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Short Communication

Does cognitive function predict changes in perception of stressful working conditions?

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Abstract: Cognitive health is a key resource for individuals to nurture their employability. We studied the longitudinal association of cognitive function with changes in stressful working conditions, testing a possible reversed causation. We used a sample of employees (N=1,355) participating in two surveys (2006 and 2011) within a German national representative study (GSOEP). Cognitive function was captured by perceptual speed (Symbol Digit Test) and word fluency (Animal Naming Test). Stressful working conditions were measured by the validated short version of the effort-reward imbalance questionnaire. Multivariate linear regression models assessed the impact of perceptual speed and verbal fluency in 2006 on changes in participants' perceptions of effort, reward, effort-reward ratio, and over-commitment between 2006 and 2011, adjusting for socio-demography, behaviours, physical and mental health at baseline. Neither perceptual speed nor verbal fluency was significantly related to changes in perceived working conditions. Our findings did not support the notion of reversed causation.

Key words: Cognitive function, Work stress, Effort, Reward, Over-commitment, Reversed causation, Longitudinal study

Current labour market transformations are linked to increased time pressure, restricted career opportunities and elevated job insecurity. Throughout the last two decades, stress-related health consequences of these developments have been analysed by Siegrist's model of effort-reward imbalance[1)]. Workers are increasingly forced to invest substantial efforts to remain employed or enter employment in a competitive economy, whereas rewards related to the work contract (e.g. job security and salary) often may not meet agreed-upon standards. In addition to extrinsic demands triggering a perceived effort-reward imbalance, workers' intrinsic effort in terms of excessive striving ('over-commitment') can contribute to stressful experiences at work[1, 2)]. Due to employees' inability to appropriately withdraw from work obligations, this maladaptive type of coping compromises recovery resources and precipitates a state of psychophysiological breakdown in the long run. Extrinsic and intrinsic determinants of 'high cost-low gain' situations at work have been shown to increase the risk of developing stress-related disorders, such as cardiovascular

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disease and depressive symptoms[3, 4].

To provide solid evidence for interventions at the organisational and/or individual level, researchers have been addressing the challenge of reversed causation. Several studies found support of the notion that reduced health, as defined by work inability[5] or sleep problems[6], for example, contributes to an increased level of work stress in terms of a perceived effort-reward imbalance.

Moreover, the presence of bi-directional associations between perceived efforts and rewards, over-commitment and health variables may indicate a vicious cycle[7] eroding employees' productivity and competitiveness. The interrelation between cognitive function and perceived work-related success for efforts spent in a fast-pacing, insecure and highly demanding labour market is therefore highly relevant in achievement-focused, but aging economies with an increasing prevalence of dementia[8]. Recently, we were the first to show positive associations of components of the effort-reward imbalance model in 2006 and improved cognitive function six years later (2012) in a sample aged 18+ ('normal causation')[9] from the representative and longitudinal German Socio-Economic Panel (GSOEP)[10]. At the same time, however, appropriate cognitive function is crucial for successful task accomplishment and job performance[11]. Hence, low level of cognitive function is expected to contribute to subsequent increase of extrinsic and intrinsic effort as well as to subsequent reduction of reward at work given the invested efforts.

For this reason, we set out to further test two measures of cognitive function regarding their contribution towards explaining changes in perception of stressful working conditions for the first time and again retrieved GSOEP data from two time points for this purpose.

The German Institute for Economic Research (Deutsches Institut für Wirtschaftsforschung), Berlin, is responsible for the coordination of the GSOEP, including annual follow-up and replenishment since 1984 as well as compliance with ethical standards. The German Council of Science and Humanities is in charge of and assures its evaluation and approval. Participation is voluntary and based on informed and written consent. The GSOEP is a public use data set that can be obtained from the German Institute for Economic Research (DIW), Berlin, for research[12].

We analysed complete data from 1,355 participants who a) worked in 2006 and in 2011, b) rated work-related effort, reward, and over-commitment at both these time points, c) belonged to a subsample participating in cognitive tests administered through a computer-assisted interview in 2006, as well as d) provided information on relevant co-variates in 2006.

The Symbol Digit Test (SDT) and Animal Naming Test (ANT) from the Wechsler Adult Intelligence Scale were used as measures of cognitive function in 2006. Both tests have been employed in previous epidemiological studies on work-related stress and cognitive function and were modified to ensure applicability in large-scale surveys like the GSOEP[13]. The SDT aims to capture information processing capacities as expressed by perceptual speed, while the ANT assesses verbal fluency, i.e. education- and training-based competencies. These capacities and competencies can be considered as key to deal with time pressure and competition successfully. Higher values indicate better perceptual speed and verbal fluency, respectively. Details on SDT and ANT were reported in our previous normal causation GSOEP study[9]. The test scores were z-standardised for the main analysis and categorised into tertiles for a sensitivity analysis.

In 2006 and 2011, the GSOEP contained the validated short version of the Effort-Reward Imbalance questionnaire which boasted good psychometric properties and included Likert-scaled items for 'effort', 'reward', and 'over-commitment'[14]. Sum scores ranged from 3–15 for 'effort' (Cronbach's alpha=0.74), 7–35 for 'reward' (Cronbach's alpha=0.79), and 6–24 for 'over-commitment' (Cronbach's alpha=0.79). Higher values indicate perceived higher 'effort', 'reward', and 'over-commitment', respectively. The effort-reward ratio was calculated by dividing the effort score by the reward score (weighted by the number of items in the numerator and denominator). Changes in perceived effort, reward, effort-reward ratio and over-commitment were computed by subtracting sum scores in 2006 from sum scores in 2011 as expressed by Delta values. In 2006, information on demographic characteristics (age, gender, marital status) and education, lifestyle behaviours (smoking, alcohol consumption, body mass index), as well as physical and mental health (SF-12 scales) was collected (Cronbach's alpha=0.84 and 0.90 for physical health and mental health, respectively). Physical health covers physical functioning, bodily pain, and general health among other physical aspects, while mental health encompasses episodes of emotional problems, melancholy, and social limitations due to mental health problems within the last four weeks before the interview. A technical description on SF-12 scales was delivered elsewhere, proving the reliability of both scales[15].

Multivariate linear regressions were used to estimate the potential effect of perceptual speed and verbal fluency

Table 1. Characteristics of study subjects (n=1,355)

Characteristics		
Continuous variables		*Mean ± SD*
Age in 2006	yr	41.81 ± 9.61
Education in 2006	yr	12.62 ± 2.66
Physical health (SF-12) in 2006		53.53 ± 7.82
Mental health (SF-12) in 2006		52.92 ± 8.02
Perceptual speed (SDT) in 2006		24.48 ± 14.43
Verbal fluency (ANT) in 2006		22.03 ± 14.15
Effort in 2006		7.08 ± 3.15
Reward in 2006		29.60 ± 5.10
E-R ratio in 2006		0.60 ± 0.37
Over-commitment in 2006		13.01 ± 3.94
Effort in 2011		7.23 ± 3.21
Reward in 2011		30.18 ± 5.08
E-R ratio in 2011		0.60 ± 0.38
Over-commitment in 2011		12.92 ± 4.02
Categorical variables		*N (%)*
Gender in 2006	Men	711 (52.47%)
	Women	644 (47.53%)
Marital status in 2006	Married	891 (65.76%)
	Single	294 (21.70%)
	Separated, divorced, widowed	170 (12.54%)
Smoking in 2006	No	911 (67.23%)
	Yes	444 (32.77%)
Alcohol drinking in 2006	Occasionally, seldom, never	1,106 (81.62%)
	Regularly	249 (18.38%)
BMI in 2006	Normal (<25)	643 (47.45%)
	Overweight (≥25 and <30)	500 (36.90%)
	Obese (≥30)	212 (15.65%)

in 2006 on changes in effort, reward, effort-reward ratio, and over-commitment between 2006 and 2011. First, we adjusted for demographic variables, education and the baseline scores of the respective perceived stressful working conditions (Model I). In two subsequent models, we added lifestyle behaviours (Model II) as well as physical and mental health (Model III) as covariates.

As displayed in Table 1, participants' mean age was 42 yr in 2006. Men and women were equally represented. Two thirds of them were married. Overall, participants had attained a medium level of formal education. Regarding stressful working conditions, scores for perceived effort and reward slightly increased over time, whereas over-commitment scores in 2011 were somewhat lower.

Table 2 shows the results of our main analyses. Neither perceptual speed (SDT) nor verbal fluency (ANT) was associated with changes in perceptions of effort, reward, effort-reward ratio, as well as over-commitment. Likewise, a sensitivity analysis using tertiles as cut-off of SDT and ANT scores (i.e., three levels as high, intermediate and low) revealed no association (results not shown).

These null findings were corroborated by additional cross-sectional analyses using data on SDT, ANT, effort, reward and over-commitment from 2006. Gender-stratified analyses did not disclose systematically different patterns.

This study addressed the reversed causation in associations of perceived stressful work with impaired cognitive health. A link of lower levels of cognitive function with subsequent increases in perceived effort and over-commitment, or a subsequent reduction of perceived reward at work could have been expected for two reasons: First, we may assume that self-reported measures of health affect subsequent self-reported assessment of stressful work ("gloomy perception"[6, 7]). Reduced cognitive function may reinforce a state of negative affectivity and perceived reward deficiency, thereby increasing employees' effort-reward imbalance. This assumption is in line with a recent review documenting relations between cognitive dysfunc-

Table 2. Associations of z-standardized, continuous Perceptual Speed (Symbol Digit Test, SDT) and Verbal Fluency (Animal Naming Test, ANT) in 2006 with perceived changes in stressful working conditions during 2006–2011 (n=1,355)

Perceptual speed	Model I	Model II	Model III
		Effort	
	0.06 (−0.09, 0.22) (p=0.4302)	0.07 (−0.09, 0.22) (p=0.3984)	0.07 (−0.08, 0.23) (p=0.3543)
		Reward	
	0.07 (−0.18, 0.33) (p=0.5725)	0.08 (−0.17, 0.34) (p=0.5405)	0.06 (−0.19, 0.32) (p=0.6276)
		Effort-reward ratio	
	0.00 (−0.01, 0.02) (p=0.6247)	0.00 (−0.01, 0.02) (p=0.6149)	0.00 (−0.01, 0.02) (p=0.5284)
		Over-commitment	
	0.06 (−0.12, 0.25) (p=0.5053)	0.06 (−0.12, 0.25) (p=0.5032)	0.08 (−0.11, 0.26) (p=0.4300)
Verbal fluency	Model I	Model II	Model III
		Effort	
	0.11 (−0.04, 0.27) (p=0.1432)	0.12 (−0.04, 0.27) (p=0.1400)	0.12 (−0.03, 0.27) (p=0.1239)
		Reward	
	−0.04 (−0.30, 0.21) (p=0.7246)	−0.04 (−0.29, 0.22) (p=0.7842)	−0.04 (−0.30, 0.21) (p=0.7290)
		Effort-reward ratio	
	0.01 (−0.01, 0.03) (p=0.2735)	0.01 (−0.01, 0.03) (p=0.2850)	0.01 (−0.01, 0.03) (p=0.2445)
		Over-commitment	
	0.10 (−0.09, 0.28) (p=0.3136)	0.09 (−0.10, 0.28) (p=0.3420)	0.10 (−0.09, 0.28) (p=0.3057)

Multivariate linear regression

Model I: adjusted for age, gender, marital status, education, and ERI measure in 2006.

Model II: Model I + additionally adjusted for smoking, alcohol drinking, and BMI in 2006.

Model III: Model II + additionally adjusted for physical health, and mental health in 2006.

tion, negative affectivity and a state of brain dopamine deficiency[16]. Second, according to the drift hypothesis, reduced health can lead to objectively disadvantaged working conditions[7].

Despite the plausible connection between cognitive function, task accomplishment and job performance, our null findings from both longitudinal and cross-sectional analyses do not support the hypothesis of reversed causation. Although men were shown to exhibit higher scores on perceived effort and on the effort-reward ratio than women in a recent GSOEP investigation[17], gender stratification did not produce findings supportive of the association under this current study.

However, cognitive tests are designed to measure the maximum level of the respective cognitive ability, which is not necessarily needed in the workplace[18]. Instead, other psychosocial factors like motivation and experience may partly counter-balance cognitive impairments. Regarding over-commitment, repeated failure experiences due to reduced cognitive ability could result in resignation[11], thereby diminishing the work motivation inherent to over-commitment and outweighing the impact of compensatory efforts to meet work requirements in our data.

Our study suffers from several drawbacks. First, with just two time points only five years apart and the second time point of prospective measurement not matching with 2012 in our earlier normal causation GSOEP study[9], we were not able to model if or to what extent cognitive function and components of perceived work stress reinforce each other over time and to provide proof of a vicious circle[7]. Second, data on covariates were not available in 2011, which is why we were unable to account for changes in lifestyle behaviours as well as in physical and mental health. Third, the GSOEP only includes two cognitive

tests, which fall short of characterising a comprehensive profile of cognitive function. Fourth, the GSOEP questionnaire did not contain information on job changes, job tenure, or changes in the work environment. Accordingly, we do not know to what extent these changes might have influenced the reported associations. Finally, cognitive ability and measures of intelligence may account for early exit from labour market including long-term sickness absence and disability retirement[19, 20]. Unfortunately, GSOEP does not provide solid data on employment outcomes. Hence, we cannot rule out the healthy worker survivor effect.

In conclusion, our preliminary results from both GSOEP studies suggest that preventive interventions may target at adverse stressful working conditions in the first place and be complemented by stress management interventions at the individual level[21].

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Conflict of Interests

None declared.

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