The Cognitive Function at Work Questionnaire (CFWQ) – a new scale for measuring cognitive complaints in occupational population

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Cognitive functioning is a relevant work and health related topic, however, validated methods to assess subjective cognitive complaints (SCC) at work are lacking. We introduce the Cognitive Function at Work Questionnaire (CFWQ) for measuring SCCs in occupational settings. 1-year follow-up data of 418 employees from a Finnish public media service company was analyzed. Participants completed web-based CFWQ, cognitive tests and a broad set of questionnaires for evaluating depression, anxiety, insomnia, daytime sleepiness, burnout, stress, mental job burden, work ability, cognitive errors, and perceived health. The factor analysis yielded a model with the CFWQ subdomains: Memory, Language, Executive Function, Speed of Processing, Cognitive Control and Name Memory. The internal consistency (Cronbach's alpha = .87) and the test-retest constancy (ICC = .84) reflected good reliability. Correlation between the CFWQ and cognitive errors at work ranged from .25 to .64 indicating adequate concurrent validity. Employees with depression, insomnia and burnout symptoms had higher ($p < .001$) CFWQ scores than participants without these symptoms. Depression and burnout symptom severity as well as accumulation of mood, sleep, and psychosocial stressors were associated with higher CFWQ scores ($p < .001$ in all). The CFWQ appears psychometrically sound measure for the assessment of SCC in occupational population.

Keywords: cognition, memory, subjective cognitive complaint, work performance, neuropsychology

Introduction

Subjective cognitive complaints (SCC), referring to self-experienced difficulties in memory functioning, clear thinking, concentration, or other cognitive abilities are common in working age. According to previous studies approximately 10 - 20 % of adults aged 45 – 65 years report cognitive problems, and the prevalence of complaints seem to increase by age (Rijs, Van Den Kommer, Comijs, & Deeg, 2015; Taylor, Bouldin, & McGuire, 2018; van Harten et al., 2018). Higher prevalence levels (about 30 %) of SCC have been reported after the outbreak of the novel coronavirus disease (COVID-19), that has led to restrictions to social interactions, involuntary isolation, increase in smart working and layoffs due to lock-down periods (Santangelo et al. 2021). SCC have been associated with several negative consequences, such as increased concerns about developing dementia (Kinzer & Suhr, 2016), longitudinal decline in cognitive performance (Hohman, Beason-Held, Lamar, & Resnick, 2011), and lower work ability (Pihlajamäki et al., 2020). Consequently, health care consultations related to concerns of cognitive symptoms are increasing (Jessen et al., 2020; McWhirter, Ritchie, Stone, & Carson, 2020; Remes, Turunen, & Ala-Mursula, 2012). Given that the proportion of older people in the workforce is rising and current retirement policies encourage working until older ages, assessment of cognitive functioning is a particularly relevant topic in occupational health service.

SCC in working age typically relate to one or several co-occurring conditions such as depression or anxiety (Comijs, Deeg, Dik, Twisk, & Jonker, 2002; Hill et al., 2016), work-related stress or other psychosocial stressors (Rickenbach, Almeida, Seeman, & Lachman, 2014; Rönnlund, Sundström, Srman, & Nilsson, 2013; Stenfors, Magnusson Hanson, Oxenstierna, Theorell, & Nilsson, 2013), sleeping problems (Eskildsen et al., 2017; Kronholm et al., 2009; Vaessen, Overeem, & Sitskoorn, 2015), excess use of alcohol (Hunt Baker, Michie, & Kavanagh, 2009), or failing physical health (Lee, 2014; Nguyen, Killcross,

& Jenkins, 2014; Valkova, Veleva, Guergueltcheva, & Burgov, 2019). Cognitive problems in these conditions can vary from subtle subjective worries to severe impairment, causing several negative work-related outcomes. For example, inadequate sleep leads to cognitive dysfunction, lower job performance, and higher risk of accidents (Pilcher & Morris, 2020). Even though mood and sleep disorders, psychosocial stress factors, and physical health problems are potentially amendable, many of such conditions have also been linked to an elevated risk of later life cognitive impairment and dementia (Cations, Withall, & Draper, 2019; Kivipelto & Ngandu, 2016; Pacholko, Wotton, & Bekar, 2019; Song et al., 2020; Wu, Wang, Yao, Yan, & Pei, 2020; Xu, Tan, Zou, Cao, & Tan, 2020). In the elderly populations, there are promising results of health interventions targeting on several risk factors simultaneously to reduce the risk of later cognitive impairment (Kivipelto, Mangialasche, & Ngandu, 2018).

From clinical neuropsychological perspective, standardized evaluation of SCC and identification of underlying conditions affecting cognitive functioning is a prerequisite for planning and evaluation of appropriate care procedures. The knowledge of affected cognitive domain or domains can be utilized for planning individual treatments and work accommodations, aiming to support work ability and to decrease the risk of sick-leave or untimely disablement. Further, early detection of problems in cognitive functioning at work helps identifying those in need of referral to an extensive neuropsychological assessment. There are, however, only a few questionnaires available designed for the assessment of cognition in working age and in occupational settings. One such measure is the Workplace Cognitive Failure Scale (WCFS) (Wallace & Chen, 2005) which is based on conceptualization of cognitive failures by Broadbent, Cooper, FitzGerald, and Parkes (1982). Broadbent et al. theorized that the cognitive lapses can be categorized under memory, attention, or action errors. WCFS assesses the frequency of cognitive errors/lapses at work

and thus it is a valuable tool for organisational safety evaluation. However, it is not designed to evaluate subjective cognitive functioning from the health care perspective.

There are several instruments available to assess SCC (Crawford, Smith, Maylor, Della Sala, & Logie, 2003; Crook, Feher, & Larrabee, 1992; Farias et al., 2008; Gifford, Liu, Romano, Jones, & Jefferson, 2015; Rami et al., 2014; Schinka et al., 2010; Vestergren, Rönnlund, Nyberg, & Nilsson, 2012) but no single generally approved standard measure. In fact, the general view among researchers supports having optimized measures for the target population of interest, rather than aiming at one gold standard method (Jessen et al., 2014; Molinuevo et al., 2017; Rabin et al., 2015). Many of the previously published measures have been developed with a primary focus on elderly populations and detection of mild cognitive impairment (MCI) or preclinical Alzheimer's disease (AD) (Farias et al., 2008; Gifford et al., 2015; van Harten et al., 2018). Another shortage of the previous cognitive questionnaires is that those mainly include questions related to common everyday situations and such questions might not capture the problems that working aged people experience. A study conducted at a memory clinic indicates that patients under the age of 65 rather experience cognitive problems in the occupational settings than in other everyday situations (Remes, Turunen, & Ala-Mursula, 2012). It presumably is because work typically is the environment with higher cognitive demands as compared with other common everyday situations. Therefore, and in line with the behavioural specificity hypothesis, we expect that individuals are capable of reporting cognitive problems accurately, provided that the questions are related to specific cognitive behaviours in a suitable context (Hertzog, Park, Morrell, & Martin, 2000).

Researchers have pointed out a need for development and validation of methods to assess SCC (Jessen et al., 2014). Therefore, the aim of the current study was to introduce a new instrument The Cognitive Function at Work Questionnaire (CFWQ) for the assessment

of SCC in occupational setting. The CFWQ is designed to provide ratings of subjective functioning in several cognitive domains (e.g., memory, executive function, processing speed) at work. We present the results of the validation procedure and reliability analysis of the new instrument. Our goal was to develop a short questionnaire that would have content validity determined by exploratory factor analysis, present a high level of reliability (internal and test-rest consistency), and demonstrate its concurrent validity by a high correlation with other cognitive measures. We provide preliminary normative and clinical group values for the 29-item version of the questionnaire and the shortened scale based on factor analysis.

As several psychological conditions and psychosocial stressors have been linked to cognitive symptoms (Comijs et al., 2002; Eskildsen et al., 2017; Stenfors et al., 2013; Vaessen et al., 2015; Wardle-Pinkston, Slavish, & Taylor, 2019) we examined if such conditions are associated with cognitive problems experienced at work according to CFWQ responses. First, we studied the cognitive complaints in main symptom groups separately, i.e., reported symptoms of either depression, anxiety, or insomnia. Due to known high co-morbidity and different degrees of mood, sleep and stress disorders, we also analysed the impact of depression and burnout symptom severity as well as the accumulation of symptoms and conditions on subjective cognitive functioning. We hypothesized that depression, insomnia, and burnout groups have more SCC as compared to reference group (subjects without these symptoms), and that the higher symptom severity is reflected as higher amount of SCC at work. Previous research has linked cognitive complaints with several conditions and symptoms but to our knowledge, not much is known about their cumulative cognitive effect. Nevertheless, we tentatively expect the mood symptoms, psychosocial stressors, and sleep problems to form a cumulative strain and accumulation of cognitive symptoms experienced at work. Finally, we examined whether SCC at work are related with perceived overall health and subjective work ability. Our hypothesis is that the better the health status

is, the lower the CFWQ score will be, reflecting less cognitive problems at work. Subjective work ability is expected to negatively correlate with the CFWQ.

Materials and Methods

Participants

The participants of the Memory@Work study were recruited in years 2014 – 2015 via e-mail from a Finnish public media service company which has about 3500 employees. The data including the follow-up measurements was gathered between 2014 and 2017. In total, 418 employees took part in the study from a wide variety of occupations such as journalistic and technical production, research, management, and maintenance. After signing the informed consent, the participants received a link to an on-line research site. Such Internet-based data collecting method is adaptive for the participants as they can choose when and where to respond. The participants responded to web-based questionnaires and carried out cognitive tasks described later in more detail. The study protocol included a baseline, 12-month, 18-month and 24-month follow-up measurements. The current paper focuses on the data at baseline and 12-month follow-up.

Sixty-eight percent of the participants were female (proportion of females in the entire organization is 57%) and the average education level was 15.9 years (SD = 3.6). The mean age of the participants was 49.7 years (SD = 8.0), which is representative of the mean age of the employees in the entire organization (47 years). Sixty-three percent of the participants (N = 263) took part in the follow-up study 12 months after the first measurement. The follow-up population represented well the initial sample by age (M = 50.8, SD = 8.1), sex (69.6 % women), and years of education (M = 15.7, SD = 3.5). There were no statistically significant differences in age (p=.693), years of education (p=.465), and sex (p=.229)

between the participants who took part in the 12 months follow-up study and who decided to opt out of the follow-up. Memory@Work study protocol was approved by the local coordinating ethics committee.

Cognitive Function at Work Questionnaire

The CFWQ is based on a questionnaire initially developed by experienced clinical neuropsychologists to help occupational health service professionals identify and rate employees' cognitive symptoms (Kuikka, Akila, Pulliainen, & Salo, 2011). It included 20 questions divided broadly on the areas of memory, attention, and executive functions at work. Response options were three verbal classifications: a) Works well, b) Sometimes difficult and c) Often difficult. In the Memory@Work study 9 additional questions of verbal, executive and emotional functions were included, and a straightforward numeric scoring was developed: 0 = Works well, 1 = Sometimes difficult, 2 = Often difficult. The scoring range for the 29 questions was 0-87 where higher scores reflect increasing problems. All the 29 questions of the CFWQ are presented in Table 1.

The participants also gave an estimate of their memory difficulties on a scale from 0 to 3 (0 = no cognitive problems, 1 = cognitive problems but no disability, 2 = some disability due to cognitive problems, 3 = a lot of disability due to cognitive problems). In the current paper, this general subjective memory disability estimate was used as a grouping variable in the follow-up analyses described in more detail in *Data analysis*.

Web-based questionnaires and cognitive tests

Web-based questionnaires were used to assess the level of several symptoms. Depressive symptoms were assessed with a commonly used Finnish translation version called the BDI21 of the Beck Depression Inventory (score range 0-63) (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Anxiety symptoms were measured with the General Anxiety Disorder-7

(GAD-7, score range 0-21) (Spitzer, Kroenke, Williams, & Löwe, 2006). Occupational burnout symptoms were evaluated with the Shirom-Melamed Burnout Measure (SMBM) (14 questions, score range for each question 1-7) (Shirom & Melamed, 2006). The participants also filled the Workplace Cognitive Failure Scale (WCFS, score range 15-75) (Wallace & Chen, 2005), the Insomnia Severity Index (ISI, score range 0-28) (Bastien, Vallières, & Morin, 2001), and the Epworth Sleepiness Scale (ESS, score range 0-24) for assessing daytime sleepiness (Johns, 1991). A higher score reflects higher symptom level in every questionnaire mentioned above. In order to keep the study length reasonable, the following variables were measured with a single question: general stress (modified scale from 0 to 10, where 0 = not at all, 10 = very much) (Elo, Leppänen & Jahkola, 2003) and the level of mental job burden (scale from 0 to 10, where 0 = not at all, 10 = very much), work ability (scale from 0 to 10, where 0 = not able to work at all, 10 = best possible work ability) (Ahlström, Grimby-Ekman, Hagberg, & Dellve, 2010), and the perceived overall health status (scale from 1 to 5, where 1 = poor, 2= fairly poor, 3 = average, 4 = fairly good, 5 = very good) (Idler & Benyamini, 1997).

Cognitive performance was assessed with cCOG, a web-based test battery originally developed to detect early cognitive signs of neurodegenerative disorders (Rhodius-Meester et al., 2020). The cCOG consists of seven subtasks modified from classical cognitive tests focusing on episodic memory learning, recall and recognition, reaction time, visuomotor speed, attention, and executive function.

Data-analysis

Statistical analyses were performed using the IBM SPSS version 25.0 software. The differences in demographic and psychological symptom variables between participants and dropouts of the follow-up study were studied with the independent samples t-test or the Chi-

square test depending on the variable measurement level. One-way analysis of variance was used to compare the group differences on CFWQ scores. Post-hoc pairwise group comparisons were performed using the Bonferroni correction.

The correlation of the 29 ~~original~~ CFWQ questions was calculated and the suitability for factor analysis was evaluated with Kaiser-Meyer-Olkin measure of sampling adequacy. Questions with a communality lower than .30 were excluded from further analysis. The explorative factor analysis was performed by using the Maximum likelihood method. Internal consistency of the subscales and total score of the shortened CFWQ based on factor analysis was studied with Cronbach's alpha coefficient. Intraclass correlation coefficient (ICC) was used to assess test-retest reliability. Concurrent validity with other tests of subjective (WCFS) and objective (cCog) cognitive functioning was evaluated with Spearman's correlation coefficients.

Group classification in the follow-up analyses based on the general subjective memory disability estimate. Three groups were formed according to the participants' answers to the general memory disability -question (none, some, or a lot of disability) and how the disability changed in the 12 months follow-up. The Stable reference group had subjective memory disability neither at baseline nor 12 months later. The Impairment group had no memory disability at baseline but reported at least some disability at the 12 months follow-up. The Improvement group reported at least some disability at baseline, but no disability at the 12 months follow-up. The CFWQ change score was calculated for the three groups with the following equation: (CFWQ 12 months follow-up) – (CFWQ Baseline) = CFWQ Change score.

Clinical subgroups. For studying the CFWQ scores in relation to clinical conditions, the participants were classified according to their reported depression (BDI21), anxiety (GAD-7),

and insomnia (ISI) symptoms. The participants in the *No symptoms group* had a score on BDI21 ≤ 9, GAD-7 ≤ 4 and ISI ≤ 7 questionnaires, reflecting no significant depressive, anxiety, or insomnia symptoms. Participants who reported at least mild depressive symptoms (BDI21 > 9) but no anxiety (GAD-7 ≤ 4) or insomnia symptoms (ISI ≤ 7) formed the *Depression group*. Participants with at least mild anxiety symptoms (GAD-7 > 4) but no depression (BDI21 ≤ 9) or insomnia (ISI ≤ 7) formed the *Anxiety group*. Those with at least mild insomnia symptoms (ISI > 7) but no depression (BDI21 ≤ 9) or anxiety (GAD-7 ≤ 4), formed the *Insomnia group*. Due to high symptom co-morbidity and partly overlap in diagnostic criteria, we also analyzed no depression (BDI21 < 10), mild (BDI21 = 10 - 18), and at least moderate (BDI21 > 18) depression groups without excluding any other symptoms. The association of burnout symptom severity and the CFWQ score was studied in a similar manner. Due to lack of Finnish norms for the SMBM, a cut-off value for burnout levels was set close to the 80th percentile in this sample for the mild burnout levels (SMBM = 3.8 – 4.3, 11.2 % of the sample). This was done in accordance with Melamed (2009) and also indicating the population-based prevalence level of at least mild occupational burnout among the Finnish employees (Ahola et al., 2006). The 90th percentile was set as a cut-off for the highest burnout levels (in this sample, SMBM > 4.3). Thus, the groups were: No burnout (SMBM ≤ 3.8), Mild burnout (SMBM = 3.9 – 4.3), and More Severe burnout (SMBM > 4.3).

Cumulative impact of multiple clinical and psychosocial symptoms. The association of increasing number of reported symptoms and the CFWQ scores was studied. A dichotomous grouping was performed for “at least mild symptoms” in depression (BDI21 > 9), anxiety (GAD-7 > 4), insomnia (ISI > 7), daytime sleepiness (ESS > 10), burnout (SMBM > 3.8), negative general stress, and subjective mental job burden. For the general negative stress and mental job burden -questions a cut off-value (score > 7) was set to resemble the highest symptom quartile in this sample (21.8% of the sample responded 8-10 to the stress -question

and 33.7% to the mental job burden -question). After dichotomous classification of every symptom, number of symptoms were summed for each participant.

The number of symptoms was used as a grouping variable where number 0 refers to no symptoms on any of the before mentioned scales and number 7 refers to having at least mild symptoms on all the seven scales.

Subjective general health status and work ability. The association of CFWQ scores with subjective general health and work ability was studied. As there only were two subjects who reported "poor health" in the health status question, the groups "fairly poor" and "poor" were united. The general health and the CFWQ responses were analysed with the one-way analysis of variance. The association between work ability and CFWQ was studied with the Spearman's correlation coefficient.

Results

The CFWQ scale validation and reliability analyses

The first purpose of the study was to examine the content validity of the CFWQ by exploratory factor analysis. The correlations of all ~~original~~ 29 questions of CFWQ were calculated and the Kaiser-Meyer -Olkin Measure of Sampling Adequacy was 0.88 indicating that the correlation matrix is suitable for factor analysis. Seven questions had a lower communality than desired (<.30) and those were excluded to improve the model fit and to form the shortened scale version (Table 1). All the seven questions excluded from the factor model were included in the original 20-item questionnaire. The factor analysis was performed using the Maximum Likelihood method for the 22 items. The analysis yielded a six-factor model explaining 58.4% of the total variance of variables. The rotated factor matrix was produced using the Varimax with Kaiser Normalization method. The questions were placed

on subscales based on highest factor loading. Exceptions were made for the questions 26 and 27, because the question content suited better to another subscale with nearly corresponding loading. The factors were named according to the question content as Memory, Language, Executive Functioning, Speed of Processing, Cognitive Control and Name Memory.

The reliability coefficients indicated a good internal consistency of the total 22-item CFWQ (Cronbach's alpha = .87) and acceptable internal consistency for the subscales (Memory = .78, Language = .66, Executive Functioning = .74, Speed of Processing = .69, Cognitive Control = .60 and Name Memory = .66). The test-retest constancy between the responds to the CFWQ at baseline and the 12 months follow-up was studied. In order to consider possible influencing factors, the baseline assessments of symptoms of depression (p = .939), anxiety (p = .272), burnout (p = .361), daytime sleepiness (p = .404), insomnia (p = .492) and workplace cognitive failures (p = .132) were compared, and no significant differences were found between the follow-up group and the dropouts of the 12 months study. The whole study sample (ICC = .79) and especially the Stable subgroup (ICC = .84) test-retest results reflected high agreement between the measurement points. The test-retest constancy was adequately lower for the Impairment (ICC = .61) and Improvement (ICC = .72) subgroups.

The concurrent validity of the CFWQ was analyzed by correlation with previously validated measures of cognition, i.e., performance in cCOG tests and self-reported cognitive errors at work (WCFS). Most of the correlations between cCOG performance measures and CFWQ responses were very small and insignificant. The only statistically significant, but weak correlation coefficients were found between the CFWQ Speed of Processing subscale and cCOG executive function speed score (r = .13) and attention accuracy score (r = .11). In addition, statistically significant weak negative correlations were found between Name Memory subscale and cCOG memory learning and delayed recall parameters (r = -.13 and r =

-.14, respectively). The CFWQ Total score, Memory, Language and Executive Functioning subscale scores did not correlate statistically significantly with any of the cCOG results. The correlation coefficients between the CFWQ and cognitive errors at work reported in the WCFS were all statistically significant (Table 2). The correlation between WCFS Total score and the CFWQ Total score was quite high (r = .64). Furthermore, moderate correlations between corresponding scales, such as the WCFS Memory errors and CFWQ Memory subscale (r = .43), were found.

As a further validity analysis, the CFWQ Change score was compared in the three subjective memory disability groups: Stable (N = 146), Impairment (N = 16), and Improvement (N = 29) (Table 3). The differences in the CFWQ Memory subscale ($F(2, 188) = 4.84$, $p = .009$) and Total score ($F(2, 188) = 6.95$, $p = .001$) change scores between the three groups were statistically significant. Post-hoc analysis revealed that the subjective cognitive problems at work increased significantly more during follow-up in the Impairment group than in the Stable group according to the change in the CFWQ Memory subscale ($p = .041$) and Total score ($p = .003$). The Impairment and Improvement groups showed significant differences in the change scores in the CFWQ Memory ($p = .007$), Names Memory ($p = .047$) subscales, and Total score ($p = .001$). There was a 0.8 points decrease in the CFWQ Total score in the improvement group adequately indicating decreasing cognitive symptoms at work in the follow-up. The difference in change scores between the Stable and Improvement groups did not yield statistical significance ($p = .717$).

The CFWQ in association to health, wellbeing and work-related factors

The CFWQ mean and standard deviations for the total study group and clinical symptom subgroups are displayed in Table 4 for the 22-item CFWQ based on the factor analysis and the whole 29-item version of the scale. The mean Total score on the CFWQ was found to be

the lowest for the no symptoms group. A significant difference was found between the groups (no symptoms, depression, anxiety, insomnia) on the CFWQ Total score ($F(3,274) = 8.93$, $p < .001$). The post-hoc analysis revealed that the difference in the CFWQ Total score was significantly lower in the no symptoms group compared to depression ($p < .001$) and insomnia ($p < .01$) groups. There was, however, no significant difference ($p = .47$) between the no symptoms and anxiety group. The CFWQ Total scores in studied pure symptom groups (depression, anxiety and insomnia) did not differ statistically significantly ($p > .37$).

In addition, depression and occupational burnout symptoms were analyzed without excluding comorbid conditions. A significant difference was found in the CFWQ Total score in relation to depression severity ($F(2, 416) = 16.54$, $p < .001$). According to post-hoc analysis, the difference between all depression symptom groups (no depression symptoms, mild symptoms, at least moderate symptoms) was significant ($p < .01$) for the CFWQ Total score. When studying the reported burnout symptom levels, significant differences were found for the CFWQ Total score ($F(2, 417) = 68.93$, $p < .001$). According to post-hoc analysis, all groups differed statistically significantly on the CFWQ Total score ($p < .01$).

A significant correlation ($p < .001$) was found between the CFWQ Total score and depression ($r = .53$), anxiety ($r = .44$), insomnia ($r = .34$), burnout ($r = .65$), daytime sleepiness ($r = .37$), mental job burden ($r = .19$), and general negative stress ($r = .32$). The cumulative impact of these mood symptoms, psychosocial stressors and sleep problems on the CFWQ Total scores are presented in Table 5. In this study sample, 32.1% had none of the symptoms, 21.6 % had one symptom, 15.8 had two, 9.8% had three, 8.6% had four, 7% had five, and 5% had altogether six or seven symptoms. In the one, two, and three symptoms groups, the most frequently appearing symptoms were insomnia, depression, and perceived mental job burden. The most common symptom combination in the two symptoms group was insomnia and mental job burden (21%) and for the three symptoms group insomnia, general

negative stress, and mental job burden (20%). Figure 1 illustrates the association of increasing number of fulfilled symptom criteria and cognitive problems reported in CFWQ ($F(6,410) = 20.68$, $p < .001$). The difference in the CFWQ Total score between zero and one symptom groups is not significant, but the difference between the no symptoms and two symptoms is significant ($p < .05$ for zero and two symptoms, and $p < .001$ for zero and at least three symptoms).

Further, the CFWQ's relationship to subjective general health and work ability was examined. Figure 2 shows that the better the health status is, the less cognitive symptoms are reported according to the CFWQ. ~~As there only were two subjects who reported "poor health" in the health status question, the groups "fairly poor" and "poor" were united.~~ Statistical analysis revealed significant differences between subjective health status (good, fairly good, average and fairly poor or poor) groups ($F(3, 413) = 22.95$, $p < .001$). According to post-hoc analysis, groups "good" and "fairly good" did not show significant differences ($p = .13$). However, there was statistically significant ($p < .001$) differences between the groups "good" and "average" or "fairly poor or poor". Moderately strong negative correlation was found between subjective work ability and the CFWQ ($r = -.40$, $p < .001$).

Discussion

The present paper introduced the Cognitive Function at Work Questionnaire (CFWQ) designed for the assessment of subjective cognitive functioning at work. The main aim was to study the properties of the new scale and therefore we presented the results of the validation procedure and reliability analysis of the CFWQ. Furthermore, the association of CFWQ scores with various symptoms and conditions previously linked to subjective cognitive complaints (SCC) was studied.

The factor analysis revealed that the CFWQ has six cognitive subdomains: Memory, Language, Executive Functioning, Speed of Processing, Cognitive Control and Name Memory. The most frequently occurring cognitive domains in previously published cognitive questionnaires are Memory (59%), Executive functioning (16%), Attention (11%, including questions related to processing speed), and Language (8%) (Rabin et al., 2015). Thus, the CFWQ succeeded in reflecting the main cognitive domains covered by other SCC measures. The factor analysis separated memory function questions and those regarding remembering of names as their own factors, implying that they seem to measure different aspects of memory functioning. Indeed, according to our experience in clinical practice, forgetting of names, especially names of new acquaintances, as a singular symptom is often a minor issue. Instead, difficulties to remember the names of familiar people might have value in screening for dementia (Ramlall, Chipps, Bhigjee, & Pillay, 2013). In the present study, Name Memory -subscale mean scores were very similar across clinically relevant subgroups (No symptoms= 1.49, Depression= 1.79, Anxiety= 1.72, and Insomnia= 1.70). Although remembering names as a single subjective complaint might clinically have relatively little relevance, it is one of the most frequently appearing single questions in previously published questionnaires (Rabin et al., 2015).

Reliability testing of the CFWQ indicated that the consistency across items (internal reliability) and time (test-retest reliability) were good. The new scale also showed concurrent validity as it compared well to another subjective cognitive measure for occupational population, the reported cognitive errors at work measured with the Workplace Cognitive Failure Scale (WCFS). The highest correlation coefficients were found between the corresponding subscales (e.g. the WCFS memory error subscale and the CFWQ memory function subscale) which supports the validity of the new instrument. However, the correlation with objective cognitive performance was low and mainly insignificant. Many

previous reports have also failed to show correlation between subjective and objective cognitive measures (Gass & Patten, 2020; Gifford et al., 2014; Mendes et al., 2008; Rami et al., 2014). The cCOG test battery used in the present study is originally a screening tool for neurodegenerative disorders and one possible explanation is that it might not be sensitive enough to detect mild cognitive changes in high functioning working population. Another explanation could be that instead of indicating objective cognitive impairment, SCC among occupational population more likely reflect strain and situation linked fluctuation in cognitive performance in mentally and physically straining conditions. This kind of situation linked subtle impairments in cognitive efficiency are not typically visible in relatively short and structured cognitive tests. The association of SCC and objective cognitive performance is a complex phenomenon and it seems to depend on several factors, such as whether there is an associated worry in relation to memory complaints and what is the study setting (Jessen, 2014; Jessen et al., 2020; Perrotin et al., 2017; Snitz et al., 2018). For example, Van Harten et al. (2018) found that SCC and feelings of worry about cognitive problems both increase the risk of MCI approximately two-fold. Future research on the validation of the CFWQ should focus on clinically relevant samples such as diagnosed patient groups or those seeking medical help because of SCC.

Interestingly, the CFWQ score reflected the change in perceived general disability of memory functions. For example, those who reported having no disability of memory functions at baseline but changed to having at least mild disability at the follow-up, scored higher in the follow-up on the CFWQ questionnaire than at baseline. The differences in the change scores of the three groups (stable, improvement and impairment) also showed logical differences as the CFWQ score of the impairment group increased significantly more during the follow-up than the score of the stable and improvement groups. The difference between the stable and improvement groups indicated a logical trend, however the difference in

change scores did not reach statistical significance. Even though not throughout statistically significant, the results support the validity of the new scale as it works in a coherent way by reflecting memory disability change in both directions.

Our study confirmed previous robust findings that cognitive complaints are related to psycho-affective and sleep-related problems (Cedres et al., 2019; Comijs et al., 2002; Lauriola et al., 2017; Nunes et al., 2018; Wardle-Pinkston et al., 2019). When examining the relationship between major conditions (depression, anxiety, and insomnia) linked to SCC, we found that those who did not have such symptoms reported the least SCC at work. Only anxiety group did not reach statistically significant differences in comparison to those having no symptoms, but this might be due to a small group size. The CFWQ results did not differ significantly between the insomnia, depression, and anxiety groups. However, the results regarding the effect of symptom severity on the CFWQ reached statistical significance throughout. The higher degree of reported depressive symptoms was associated with lower subjective cognitive functioning at work. Similar results have been previously reported among different study populations or study settings (Gass & Patten, 2020; Loprinzi, 2019; Sousa, Pereira, & Costa, 2015). Our results imply that also in the occupational population, the higher the intensity of depressive symptoms, the more cognitive problems an individual experiences. As various psychosocial stressors have been linked to SCC (Österberg, Skogsliden, & Karlson, 2014; Rönnlund et al., 2013), we analyzed the association of burnout symptoms and the CFWQ in a similar manner as depression symptoms and found that also higher burnout symptoms were associated with increasing problems with cognitive functioning at work. Our results are in line with previous reports conducted with other SCC measures in nonclinical and clinical burnout (Oosterholt, Maes, Van Der Linden, Verbraak, & Kompier, 2014; Van Der Linden, Keijsers, Eling, & Van Schaijk, 2005). According to the

current study, burnout symptom severity affects the way individuals rate their cognitive functioning at work environment.

In line with previous evidence (Lee, 2014), better subjective general health was associated with a lower score on the CFWQ when compared to lowest subjective health status groups. The difference between "good" and "fairly poor or poor" health status was six points on the CFWQ Total score, which is more than one standard deviation difference in the total sample and therefore reflects a clear difference in the subjective cognitive functioning. Further, a moderate negative correlation emerged between the CFWQ and perceived work ability. Thus, higher amounts of cognitive problems at work were associated with lower subjective working ability. SCC in relation to working ability have been previously studied among breast cancer survivors (Von Ah, Storey, & Crouch, 2018), multiple sclerosis (Honan, Brown, & Batchelor, 2015), and with healthy participants (Pihlajamäki et al., 2020). For example, Pihlajamäki et al. (2020) found that SCC predict sickness absence in cognitively demanding occupations, reflecting decreased work ability with cognitive complaints. Our study supports the previous reports on the association of work ability and SCC.

Because there is notable comorbidity among conditions linked to SCC (Aasvik et al., 2015; Bergdahl & Bergdahl, 2002; Bhaskar, Hemavathy, & Prasad, 2016; Bothelius, Hysing, Filén, Lundeborg, & Gordh, 2019; Grandner & Malhotra, 2017), the current study sought to investigate whether mood symptoms, psychosocial stressors, and sleep problems form cumulative strain and accumulation of cognitive symptoms experienced at work. To our knowledge, the cumulative effects of symptoms on SCC have not been previously studied in this manner. As we hypothesized, increasing number of the reported symptoms (depression, anxiety, insomnia, daytime sleepiness, burnout, overall stress, and mental job burden) was associated with increasing subjective cognitive difficulties at work. Even the difference between zero and two symptoms was significant. We did not separate which strain factors

were in question, because possible combinations are outnumbered. The most frequently appeared conditions in the one, two or three symptoms groups were depression, insomnia and mental job burden. The identification of depression and insomnia symptoms were based on well-known questionnaires in research and clinical settings, but the mental job burden was enquired with a single question. Although to a lesser extent studied concept in relation to SCC, previous reports have linked psychosocial work factors, such as quantitative psychological job demands (e.g. having to work fast or with too much effort) with higher SCC (Stenfors et al., 2013). The current results imply that an accumulation of strain factors might underlie cognitive symptoms. Further, the results give support to an individual approach proposed by Jessen et al. (2020) that the association between SCC and the underlying condition should be considered individually and appropriate psychoeducation planned according to a subject's needs.

Major limitations of the study are related to the study sample: participants were volunteers recruited through job email and it could not be controlled who decided to enroll in the study and who did not. All the about 3500 employees of the media service company were sent an invitation to participate in the study, but only 418 decided to enroll. Hence, the sample sizes in clinical groups (e.g. depressive, anxiety and insomnia groups) were quite small. ~~Further, t~~The participants were relatively highly educated and working in one industry sector (i.e. media service) and therefore the sample is not representative of the occupied population in general. Further, work-related variables, such as working hours, distance to work or differences in job positions, might affect SCC but could not be considered in this study. Other limitations of this study include that we did not have access to health care system data of the participants and consequently clinical groups were based on self-reported symptoms. It is important to bear in mind that the groups were not based on diagnoses but instead symptoms experienced at the time of participation. Having a longitudinal study

setting has definitively its strengths, but results might also be unreliable when study participation in the follow-up is lower. In our study, 63% of the participants took part in the 12 months follow-up study. However, the follow-up participants resembled well the original study sample by demographic variables (age, sex, and years of education), and no significant differences were found concerning several psychological symptom variables between the follow-up group and the dropouts of the 12 months study.

In conclusion, the topic of assessing cognitive functioning in the working population is timely, because of relatively high rates of SCC in the working age and changes in working life, such as increase in smart working and working until older ages. The results of the present study support the validity and reliability of the CFWQ scale in measuring SCC in the occupational population. It can be applied to evaluate effects of work and health related factors in cognitive functioning at work. We showed a "dose-response effect" of increasing SCC in relation to clinical symptom severity and accumulation. Additionally, the CFWQ can be applied in clinical practice when cognitive symptoms need to be evaluated regarding work ability or occupational safety. Future studies should further validate the CFWQ, for example in clinical settings (e.g., diagnosed patient groups or individuals seeking medical consultation due to cognitive problems). It would also be of high importance to study whether the CFWQ could be successfully applied in work accommodation if employee has identified cognitive problems.

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Declaration of interest statement

Author JL is a shareholder at Combinostics Ltd. Other authors report no conflict of interests for this study.

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Table 1. The Cognitive Function at Work Questionnaire Items and the Factor Loadings for the Final 22-Item Model

CFWQ Item	CFWQ subscale					
	Mem	Lan	Exe	Spe	Con	Nam
The following questions relate to your memory function at work: How do you remember and learn?						
1. Tasks agreed with other people?	**.37**					
**2. Appointments agreed with other people?*						
3. Your own work plans?	.33		**.44**			
4. Things you have read?	**.67**	.31				
5. Things you have heard?	**.65**					
6. Precise details of things?	**.60**					
7. Names of new people/acquaintances?						**.78**
8. Names of familiar people?						**.58**
**9. Location of tools and objects?*						
**10. Familiar work methods or use of familiar tools?*						
**11. New work methods and use of new tools?*						
How does your attention and action function at work?						
**12. Continuing a task after an interruption?*						
**13. Monotonous repetitive tasks?*						
14. Finalizing tasks?			**.56**			
15. Completing/performing tasks fast?				**.87**		
16. Fluent recall of things?	**.55**					
17. Forethoughts needed in tasks?		.36	**.57**			
18. Starting/engaging in tasks?			**.60**			
**19. Checking the correctness of work performance?*						
20. Making decisions and judgments at work?			**.38**	.31		
How do you appraise your performance?						
21. Speech comprehension?		**.53**				
22. Speech production?		**.55**				
23. Reading?		**.51**				
24. Writing?		**.56**				
25. Speed of actions?		.34		**.49**		
26. Initiative?		.45	**.35****			
27. Coherence of thinking?		.33			**.32****	
28. Judgment in financial or problematic situations?					**.59**	
29. Control of emotions and behavior?					**.65**	

Abbreviations: Mem = Memory; Lan = Language; Exe = Executive Function, Spe = Speed of Processing; Con = Cognitive Control; Nam = Name Memory

Note. N = 418. Factor analysis was performed with Maximum likelihood method. Rotated factor matrix displayed (Varimax with Kaiser Normalization). Only factor loadings exceeding .30 are presented. Bolding indicates the CFWQ subscale where the question is located. *Questions in italics with communality lower than .30 were excluded from the factor model. **Questions 26 and 27 were placed on a subscale of a slightly lower factor loading based on the suitability of the content to the CFWQ subscale.

Table 2. Spearman correlation coefficients between the CFWQ and the WCFS

WCFS susbcale	CFWQ subscale						
	Mem	Lan	Exe	Spe	Con	Nam	Total Score
Memory	.43	.26	.37	.30	.35	.33	.52
Action	.35	.24	.26	.26	.34	.26	.42
Attention	.49	.34	.52	.35	.39	.25	.61
Total Score	.52	.35	.47	.38	.42	.34	.64

Abbreviations: Mem = Memory; Lan = Language; Exe = Executive Function, Spe = Speed of Processing; Con = Cognitive Control; Nam = Name Memory

Note. $p < .001$ for all values

Table 3. Means (and Standard Deviations) for the CFWQ Subscales and the Total Score Change Scores (12 months - baseline = subtraction score) for the Stable, Impairment, and Improvement Groups

	CFWQ Change Scores						
	Mem	Lan	Exe	Spe	Con	Nam	Total Score
Stable	-.12 (1.46)	-.01 (.71)	.03 (1.08)	-.03 (.64)	.11 (.78)	-.10 (.83)	-.12 (2.82)
Impairment	.81 (.75)	.19 (.54)	.63 (1.36)	.25 (.68)	.19 (.83)	.31 (.87)	2.38 (2.60)
Improvement	-.59 (1.64)	-.17 (.80)	.28 (1.44)	.03 (.50)	-.03 (.68)	-.31 (.71)	-.79 (2.90)

Abbreviations: Mem = Memory; Lan = Language; Exe = Executive Function, Spe = Speed of Processing; Con = Cognitive Control; Nam = Name Memory

Note. Stable (N = 146), Impairment (N = 16), and Improvement (N = 29)

Table 4. Means (and Standard Deviations) for the CFWQ Subscales and the Total Score for the Total Sample, Clinical Subgroups, and According to Symptom Severity

	22-Item CFWQ based on Factor Analysis							29-Item CFWQ
	Mem	Lan	Exe	Spe	Con	Nam	Total Score	
Total sample *(N* = 418*)*	2.78 (2.02)	.62 (1.07)	1.68 (1.66)	.60 (.86)	.71 (1.01)	1.74 (1.05)	8.11 (5.33)	10.50 (6.81)
Clinical subgroups								
No symptoms[1]	2.22 (1.72)	.29 (.64)	1.08 (1.32)	.42 (.76)	.26 (.52)	1.49 (.95)	5.76 (3.88)	7.46 (4.81)
Depression[2]	3.04 (2.28)	1.04 (1.46)	2.04 (1.93)	1.12 (1.09)	1.04 (1.31)	1.72 (1.02)	10.00 (6.73)	12.68 (8.65)
Anxiety[3]	3.33 (2.58)	.83 (2.04)	2.17 (1.47)	.50 (.55)	.50 (.84)	1.83 (1.33)	9.17 (4.58)	12.00 (5.97)
Insomnia[4]	2.71 (2.07)	.61 (.97)	1.71 (1.70)	.61 (.86)	.61 (.95)	1.70 (1.00)	7.97 (5.45)	10.30 (6.90)
Symptom severity								
Mild Depression[5]	3.44 (1.93)	0.91 (1.22)	2.34 (1.60)	.81 (.88)	1.21 (1.11)	1.97 (1.10)	10.68 (4.92)	13.76 (6.19)
At least Moderate Depression[6]	4.03 (2.64)	1.59 (1.66)	3.00 (2.33)	1.14 (1.13)	2.07 (1.46)	2.28 (1.16)	14.10 (6.90)	19.07 (8.74)
Mild Burnout[7]	4.15 (2.16)	.94 (1.10)	2.32 (1.71)	0.70 (.98)	1.26 (1.11)	2.21 (1.04)	11.57 (4.16)	15.06 (5.02)
More Severe Burnout[8]	4.53 (2.06)	1.63 (1.62)	3.16 (2.11)	1.14 (.99)	1.77 (1.39)	2.35 (1.02)	14.58 (6.33)	19.23 (8.41)

Abbreviations: Mem = Memory; Lan = Language; Exe = Executive Function, Spe = Speed of Processing; Con = Cognitive Control; Nam = Name Memory

[1]No symptoms (*N* = 177): BDI21 ≤ 9, GAD-7 ≤ 4, and ISI ≤ 7

[2] Depression (pure) (*N* = 25): BDI21 > 9, GAD-7 ≤ 4, and ISI ≤ 7

[3] Anxiety (*N* = 6): BDI21 ≤ 9, GAD-7 > 4, and ISI ≤ 7

[4] Insomnia (*N* = 70): BDI21 ≤ 9, GAD-7 ≤ 4, and ISI > 7

[5] Mild Depression symptoms (*N* = 100): BDI21 = 10 – 18

[6] Moderate or Severe Depression symptoms (*N* = 29): BDI21 ≥ 18

[7]Mild Burnout (*N* = 47): SMBM = 3.9 – 4.3

[8]More Severe Burnout (*N* = 43): SMBM > 4.3

Table 5. Means (and Standard Deviations) for the CFWQ Subscales and the Number of Symptoms: Depressive, Anxiety, Insomnia, Daytime sleepiness, Burnout, General Stress, and Mental Job Burden

Number of Symptoms	CFWQ Subscale						
	Mem	Lan	Exe	Spe	Con	Nam	Total Score
0	2.16 (1.65)	.33 (.73)	1.06 (1.26)	.42 (.78)	.27 (.51)	1.52 (.96)	5.76 (3.74)
1	2.44 (2.02)	.54 (1.05)	1.36 (1.52)	.59 (.81)	.41 (.65)	1.54 (1.02)	6.89 (4.95)
2	2.77 (1.80)	.48 (.98)	1.94 (1.54)	.56 (.73)	.71 (1.06)	1.71 (.94)	8.18 (4.61)
3	3.07 (1.66)	.78 (1.08)	2.07 (1.77)	.66 (1.04)	.90 (1.00)	1.78 (1.19)	9.27 (5.32)
4	3.31 (2.25)	1.03 (1.06)	2.31 (1.83)	.78 (.93)	1.39 (1.05)	2.22 (1.20)	11.03 (5.51)
5	4.31 (2.44)	1.00 (1.28)	2.31 (1.58)	.90 (1.01)	1.62 (1.29)	2.28 (.92)	12.41 (5.30)
6-7*	4.57 (2.23)	1.67 (1.77)	3.38 (2.18)	1.00 (1.00)	1.95 (1.56)	2.38 (.97)	14.95 (5.92)

Abbreviations: Mem = Memory; Lan = Language; Exe = Executive function, Spe = Speed of Processing; Con = Cognitive control; Nam = Name Memory.

Note. Symptoms assessed with BDI21, GAD-7, ISI, ESS, SMBM, and single questions about general stress and mental job burden. Number 0 refers to no symptoms according any of the scales and number 7 refers to having at least mild symptoms on all the seven scales. * Groups 6 and 7 were combined because of small group size.