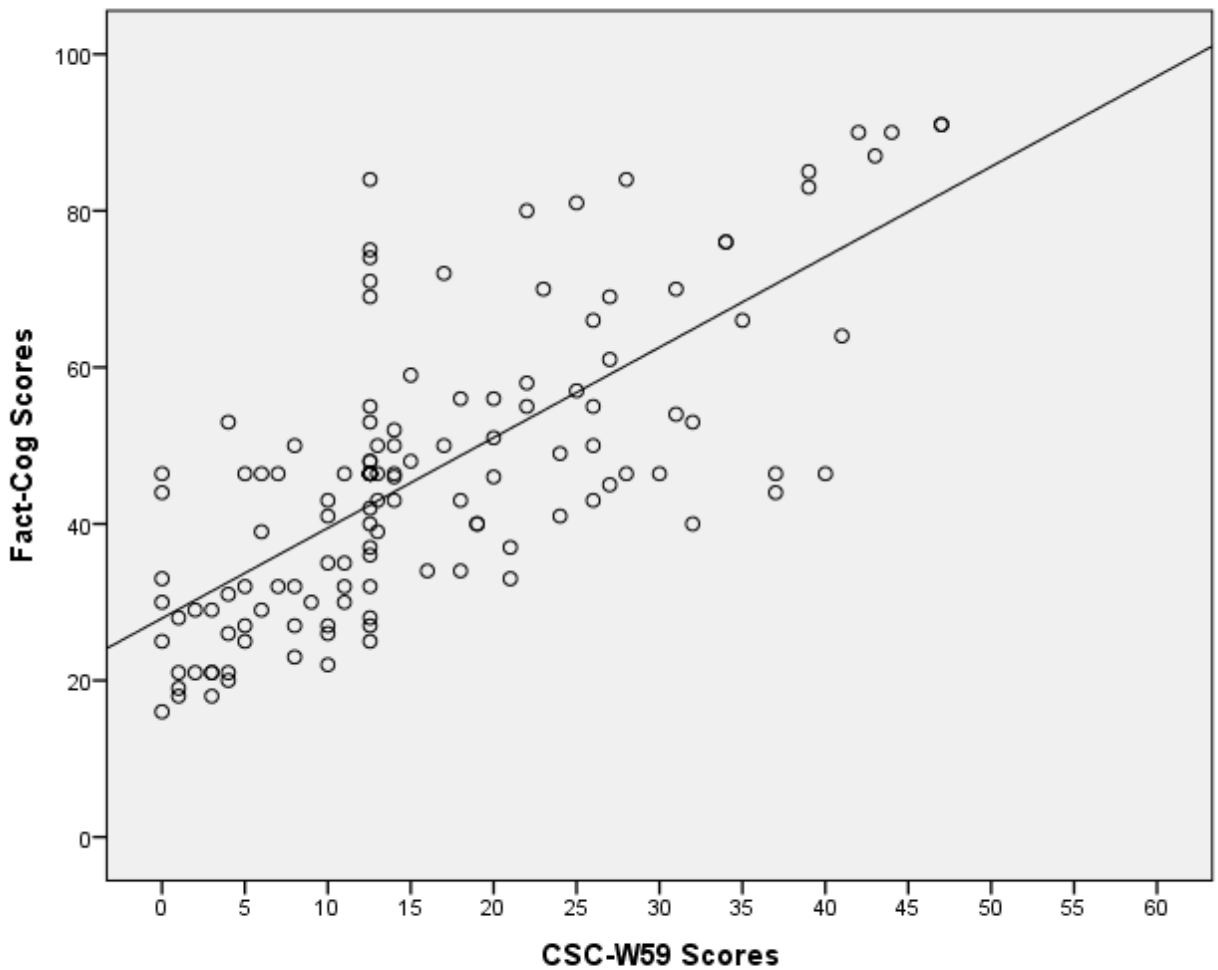
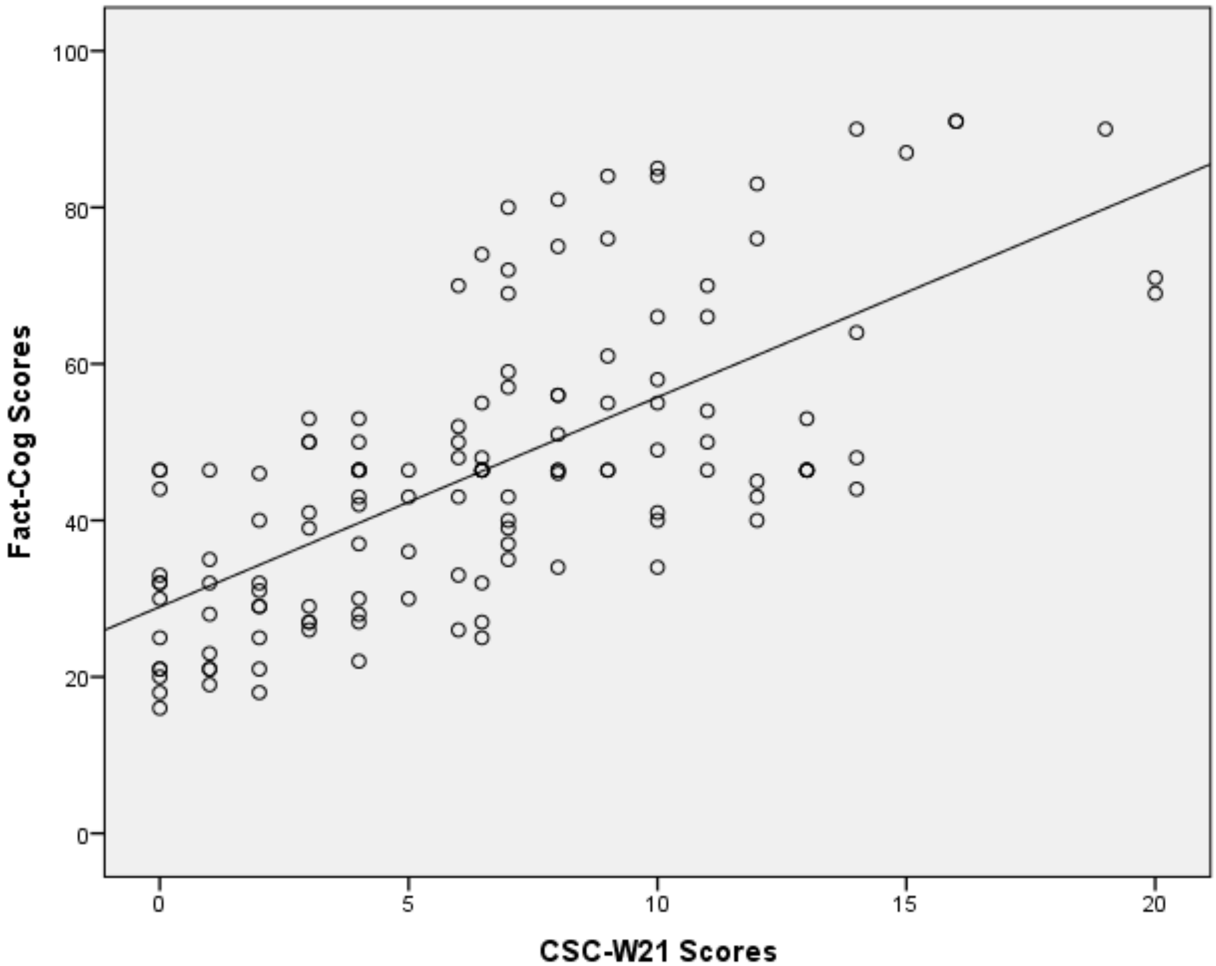


Figure 2. Scatterplot of Relationship between CSC-W21 and FACT-Cog (R^2 Linear = .459)



Construct Validity. In order to evaluate the construct validity of the CSC-W21, we conducted additional correlational analyses determining the relationship between the reported cognitive limitations in each of the three measures and specific demographic, occupational, medical, and symptom variables. The results of these analyses are presented in Table 8. Because many of the breast cancer survivors in our sample had received more than one type of cancer treatment, treatment type was a constant and could not be evaluated in these follow-up analyses.

The analyses revealed a significant correlation between all three measures of cognitive limitations and job stress ($\rho < .001$), as well as affective states such as pain ($\rho < .01$), fatigue ($\rho < .001$), anxiety ($\rho < .001$), and depressive symptoms ($\rho < .001$). These findings are not surprising considering previous research which demonstrates a positive relationship between cognitive problems and psychological stress, depression, fatigue, and pain (Biglia et al., 2012; Gijsen, Dijkstra, & van Boxtel, 2011; Jenkins et al., 2006; Munir et al., 2011; Shilling & Jenkins, 2007; Todd et al., 2011).

Additionally, the positive relationship shown between tumor stage and both the CSC-W21 ($\rho < .05$) and the CSC-W59 ($\rho = .05$) supports the construct validity of these measures. Specifically, some studies have reported a dose-dependent relationship between cognitive impairment and certain anticancer treatments such as radiation in brain cancer survivors 6-months post-treatment (Hahn et al., 2009), chemotherapy in breast cancer survivors 6-months post-treatment (Schagen, Muller, Boogerd, Mellenbergh, & van Dam, 2006), and adjuvant chemotherapy in breast cancer survivors 21-years post-treatment (Koppelmans et al., 2012). We would expect that a more severe cancer stage at diagnosis would typically be treated with a more aggressive approach, such as elevated treatment dosages and adjuvant therapy, and therefore positively correlate with increased cognitive problems as observed in our findings.

An unexpected finding was the significant inverse correlation between race and the three measures. These results may suggest that the measures are identifying more cognitive problems in Caucasians. However, recent research suggests we should find the opposite result. Warner and colleagues (2012) examined a national sample of breast cancer survivors (n = 21,427) who were White, Black, Hispanic, and Asian. They found that Blacks, Hispanics, and Asians experienced a longer time to definitive diagnosis of cancer than Whites. Additionally, Blacks and Hispanics more often presented with later stage cancer than Whites in the study. Based on these findings we would expect Blacks, Hispanics, and Asians to demonstrate greater cognitive limitations than Whites, which is not what our data revealed. An alternative explanation may be that our results are an artifact of the data considering our sample primarily consisted of

Caucasian women. It is also possible that patterns of perception or communication of symptoms differ across cultural groups.

Finally, it should be noted that although some of the correlational findings are significant, most of the correlations in Table 8 are quite low, indicating these variables only account for a small percentage of the variance observed in the measures of cognitive limitations.

Table 8. Pearson's Correlational Analyses of the CSC-W21, CSC-W59, and FACT-Cog with Demographic, Occupational, Medical, and Symptom Variables (n = 133)

	CSC-W21	CSC-W59	FACT-Cog
Age	.01	.04	.07
Education	-.14	-.06	-.03
Relationship status	.06	.12	.09
Race	-.21***	-.19**	-.20**
Occupation	-.10	-.12	.01
Time at current job	.03	-.02	.03
Job stress	.34****	.35****	.43****
Tumor stage at diagnosis	.15**	.14*	.14
Pain	.22***	.22***	.24***
Fatigue	.32****	.28****	.33****
HADS-Anxiety	.37****	.36****	.38****
HADS-Depression	.41****	.36****	.40****

1-tailed significance at *$\rho = .05$, **$\rho < .05$, ***$\rho < .01$, ****$\rho < .001$

Discussion

EFA conducted on the 59 items of the CSC-W59 indicated that the measure could successfully be reduced to 21 items and that these items were best represented by a three-factor model consisting of the Memory, Executive Function, and Task subscales. The cross-validation approach to factor analysis indicated that the factor structure of the final CSC-W21 is internally consistent. Additionally, the two-pronged criterion used for retention of items in the EFA is a more rigorous analytical approach which focused on optimizing the generalizability of the final 21-item measure (Preacher et al., in press).

A subsequent correlational analysis was conducted with the CSC-W21 and a measure of global cognitive problems, the FACT-Cog. The significant correlations between the two measures support the construct validity of both the CSC-W21 and its subscales as a measure of cognitive limitations. Although the CSC-W21 has yet to be validated with a measure of work productivity, the measure demonstrates considerable face validity with regard to work-related cognitive problems for both patients and providers. Despite the correlations observed, the association accounted for 68% of the variance in each measure. Therefore, while the measures appear to be tapping in to some commonalities, further research is needed to explain those factors which may account for the additional error variance.

As mentioned previously, there is evidence to suggest that affective states such as psychological stress (Biglia et al., 2012; Jenkins et al., 2006; Shilling & Jenkins, 2007) and common cancer-related symptoms such as depression and fatigue (Munir et al., 2011; Todd et al., 2011) can influence self-perceived cognitive function but there was no clear indication whether these variables also impacted work-related cognitive function. Our findings in the current study demonstrated that job stress, anxiety, depressive symptoms, fatigue, and pain all significantly contribute to both global and work-related cognitive limitations although the degree to which these variables contribute varies. Therefore, future research of work-related cognitive limitations should include measures of affective state and cancer-related symptoms. Additionally, the social aspect of perceived cognitive problems at work may tend to amplify self reports of work-related cognitive limitations which can involve some form of self-evaluation in terms of optimal performance ability of certain work tasks (Munir et al., 2010; Von Ah et al., 2012). The role of social evaluation at work and the stress that results between cognitive skills and work tasks, perceived or not, needs to be specifically studied in order to better understand the role of cognitive limitations in the work of breast cancer survivors. Our results also demonstrated a significant positive relationship between advanced cancer stage and increased work-related cognitive problems which may be indicative of the more aggressive anticancer treatment utilized in later stage cancer. Finally, we found a significant inverse relationship between race and cognitive problems such that more Whites were identified as experiencing cognitive problems than other races in our study. This finding was unexpected considering the current research on race and cancer stage at diagnosis however our findings may have been affected by the large number of Whites included in our sample. Finally, there is some evidence to suggest that certain personality characteristics may contribute to affective problems such as depressive symptoms and anxiety (Mols, Thong, van de Poll-Franse, Roukema, & Denollet, 2012). Given the results of our regression analyses and the significant contribution of depressive symptoms, fatigue, and job stress to both work-related and global cognitive problems, we cannot exclude the possibility that self-perceived work problems may also be measuring personality traits. Therefore, it would be informative to include a measure of personality characteristics in future research on cognitive limitations in order to examine to what degree such traits may be accounting for the symptom burden or the reported cognitive limitations.

It is currently unclear whether existing interventions can adequately address work-related cognitive problems in breast cancer survivors (Fardell, Vardy, Johnston, & Winocur, 2011; Ferguson, Ahles, et al., 2007; Kohli et al., 2009). Furthermore, without some type of brief measure such as the CSC-W21 to assess the specific cognitive domains in the context of work tasks that are problematic for breast cancer survivors, existing interventions are not able to evaluate the specific impact of certain cognitive problems at work and subsequent work outcomes. The present study indicates that the CSC-W21 is a brief, psychometrically sound measure designed specifically to evaluate work-related cognitive limitations and may be helpful in assessing cognitive-work problem areas.

Certain methodological limitations regarding the current study should be considered. Our research is a secondary analysis of two previous cross-sectional research studies. As a result, we were dependent upon the sampling method, measures used, and data gathered in the original studies. This prevented us from incorporating other measures that may have been of interest to our current aims, such as a measure of work productivity, other demographic information or a neuropsychological assessment in conjunction with the self-report measure of cognitive limitations. Furthermore, it is unknown to what extent a participant's cognitive abilities or the original studies' requirement of internet access limited the selection of participants in our final sample. Additionally, the cross-sectional nature of our study prevents us from speculating on changes in reported work-related cognitive function over time or how the CSC-W21 would perform prospectively. Finally, our analysis was limited to working breast cancer survivors and the majority of our sample was Caucasian, educated, and employed in professional or technical-level jobs; therefore caution must be used in generalizing the results to other populations as well as other groups of breast cancer survivors. Future research involving the CSC-W21 should focus on confirmatory factor analysis to evaluate the measure across more diverse populations and different types of cancers. Additionally, an investigation of the correlation and performance of the CSC-W21 with validated measures of work productivity including both self-report and observed measures in the workplace should provide needed additional external validation of the measure.

While innovative measures of cognitive and brain functioning have been used over the past decade there have been very few self-report measures of cognitive function in breast cancer survivors and even fewer that assess self-reported cognitive limitations at work. Given the increased prevalence of breast cancer survivors, along with the desire and need to work for some and the role cognitive function plays in everyday work (especially knowledge-based work), there is a need to better understand the pathways and various work outcomes related to cognitive function.

Appendix A: Cognitive Symptom Checklist-Work-59 item (CSC-W59)

Cognitive Symptom Checklist-Work-59 item (CSC-W59)

Please read each of the following items below. They describe problems that you may or may not experience at work.

CSC-W59 Item:	Yes: 1 No: 0
1 – I have difficulty doing math in my head [M]	
2 – I have difficult answering questions quickly [M]	
3 – I have difficulty seeing and correcting mistakes on my own [EF]	
4 – I have difficulty seeing and correcting mistakes pointed out to me by others [EF]	
5 – I have difficulty focusing on a task when there is too much detail or clutter [A, M]	
6 – I have difficulty making decisions [A]	
7 – I have difficulty understanding what I read without rereading it [M]	
8 – I have difficulty understanding what I hear the first time I hear it [M]	
9 – I have difficulty seeing mistakes that I make as they occur [M]	
10 – I have difficulty seeing mistakes after I have completed the task [M]	
11 – I have difficulty trying new ideas or actions [EF]	
12 – I have difficulty planning a speech [EF]	
13 – I have difficulty shifting my attention among two or more things [M]	
14 – I have difficulty staying with a task until completion [A]	
15 – I have difficulty planning what to discuss when I meet someone [EF]	
16 – I have difficulty following directions to a specific place [EF]	
17 – I have difficulty shifting from 1 task or activity to another [M]	
18 – I have difficulty completing all steps of a task or activity [M]	
19 – I have difficulty following step-by-step instructions [M]	
20 – I have difficulty putting steps in order such that the most important steps are done first [EF]	
21 – I have difficulty setting up a routine or system to approach tasks [EF]	
22 – I have difficulty understanding what a problem is when it occurs and clearly stating what the problem is [EF]	
23 – I have difficulty starting a task or activity on my own [A]	
24 – I have difficulty remembering where my car is parked [A]	
25 – I have difficulty focusing on a task when there is a sudden movement around me [A]	
26 – I have difficulty knowing where to look for information to solve a problem [EF]	
27 – I have difficulty using new information to re-evaluate what I know [EF]	
28 – I have difficulty choosing a solution to a problem from several possible sources [EF]	
29 – I have difficulty focusing on a task when there is a lot of movement happening around me [A]	
30 – I have difficulty focusing on a task when there is a sudden loud noise [A]	
31 – I have difficulty following written instructions [M]	
32 – I have difficulty writing to other people in an organized manner [M]	
33 – I have difficulty organizing information to be remembered [M]	
34 – I have difficulty focusing on a task when more than one person is speaking at a time [A]	
35 – I have difficulty focusing on a task when a radio or TV is playing in the background [A]	
36 – I have difficulty following or retracing steps to solve a problem [M]	
37 – I have difficulty remembering to perform daily routines [M]	
38 – I have difficulty remembering things someone has asked me to do [M]	
39 – I have difficulty remembering the content of telephone conversations [M]	
40 – I have difficulty focusing on a task when I feel hot or cold [A]	
41 – I have difficulty remembering the content of conversations and/or meetings [M]	
42 – I have difficulty remembering a word I wish to say [M]	
43 – I have difficulty acting on a decision that I made [EF]	
44 – I have difficulty putting together the materials needed for a task [EF]	
45 – I have difficulty understanding a system [EF]	
46 – I have difficulty remembering my train of thought as I am speaking [M]	

CSC-W59 Item:	Yes: 1 No: 0
47 – I have difficulty remembering the name of a familiar object or person [M]	
48 – I have difficulty understanding graphs or flowcharts [EF]	
49 – I have difficulty understanding how a task fits into a plan or system [EF]	
50 – I have difficulty understanding systems and models [EF]	
51 – I have difficulty remembering information that is “on the tip of my tongue” [M]	
52 – I have difficulty remembering what I intended to write [M]	
53 – I have difficulty figuring out how a decision was reached [EF]	
54 – I have difficulty following the flow of events [EF]	
55 – I have difficulty considering all aspects of what I hear or see instead of focusing on only one part [EF]	
56 – I have difficulty remembering to schedule appointments [EF]	
57 – I have difficulty staying focused in places where there are many sights and sounds [A]	
58 – I have difficulty remembering to keep appointments once they are scheduled [EF]	
59 – I have difficulty focusing on a task when I am in a large area [A]	

Subscale from the original CSC-W59 denoted in brackets [ ]; [A]=Attention subscale, [EF]=Executive Function subscale, [M]=Working Memory subscale

Appendix B: Cognitive Symptom Checklist-Work-21 item (CSC-W21)

Cognitive Symptom Checklist-Work-21 item (CSC-W21)

Please read each of the following items below. They describe problems that you may or may not experience at work.

Item:	Yes	No
1. I have difficulty remembering what I intended to write		
2. I have difficulty remembering my train of thought as I am speaking		
3. I have difficulty remembering the content of telephone conversations		
4. I have difficulty remembering the content of conversations and/or meetings		
5. I have difficulty remembering a word I wish to say		
6. I have difficulty remembering the name of a familiar object or person		
7. I have difficulty remembering information that is "on the tip of my tongue"		
8. I have difficulty remembering things someone has asked me to do		
9. I have difficulty understanding a system		
10. I have difficulty understanding how a task fits into a plan or system		
11. I have difficulty knowing where to look for information to solve a problem		
12. I have difficulty understanding systems and models		
13. I have difficulty figuring out how a decision was reached		
14. I have difficulty using new information to re-evaluate what I know		
15. I have difficulty considering all aspects of what I hear and see instead of focusing on only one part		
16. I have difficulty understanding what a problem is when it occurs and clearly stating what the problem is		
17. I have difficulty following the flow of events		
18. I have difficulty understanding graphs and flowcharts		
19. I have difficulty completing all steps of a task or activity		
20. I have difficulty staying with a task until completion		
21. I have difficulty putting steps in order such that the most important steps are done first		

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