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Original Article

Job Characteristics in Nursing and Cognitive Failure at Work

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Objectives: Stressors in nursing put high demands on cognitive control and, therefore, may increase the risk of cognitive failures that put patients at risk. Task-related stressors were expected to be positively associated with cognitive failure at work and job control was expected to be negatively associated with cognitive failure at work.
Methods: Ninety-six registered nurses from 11 Swiss hospitals were investigated (89 women, 7 men, mean age = 36 years, standard deviation = 12 years, 80% supervisors, response rate 48%). A new German version of the Workplace Cognitive Failure Scale (WCFS) was employed to assess failure in memory function, failure in attention regulation, and failure in action exertion. In linear regression analyses, WCFS was related to work characteristics, neuroticism, and conscientiousness.
Results: The German WCFS was valid and reliable. The factorial structure of the original WCF could be replicated. Multilevel regression task-related stressors and conscientiousness were significantly related to attention control and action exertion.
Conclusion: The study sheds light on the association between job characteristics and work-related cognitive failure. These associations were unique, i.e. associations were shown even when individual differences in conscientiousness and neuroticism were controlled for. A job redesign in nursing should address task stressors.

Key Words: Nurses, Patient safety, Cognitive failure, Occupational stress

Introduction

Job characteristics in nursing are related to safe patient care [1]. An important study that related working conditions, such as nurse staffing (e.g., nurse-to-patient-ratio), to outcomes showed that staffing was related to the burnout of nurses [2]. Concerning patient outcomes, each additional patient per nurse was associated with a 7% increase in the likelihood of dying within 30 days of admission and a 7% increase in the odds of failure-to-rescue (deaths following complications) among surgical patients [2].

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Job characteristics that are associated with nurse staffing include overtime, work interruptions, distractions, and role conflict. Job characteristics have been found to be the risk factors that are most likely cause a reduction in patient safety [3]. In nursing, stressful events are frequently safety-related [4]. Cognitive functioning is the critical resource of registered nurses and it relates to error prevention, error interception, and error correction in nursing [5]. When nurses were asked to report stressful situations while working, 20% of all reported events were coded as being safety-related [4]. High stress levels can impair concentration, information processing, decision-making, and work behaviour [6-8]. Stressed hospital staff is, therefore, more likely to make mistakes. Mistakes, in turn, can contribute to the emergence of accidents.

This study investigated the association between nursing job characteristics that are likely to disturb cognitive function, i.e. elicit cognitive failures while working. Cognitive failures are mistakes on everyday tasks that a person normally is capable of

completing without error. Cognitive failures cover all types of execution failures or storage failures while excluding failures of ability or knowledge [9,10].

Job characteristics in nursing and cognitive failures

In nursing, performing routine tasks is often constrained by time and frequent and unpredictable interruptions [11]. Interruptions are frequent, because people need to move around often and then need to be located, task sequences need to be changed because people are absent, etc. [12], and staff need to temporarily resign from tasks often due to interruptive calls [13]. Frequent interruptions disrupt attention focus, induce a shift of attention away from the primary task, and increase working memory load because information of the primary task has to be stored while new information needs to be processed [1]. Thus, work in highly interruption-driven work environment puts high demands on cognitive control and therefore increases the risk of cognitive failure at work [14,15] and rumination after work [16-18]. In nursing, we therefore expect interruptions, concentration demands, and time pressures to be positively related with cognitive failures. Control at work - the possibility to decide when to perform tasks in what sequence and the ability of how to perform a task - are important resources in action regulation [19]. Job control can help prevent or ameliorate job stressors, like interruptions and the need for polychronicity, i.e. participation in many tasks at the same time instead of monochronicity, i.e., work with one task at a time. Polichronicity is known to increase cognitive load [20]. Hence control at work should lower the risk of cognitive failures.

Individual differences in cognitive failure were found to be rather stable over time [9]. Research has shown that conscientiousness is negatively related with cognitive failure and neuroticism is positively related with cognitive failure [21]. The mechanism behind associations between personality traits and cognitive failures are suspected to reflect differences in coping with stressors that are also related to neuroticism and conscientiousness. Individuals who are less vulnerable to cognitive failures and who are less neurotic and higher in conscientiousness seem to cope more actively with problems than individuals that are more vulnerable to such failures [21]. The main research question that guided the present study was whether work stressors and resources predict cognitive failures in nursing. Work stressors were expected to be positively associated with work-related cognitive failures and job control was expected to be negatively associated with work-related cognitive failures. Therefore, we controlled for neuroticism and conscientiousness when we predicted work-related cognitive failures based on working conditions.

Materials and Methods

The study was performed in accordance with the code of ethics of the World Medical Association (Declaration of Helsinki).

Sample

The sample consisted of 96 registered nurses (89 women, 7 men, 80% supervisory position). Participants worked in 11 hospitals across the German speaking part of Switzerland. Participation rate in this questionnaire study was 48%. All participants were contacted by the third author and they all gave their informed consent before a questionnaire was handed to them. Half of the sample worked full-time, 36 % worked between 50% and 80 %, and 14 % worked 50% or less. The mean age was 36 years (standard deviation = 12 years).

Questionnaires

In 1982, Broadbent and colleagues developed a general cognitive failure questionnaire [9,10]. In 2005, Wallace and Chen introduced their Workplace Cognitive Failure Scale (WCFS) that was intended to show closer relationships to occupational variables than the general cognitive failure scale [22]. Indeed the WCFS was found to be significantly related with role-overload, unsafe behaviour, and micro-accidents at work [22]. The WCFS consists of 15 items with a five point Likert response format, asking for the frequency of cognitive failure at work. The WCFS includes three subscales: Failure in memory function, failure in attention regulation, and failure in action excretion. Failures in memory function comprise 5 items (e.g., "Cannot remember whether you have or have not turned off work equipment?"). Failures in attention also included 5 items (e.g., "Do not fully listen to instructions?"). Action exertion also comprised 5 items (e.g., "Throw away something you meant to keep (e.g., memos, tools)?").

All items of the WCF were translated into German. First, a native German speaker translated the WFC into German. Second, a native British English speaker translated the German version independently back into English. Third, a native American English speaker compared the original version with the back-translated versions. Fourth, based on these translations, a final version was developed in a meeting.

Job characteristics were measured by a shortened version of the Instrument for Stress Oriented Task Analysis (ISTA) [23]. ISTA scales have been shown to be associated with well-being in a number of studies, using different designs and methods of analysis [24-32]. Task-related stressor scales are *time pressure, concentration demands, uncertainty* (e.g., unclear instructions or decisions based on insufficient information), *interruptions*,

Table 1. Descriptive statistics and internal consistencies (Cronbach's alpha) for all study variables

Variables	No. of items	Range	M	SD	n	α
WCF: Total	15	1-5	1.84	0.42	96	.83
WCF: Memory	5	1-5	1.97	0.64	96	.76
WCF: Attention	5	1-5	1.99	0.50	96	.66
WCF: Action	5	1-5	1.57	0.44	96	.77
Task stressors	19	1-5	3.14	0.44	94	.75
Time pressure	4	1-5	3.47	0.70	94	.77
Concentration demands	4	1-5	3.77	0.75	94	.76
Performance constraints	3	1-5	2.22	0.63	88	.54
Uncertainty	4	1-5	2.51	0.64	94	.65
Work interruptions	4	1-5	3.64	0.70	94	.78
Job control	6	1-5	3.22	0.65	96	.79
Neuroticism	6	1-6	2.69	0.74	95	.80
Conscientiousness	6	1-6	4.92	0.65	94	.84

SD: standard deviation, WCF: workplace cognitive failure.

and *performance constraints* (includes 3 items e.g., having to work with inadequate devices or obsolete information). The scale of *control* included 6 items, 3 relating to method control and 3 relating to time control. Method control assesses the possibility to decide on how to do one's work (3 items) and time control assesses whether employees can decide what tasks to do and when to perform such tasks (3 items).

The five task stressors, time pressure, concentration demands, performance constraints, uncertainty, and work interruptions, were aggregated into one task stressor index (see [24], and [26] for a similar procedure with the same scales as the ISTA).

Neuroticism and *conscientiousness* are part of the five-factor model of personality [33,34]. The five-factor model questionnaire we used is based on an adjective-rating list developed by Ostendorf and colleagues [35,36]. The adjective-rating list was reduced by Schallberger and Venetz [37]. Neuroticism and conscientiousness scales each consist of six bipolar items on a 6-point scale, with each pole ranging including "very" (1 and 6), "quite" (2,5), and "rather" (3,4). Reliability coefficients of all questionnaire instruments were satisfactory (Table 1).

Data analysis

To predict variation in WCF from job characteristics, we conducted linear multiple regression analyses, with first including age, gender, and job characteristics, which was followed by neuroticism and conscientiousness in a second step. Thus, we tested the predictive value of the measured job characteristics in a first regression model and tested, in a second regression model, whether job characteristics keep their predictive value when neuroticism and conscientiousness enter the model. Data analyses were performed with SPSS 15.0 (SPSS Inc., Chicago, IL, USA); in all analyses, p-values were two-tailed with an α set to 5%.

Results

The proposed three-factorial structure of the German version of the WCFS was tested in a Confirmatory Factor Analysis (CFA) using structural equation modelling. The German version of the WFC fitted very well with the factorial structure of the English version in the CFA (Table 2). All items showed sufficient item loadings on latent variables representing WCF memory, WCF attention, and WCF action factors. The fit of the hypothesized three-factorial model showed good convergence with the empirical pattern of covariation (Chi^2 = 158.38 df =87 Chi^2/df = 1.82 p = .00, rmsea = .09).

Descriptive statistics

Table 1 shows the mean values and standard deviations of the study variables. Mean values of time pressure, interruptions, and concentration demands reflect high stressor exposure [38].

Table 2. Summary of confirmatory factor analysis of WCF questionnaire

	B	SE B	β	Communality
WCF: Memory				
Item 1	1.35	0.29	0.75	0.57
Item 2	1.00	-	0.55	0.31
Item 3	1.02	0.25	0.59	0.35
Item 4	0.91	0.23	0.58	0.33
Item 5	0.80	0.19	0.61	0.37
WCF: Attention				
Item 1	0.53	0.26	0.26	0.07
Item 2	1.00	-	0.54	0.29
Item 3	1.44	0.35	0.71	0.51
Item 4	1.06	0.29	0.58	0.34
Item 5	1.26	0.33	0.62	0.38
WCF: Action				
Item 1	1.00	0.28	0.44	0.19
Item 2	1.00	-	0.61	0.37
Item 3	1.09	0.24	0.58	0.34
Item 4	1.33	0.23	0.87	0.76
Item 5	1.13	0.20	0.80	0.63

WCF: workplace cognitive failure, B: non-standardized factor loading, SE B: standard error of B, β: standardized factor loading, Communality: percentage of variability in scores of items that is common-factor variance.
N = 90.

Table 3. Intercorrelations of all study variables

	1	2	3	4	5	6	7
1 WCF: Total							
2 WCF: Memory	.86*						
3 WCF: Attention	.75*	.44*					
4 WCF: Action	.76*	.51*	.37*				
5 Task Stressors	.22†	.12	.24†	.20			
6 Job control	-.12	-.08	-.03	-.18	-.19		
7 Neuroticism	.21*	.12	.17	.23†	-.07	-.05	
8 Conscientiousness	-.25†	-.14	-.24†	-.22†	.10	-.12	-.32‡

WCF: workplace cognitive failure.
N = 96, *p < .001, †p < .05, ‡p < .01, two-tailed.

Table 3 shows Pearson correlations between study variables. WCF scales were significantly interrelated. The WCF total scale was significantly related with task stressors, neuroticism, and conscientiousness. The pattern of correlations between the three WCF sub-scales and task stressors showed no significant associations with WCF memory and WCF action, while WCF attention was significantly positively related with task stressors. Job control showed no significant association with WCF scales. Neuroticism showed a significant positive association with WCF Total and WCF action, while conscientiousness was, as expected, significantly negatively related with WCF total and WCF attention.

Linear regression analyses

In their final models, regression analyses tested the power of job characteristics to predict WCF score when age, gender, neuroticism, and conscientiousness were controlled. Table 4 shows the results of the linear regression analyses. Task stressors were significantly positively associated with WCF total, WCF attention, and WCF action. Conscientiousness negatively predicted WCF total, WCF attention, and WCF action (Table 4).

Discussion

The study sheds light on the association between job characteristics and work-related cognitive failure. A newly translated German version of the WCFS, measuring work-related cognitive failure, was shown to agree well in a factorial structure with the original questionnaire [22]. The two items with the lowest factor loadings also showed the lowest loadings in the validation study of the original questionnaire [22]. The fit of the three-dimensional factor model in the confirmatory factor analysis using structural equation modelling was comparable to the fit of the three-factor model in the validation study of the original questionnaire (Combined sample of study 2: Chi^2 = 161.10 df = 87 chi^2/df = 1.85, rmsea = .09, [22]). The mean levels of the WCF total scale, WCF memory, and WCF attention are rather comparable to the mean values in the original validation study. Standard deviations in all WCF scales, however, were smaller than those in the original study. With respect to the background of the action theory, stressors do hinder employees from reaching their goals and resources do function as promoters of task fulfilment [19]. Task stressors consisting of frequent interruptions, time pressure, performance constraints, and task uncertainty were expected to increase cognitive load and thereby make cognitive failure more likely. Results did

Table 4. Summary of multiple linear regression analyses for variables predicting WCF

	WCF											
	WCF: Total			WCF: Memory			WCF: Attention			WCF: Action		
	B	SE B	β	B	SE B	β	B	SE B	β	B	SE B	β
Step 1												
Age	-.004	.004	-.120	-.003	.006	-.065	-.003	.005	-.070	-.006	.004	-.167
Gender	.045	.183	.026	.112	.287	.044	.086	.219	.043	-.063	.191	-.036
Task stressors	.229	.107	.231*	.197	.168	.130	.300	.129	.253*	.192	.112	.184
Job control	-.002	.076	-.004	-.003	.119	-.003	.068	.091	.081	-.058	.079	-.079
Step 2												
Age	-.004	.004	-.122	-.004	.006	-.068	-.003	.004	-.074	-.006	.004	-.165
Gender	.176	.179	.105	.227	.293	.088	.244	.214	.121	.059	.188	.034
Task stressors	.281	.103	.284†	.242	.169	.159	.362	.123	.306†	.242	.108	.233*
Job control	-.016	.072	-.022	-.019	.119	-.018	.046	.087	.055	-.075	.076	-.102
Neuroticism	.056	.060	.099	.037	.099	.043	.060	.072	.090	.072	.063	.123
Conscientiousness	-.199	.072	-.307†	-.175	.118	-.176	-.241	.086	-.310†	-.180	.075	-.265*

WCF: workplace cognitive failure, B: non-standardized regression coefficient, SE B: standard error of B, β: standardized regression coefficient, WCF: R2 Step 1 = .06, p = .236, R2 Step 2 = .12, p = .004. WCF: Memory: R2 Step 1 = .02, p = .772, R2 Step 2 = .04, p = .221.WCF: Attention: R2 Step 1 = .07, p = .230, R2 Step 2 = .11, p = .005. WCF: Action: Step 1 = .07, p = .162, R2 Step 2 = .10, p = .009.
Sample size: n = 90.
*< .05, †< .01, p < .001, two-tailed.

confirm that task stressors do foster cognitive failure, especially in attention regulation. In the study by Wallace and Chen [22], the subscale of attention also showed the largest association with working conditions. This pattern reappeared in the current study. The mechanism behind this relation is presumably that regulation of attention is always needed when tasks are not performed automatically [10]. Therefore, it is not astonishing that attention regulation is most closely connected to job characteristics. This association between job characteristics and WCF subscale attention was unique, i.e., it was shown even when individual differences in conscientiousness and neuroticism were considered in the analyses. Results also documented the successful validation of a new German version of the WCFS. The WCFS is a promising process-oriented instrument that helps to link working conditions to important outcomes like patient safety. A recent meta-analysis on job characteristics and work outcome strongly recommended that future research should focus on processes relating to both constructs [39]. WCFS seem to be a promising tool with respect to process-oriented research relating to job characteristics and performance, job characteristics, stress, and occupational safety [40]. Results showed that task stressors in nursing foster cognitive failure, especially in attention control. Job characteristics that allow for optimal self-regulation of attention focus in nurses do enhance the effectiveness of nurses in preventing, intercepting and correcting healthcare errors [5]. Work with high task stressors is costly even without working overtime. Prolonged work under time pressures, high concentration demands, frequent interruptions, task uncertainty, and performance restraints results in a 'compensatory effort' that is related to extra effort spent when workers perform tasks under adverse conditions, and maintaining achievement levels is only possible with higher mental costs [41]. Given that stress, especially workload, has been increasing for a number of years now [42], our results, together with a number of other findings [4], do raise concerns about working conditions in hospitals that enhance WCF; it would appear that WCF is not only a threat to the nurse health and well-being [25], but also to patient safety [1].

In this study correlations might have been underestimated because of a restriction in WCFS variance. Variation in WCFS was smaller than in the study by Wallace and Chen [22]. The participation rate of 50 % is comparably high and is unlikely to have caused restriction in variation. Meanwhile, in nurses, a certain restriction of variation might not reflect bias, but re-

flect action regulation in "high reliability organisations" that are more preoccupied with the possibility of failure than other organisations [43]. Nevertheless, we cannot exclude restrictions of variation that emerge from fear or shame or a "that which must not, cannot be" attitude in health care [44,45].

The study sheds light on the association between job characteristics in nursing and work-related cognitive failure. Task stressors at work predict cognitive failure in nursing. Thus, the WCFS in combination with ISTA is promising also in screening for risky job characteristics. Researchers should incorporate the WCFS into task analysis in nursing; at least the WCF attention subscale should be included. The evaluation of job redesign in nursing also should include the WCFS.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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