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Does Match Really Matter? The Moderating Role of Resources in the Relation between Demands, Vigor and Fatigue in Academic Life

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ABSTRACT
The goal of the present study is to examine the moderating role of resources at work or study in the relation between demands, vigor, and fatigue in academic life. Trying to replicate scarce research on both academic and student stress simultaneously, we tested the so-called triple-match principle in an academic context to study whether or not match between specific resources, demands and well-being/health outcomes does really matter. A cross-sectional survey study using online self-completion questionnaires was carried out among 96 academics and 221 engineering students from a technological university ($n = 317$ in total). Findings showed a moderating, matching, role of resources in the association between demands, vigor, and particularly fatigue. Specifically, high cognitive resources strengthened the positive relation between cognitive demands and cognitive liveliness. In addition, high emotional resources buffered the positive association between emotional demands and successively emotional, cognitive and physical fatigue. This study reveals that matching resources are important in academic life. Therefore, it seems essential to create an appropriate equilibrium between specific resources and corresponding demands to promote academic well-being and health.

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Vigor; fatigue; triple-match principle; academic staff; engineering students

Introduction

Academic life at universities today can be very stressful (e.g. Han et al., 2020; Mark & Smith, 2018; Usher & Curran, 2019). There is evidence that the level of stress at universities has increased in the past years (e.g. Mudrak et al., 2018; Ribeiro et al., 2018; Williams et al., 2017). Factors associated with stress in academics include time pressure, high workload, work-home conflict, lack of job autonomy, lack of workplace social support, lack of promotion prospects, job insecurity, high bureaucracy, and lack of support services (e.g. Mark & Smith, 2018; Mudrak et al., 2018; Winefield et al., 2014). As a consequence, work stress in academic life is associated with poor well-being and adverse health (e.g. Han et al., 2020; Mark & Smith, 2018; Williams et al., 2017).

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Stress at universities has implications not only for academic staff but also for university students (Salmela-Aro & Read, 2017; Zeijen et al., 2021). Core activities of university students can be labeled 'work', despite the fact they are not employed (Chambel & Curral, 2005; Rahmati, 2015). Like academic staff, students have to deal with time pressure, high workload, tight deadlines, high bureaucracy, and work-home conflict (e.g. Chambel & Curral, 2005; Kyndt et al., 2014). Researchers have revealed mounting levels of stress among students accordingly, largely due to academic obligations, career expectations, and interpersonal difficulties (e.g. Bedewy & Gabriel, 2015; García-Ros et al., 2012; Ribeiro et al., 2018), but also due to high study demands and low study resources (Salmela-Aro & Read, 2017). In addition, more and more university students have to unite their studies with paid work activities that support their finances in situations where they do not get sufficient financial support to study (Chacón-Cuberos et al., 2019; Sánchez-Gelabert et al., 2017). This has increased their work stress as well (Creed et al., 2015; Taylor et al., 2020). So, what university students do is rather identical to the tasks and duties of academic staff. This implies that theoretical links can be studied between (1) academics' and students' working environment and (2) their well-being and health.

To summarize, both academic staff and university students are suffering from increased work stress. As there is little research focusing on both staff and student stress simultaneously, one of this study's contributions is to fill this gap.

Theoretical Background

According to modern work stress models, work-related well-being and health can be explained by at least two key job characteristics: (1) job demands and (2) job resources (e.g. De Jonge & Dormann, 2017). Job demands can be defined as tasks that require immediate or prolonged effort, and vary from solving complex problems *via* dealing with very demanding emotions to moving heavy objects. Job resources are assets present in a person's work (such as data, people, and devices) that can be employed to deal with those job demands (Van den Tooren et al., 2011). Specific examples of job resources are job or study autonomy, emotional support from colleagues or fellow-students, and technical equipment. Work stress research has predominantly tried to establish these key job characteristics in a rather broad way which are therefore universally applicable. For example, according to Karasek and Theorell's (1990) Job Demand-Control Model, stressful work is characterized by high job demands and low job decision latitude (i.e. job control). Or, according to the Job Demands-Resources Model of Demerouti et al. (2001), any job demand and any job resource may affect employee health and motivation, as long as these demands and resources are a salient aspect of a particular job (see also Mudrak et al., 2018). Such universal approaches to work stress have been very successful so far, both in their influence on research and on practice (De Jonge et al., 2014). However, the idea that measures of job characteristics need to be more specific and targeted, and the practical imperative of finding ways to attenuate the harmful effects of job demands have opened new research avenues. For instance, in the social support literature, workplace social support buffers against work stress especially when workplace social support is targeted toward a specific job demand (e.g. Cohen & Wills, 1985).

A theoretical model that has been developed to explain the moderating role of *specific* job resources in the relation between *specific* job demands and *specific* well-being/ health outcomes, is the Demand-Induced Strain Compensation (DISC) Model (De Jonge & Dormann, 2003; 2006). Contrary to other work stress models, the DISC Model states in general that moderating effects of job resources largely depend on the notion of 'match' or 'correspondence' between different kinds of job demands and job resources (De Jonge et al., 2019; Van den Tooren et al., 2011). Specifically, the model consists of two key principles; that is, (1) the multidimensionality principle, and (2) the triple-match principle (De Jonge & Dormann, 2003, 2017). The multidimensionality principle was introduced by De Jonge and Dormann in 2003, and proposes that job demands, job resources, and well-being/health outcomes consist at a very basic level of at least cognitive, emotional, and physical elements. Job demands can be primarily cognitive (e.g. high levels of necessary concentration and high complexity), emotional (e.g. having to handle emotions due to a conflict), or physical (e.g. having to bend and/or to stretch a lot). A similar distinction is possible for job resources, which can be primarily cognitive (e.g. having the opportunity to decide your own work or study method), emotional (e.g. getting emotional support from others), or physical (e.g. being able to use adequate ergonomic devices). Finally, the model distinguishes well-being/health outcomes of cognitive, emotional, and physical nature, which can be either negative (e.g. concentration problems, emotional exhaustion, and physical health complaints) or positive (e.g. competence, emotional energy, and physical strength) (Van de Ven et al., 2014).

The DISC Model's second key principle is the so-called triple-match principle, abbreviated TMP (De Jonge & Dormann, 2003, 2006). This principle claims that the moderating role of resources is particularly observed if both demands and resources as well as outcomes are based on corresponding elements. To put it differently, the moderating role of resources at work or study is based on the issue of match. Here, match refers to a so-called complementary fit between demands and resources (Van den Tooren et al., 2011), whereby resources provide the optimal power or strength that is needed to deal with the particular demands. For instance, if people need to move a heavy object (e.g. a desk), instrumental support from colleagues or fellow-students will provide the optimal power needed to deal with the physically demanding task in question. Other forms of social support, like a listening ear from colleagues or fellow-students, seem to be less helpful in this situation. Because physical resources show a complementary fit to physical demands, it follows that physical resources are most likely to mitigate the adverse effect of high physical demands on health and well-being (Van den Tooren et al., 2011).

Moreover, the TMP states not only that demands and resources should match, but also that they should match well-being/health outcomes (cf. Frese, 1999). In addition, the DISC Model proposes that high demands stimulate positive psychological outcomes best as long as people have sufficient corresponding kinds of resources (e.g. De Jonge et al., 2019). In the case people have relatively high boosting resources, they can explore different ways of dealing with their demands. The matching combination of demands and resources could then result in positive outcomes such as creativity, liveliness and growth (e.g. De Jonge et al., 2019). For example, a study task which is cognitively challenging (e.g. having to make a complex assignment) may stimulate learning, growth and cognitive liveliness only in the case of relatively high cognitive resources (e.g. study autonomy or access to information).

The DISC Model proposes in general that people will first deal with demands at work or study using easily available or accessible matching resources (De Jonge et al., 2019; De Jonge & Dormann, 2017). However, if these matching resources are not present, or are drained, people will search for other resources that are less fitting. In the case those less-matching resources are not available, or are drained, people will then use resources that do not correspond at all to their demands. In addition to triple-matches, the DISC Model also differentiates two kinds of so-called double-matches that are weaker in terms of complementary fit (i.e. only two out of three constructs match) and thus less likely to occur than triple-matches. For example, a study by De Jonge et al. (2008) among 826 health care professionals showed such a double-match between high emotional demands (e.g. aggressive patients) and high emotional resources (e.g. emotional support from a supervisor) in the prediction of employee creativity (i.e. a cognitive outcome). Although this kind of double-match is known as the regular matching hypothesis (De Jonge & Dormann, 2017), it is referred to as a 'double-match of common kind' in the context of the TMP. That is, there is a common match between demands and resources, while the outcome measure comprises a deviant component. In a similar vein, there could be a double-match between demands and outcomes when resources comprise a deviant component. For instance, an association between emotional demands (e.g. an insolent customer) and emotional fatigue is moderated by physical resources (e.g. instrumental support from colleagues). This notion of match is introduced by Frese (1999) and is referred to as a 'double-match of extended kind'. Finally, in the case of a non-match between all constructs, moderating effects of resources are least likely to take place, or even do not happen at all. That is, when both demands and resources as well as outcomes are all different in nature (e.g. a relation between cognitive demands and emotional fatigue that is moderated by physical resources). In sum, the TMP proposes that the likelihood of finding moderating effects of resources increases as the level of match between demands, resources, and outcomes increases (De Jonge & Dormann, 2017).

Aim, Research Question and Hypotheses

In this survey study, we will try to replicate former and scarce stress research among both academic staff and university students (e.g. De Jonge et al., 2019; Mudrak et al., 2018; Salmela-Aro & Read, 2017) by studying the moderating role of specific resources at work or study in the relation between specific demands and well-being/health outcomes in a new sample. The key question is: does match really matter? The DISC Model's triple-match principle will be tested using both a positive and a negative well-being/health marker: vigor and fatigue. Vigor refers to individual's feelings that s/he possesses cognitive liveliness, emotional energy and physical strength, and represents a moderate-intensity affect experienced at work or study (Shirom, 2011). Fatigue is generally defined as a sense of persistent tiredness or exhaustion, and may be experienced by individuals in different dimensions as cognitive, emotional and physical exhaustion (Stein et al., 2004). These work-related outcomes can be seen as representatives of healthy and vital organizations (De Jonge & Peeters, 2019), and have also been used in studies among academic staff and students (e.g. De Jonge et al., 2019; Salmela-Aro & Read, 2017). As a consequence, the following six hypotheses are formulated, each reflecting a particular outcome:

Hypothesis 1: The relation between cognitive demands and cognitive vigor (i.e., cognitive liveliness) will be moderated by cognitive resources, such that this relation will be stronger for people with high cognitive resources than for people with low cognitive resources.

Hypothesis 2: The relation between emotional demands and emotional vigor (i.e., emotional energy) will be moderated by emotional resources, such that this relation will be stronger for people with high emotional resources than for people with low emotional resources.

Hypothesis 3: The relation between physical demands and physical vigor (i.e., physical strength) will be moderated by physical resources, such that this relation will be stronger for people with high physical resources than for people with low physical resources.

Hypothesis 4: The relation between cognitive demands and cognitive fatigue will be moderated by cognitive resources, such that this relation will be weaker for people with high cognitive resources than for people with low cognitive resources.

Hypothesis 5: The relation between emotional demands and emotional fatigue will be moderated by emotional resources, such that this relation will be weaker for people with high emotional resources than for people with low emotional resources.

Hypothesis 6: The relation between physical demands and physical fatigue will be moderated by physical resources, such that this relation will be weaker for people with high physical resources than for people with low physical resources.

Furthermore, researchers conducted two large narrative review studies in different occupational groups from different countries to evaluate the empirical evidence for the DISC Model's TMP, and revealed that the TMP received empirical support (Van de Ven, 2011; Van den Tooren et al., 2011). Moreover, a cross-sectional study among academics showed support for the TMP as well (De Jonge et al., 2019). All these studies showed that triple-matches were more likely to be found than double-matches or non-matches. In agreement with these empirical findings, the seventh and final hypothesis is:

Hypothesis 7: Triple-match interactions between demands, resources, and outcomes are most likely to occur, followed by double-match interactions of common kind, followed by double-match interactions of extended kind, and finally followed by non-matching interactions.

Method

Design and Participants

A cross-sectional survey study was performed using online self-administered questionnaires. Academic staff and engineering students of a technological university in the Netherlands received an email message with a link to the survey. The email was distributed *via* the Human Resources department and the Central Student Administration. The survey was implemented as an online questionnaire using Google Forms. The participants could respond to the questionnaire during four weeks. After two weeks, everybody received an email reminder to fill out the survey. The total sample included 317 respondents: 30.3% of them were academic staff (96 people), and 69.7% of them were engineering students (221 people). The majority of the academics (60.4%) was male, and 64.3% of the students were male. Mean age of academic staff was 38.8 years (SD = 13.9), and mean age of students was 21.8 years (SD = 3.4). Median education of the total sample was a Bachelor's degree. Most of the respondents had a Dutch nationality (84.3%).

Instruments

Demands and Resources

Demands and resources at work or study were measured with the English version of the well-validated DISC Questionnaire, version 2.1 (DISQ 2.1 UK; De Jonge et al., 2009). The DISQ entails six scales for cognitive, emotional, and physical demands and resources. The scales consist of four items each, except for the emotional demands, emotional resources and cognitive resources scales, which have five items each. All items were rated on a 5-point frequency scale ranging from 1 (never or very rarely) to 5 (very often or always). Example items for demands at work or study are 'I have to make complex decisions at work/study' (cognitive; Cronbach's α's for students and employees are 0.68 and 0.74, respectively), 'I have to expend a lot of emotionally draining work' (emotional; Cronbach's α's are 0.74 and 0.81), and 'I have to perform physical activities in uncomfortable or impractical postures' (physical; Cronbach's α's are 0.70 and 0.71). Example items of resources at work or study are 'I have the opportunity to determine my own work method' (cognitive; Cronbach's α's are 0.61 and 0.62), 'I get emotional support from others when an upsetting situation occurs' (emotional; Cronbach's α's are 0.82 and 0.78), and 'I have the opportunity to take a physical break when things get physically strenuous' (physical; Cronbach's α's are 0.77 and 0.86). To test the construct validity and measurement invariance of the DISQ scales in both groups simultaneously, we performed multi-group confirmatory factor analysis (MGCFA; Milfont & Fischer, 2010) using LISREL 9.30 (Jöreskog et al., 2016). Model tests were based upon covariance matrices and used maximum likelihood estimation. Because non-significant chi-square test values are rarely obtained in this kind of analysis, we also used other fit indices such as the root mean squared error of approximation (RMSEA), the non-normed fit index (NNFI), and the comparative fit index (CFI) as recommended by Hair et al. (2014). In line with Milfont and Fischer (2010), two important models were investigated: (1) metric invariance and (2) factor covariance invariance. The first model was tested by constraining all factor loadings to be equal across groups, whereas the second model was tested by constraining all factor covariances to be the same across groups. As the models estimated stand in a nested sequence, the relative fit of the models was tested through use of a chi-square differences test ($\Delta\chi^2$; Jöreskog et al., 2016). The MGCFAs for demands (3-factor structure) showed both metric invariance ($\Delta\chi^2(13) = 20.08$, $p < 0.05$) and factor covariance invariance ($\Delta\chi^2(3) = 9.26$, $p < 0.05$). This implies that factor loadings as well as factor structure are equal in both groups. The best fitting model had good fit indices (RMSEA = 0.05, NNFI = 0.96, CFI = 0.96), though the overall chi-square test was significant ($\chi^2(140) = 199.65$, $p < 0.001$). As far as the 3-factor structure of resources is concerned, the MGCFAs revealed metric invariance ($\Delta\chi^2(14) = 40.91$, $p < 0.05$) as well as factor covariance invariance ($\Delta\chi^2(3) = 8.56$, $p < 0.05$). Again, both factor loadings and factor structure are equal in both groups. Despite the overall chi-square test was significant ($\chi^2(165) = 441.69$, $p < 0.001$), the ultimate model had reasonable other fit indices (RMSEA = 0.08, NNFI = 0.92, CFI = 0.93),

Vigor

The Shirom–Melamed Vigor Measure (SMVM) was used to measure employee or student vigor. This instrument was tested and validated in a huge number of empirical studies in different countries (Shirom, 2004, 2011). The SMVM measures three different components of vigor; i.e. cognitive liveliness (three items), emotional energy (four items) and physical strength (five items). Academics and students had to report how often they displayed these feelings during a one-month time period. All items were rated on a 7-point Likert scale, ranging from 1 (almost never) to 7 (almost always). For instance, 'I feel I am able to contribute new ideas' (cognitive liveliness; Cronbach's α's for students and employees are 0.78 and 0.85, respectively); 'I feel capable of investing emotionally in people' (emotional energy; Cronbach's α's are 0.92 and 0.93); 'I feel energetic' (physical energy; Cronbach's α's are 0.92 and 0.94). The MGCFAs for the 3-factor structure of vigor showed both metric invariance ($\Delta\chi^2(12) = 22.13$, $p < 0.05$) and factor covariance invariance ($\Delta\chi^2(3) = 9.57$, $p < 0.05$). This implies that factor loadings as well as factor structure are equal in both groups. The best fitting model had good fit indices (RMSEA = 0.06, NNFI = 0.97, CFI = 0.97), although the overall chi-square test was significant ($\chi^2(117) = 235.40$, $p < 0.001$)

Fatigue

To measure employee and student fatigue, the Multidimensional Fatigue Symptom Inventory–Short Form (MFSI–SF) was used (Stein et al., 1998, 2004). This instrument reflects three different fatigue scales; i.e. cognitive, emotional, and physical fatigue. Academic staff and students had to agree or disagree with 18 statements during a one-month time period, on a 5-point Likert scale that ranged from 1 (not at all) to 5 (extremely). The three scales had six items each. For example, 'I am unable to concentrate' (cognitive fatigue; Cronbach's α's for students and employees are 0.86 and 0.83, respectively); 'I feel upset' (emotional fatigue; Cronbach's α's are 0.91 and 0.89); 'I ache all over' (physical fatigue; Cronbach's α's are 0.88 and 0.86). With regard to the 3-factor structure of fatigue, the MGCFAs revealed metric invariance ($\Delta\chi^2(18) = 29.96$, $p < 0.05$) as well as factor covariance invariance ($\Delta\chi^2(3) = 8.37$, $p < 0.05$). Again, both factor loadings and factor structure are the same in both groups. The overall chi-square test was significant ($\chi^2(285) = 834.76$, $p < 0.001$), but the ultimate model had good other fit indices (RMSEA = 0.06, NNFI = 0.95, CFI = 0.96),

Demographic Characteristics

Demographic characteristics included were gender (0 = female; 1 = male), age (years), educational level (1 = low level to 7 = high level), and nationality (0 = non-Dutch;

1 = Dutch). These confounding characteristics were rather crucial in other research among academics and students (e.g. De Jonge et al., 2019; Ribeiro et al., 2018). They were also significantly related to the vigor and fatigue measures in the present study (see Table 1).

Data Analysis

We performed three different statistical analyses in IBM SPSS® for Windows, version 27. Firstly, psychometrical analyses were employed to determine construct validity, measurement invariance, and internal consistency of the multi-group, multi-item, instruments. Secondly, we computed means, standard deviations, and Pearson correlations to get a first impression of the data. Finally, we used multiple regression analyses (MRAs) in a hierarchical way to examine assumed associations between demands, resources, vigor and fatigue.

As no significant violations of linear regression assumptions were detected, the MRAs were performed with forced entry of variables within each hierarchical step (cf. De Jonge et al., 2019). In the first step, we introduced demographic characteristics and standardized main terms of demands and resources. In the second step, we tested moderating effects of resources by adding multiplicative interaction terms of standardized demands and resources into the MRAs (cf. Aiken & West, 1991). Two different series of MRAs (twelve MRAs in total) were carried out due to the relatively large number of possible interaction effects in one single analysis. In line with suggestions of De Jonge and Dormann (2006), we split the analyses into matching and non-matching demands-resources interaction testing. So, the first series of six MRAs tested three triple-matches and six double-matches of common kind for both vigor and fatigue. The second series of six MRAs tested twelve double-matches of extended kind and six non-matches for each outcome measure, respectively. Furthermore, if a significant moderating effect is in agreement with our theoretical framework, it is tagged a theoretically valid triple-match, double-match, or non-match. However, if a significant moderating effect is not in line with our framework, it is tagged a theoretically non-valid triple-match, double-match, or non-match (Van den Tooren et al., 2011). Following the recommendations of Aiken and West (1991), moderating effects were graphically represented. In addition, slope significance tests of the simple regression lines were performed (Dawson & Richter, 2006).

Finally, we checked if it would be necessary to split the sample in academic staff and students, and to perform subgroup regression analyses (Aiken & West, 1991, see also De Jonge et al., 2019). For that reason, we created a dummy variable depicting the academics' or students' subgroup (0 = student; 1 = academics) and entered this variable in each regression model. Six subgroup tests were conducted; that is, three for vigor and three for fatigue. Only one out of these six tests (16.6%; for cognitive liveliness only) showed significantly different regression models between staff and students.[1] For that reason, and given the invariance of measures in both groups, we decided to conduct the twelve MRAs on the whole sample, and corrected for academics and students by means of a dummy variable in the first hierarchical step of the analysis (cf. Aiken & West, 1991).

Table 1. Means (M), standard deviations (SD) and Pearson correlations among study variables ($n = 317$).

Variables	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Age	26.64	11.00																
2. Gender	0.63	0.48	−0.05															
3. Education	4.64	1.31	0.55 **	0.12 *														
4. Nationality	0.84	0.37	−0.05	−0.07	−0.23 **													
5. Employee/ Student	0.30	0.46	0.71 **	−0.09	0.61 **	−0.15 *												
6. Cognitive Demands	3.77	0.62	0.06	0.12 *	0.22 **	−0.13 *	0.08											
7. Emotional Demands	2.17	0.75	0.10	−0.13	0.03	−0.03	0.01	0.31 **										
8. Physical Demands	1.46	0.59	−0.11	0.06	−0.09	−0.10	−0.13 *	0.07	0.32 **									
9. Cognitive Resources	3.83	0.57	−0.05	0.08	0.12	0.05	0.00	−0.09	−0.33 **	−0.16 **								
10. Emotional Resources	3.50	0.71	0.03	−0.06	0.09	−0.04	0.02	0.06	−0.19 **	−0.08	0.49 **							
11. Physical Resources	3.48	0.90	0.07	0.02	0.18 **	−0.10	0.08	−0.01	−0.11	−0.12 *	0.30 **	0.27 **						
12. Cognitive Fatigue	2.28	0.83	−0.12 *	−0.03	−0.14 *	−0.12 *	−0.18 **	0.10	0.40 **	0.19 **	−0.32 **	−0.28 **	−0.17 **					
13. Emotional Fatigue	2.20	0.92	−0.11	−0.06	−0.13 *	−0.10	−0.16 **	0.23 **	0.47 **	0.21 **	−0.31 **	−0.28 **	−0.13 *	0.73 **				
14. Physical Fatigue	1.84	0.78	0.03	−0.13 *	0.01	−0.09	−0.00	0.10	0.36 **	0.25 **	−0.32 **	−0.29 **	−0.13 *	0.58 **	0.60 **			
15. Cognitive Liveliness	5.07	1.16	−0.05	0.10	0.08	0.05	0.07	0.08	−0.24 **	−0.06	0.39 **	0.35 **	0.09	−0.42 **	−0.43 **	−0.26 **		
16. Emotional Energy	5.27	1.17	0.01	−0.12 *	−0.03	−0.02	−0.02	0.07	0.02	−0.01	0.23 **	0.49 **	0.17 **	−0.21 **	−0.16 **	−0.22 **	0.33 **	
17. Physical Strength	4.70	1.14	0.10	−0.00	0.07	0.01	0.12 *	0.00	−0.19 **	0.04	0.27 **	0.36 **	0.13 *	−0.53 **	−0.55 **	−0.50 **	0.49 **	0.40 **

* significant at $p < 0.05$; ** significant at $p < 0.01$ (two-tailed).

Results

First, Table 1 shows that all but one demands were significantly and positively associated with the three fatigue outcomes. Only cognitive demands were not significantly related to cognitive and physical fatigue, despite the sign of the associations was in the expected direction. Next, emotional demands were negatively related to cognitive liveliness and physical strength. Finally, all resources were negatively associated with all fatigue outcomes, and all but one resources were positively related to all vigor outcomes. Only physical resources were not related to cognitive liveliness.

Predictors of Vigor

We tested all demands and resources as well as their interactions as predictors of the three vigor outcomes, controlled for demographic characteristics.

Table 2 shows the six MRAs for the tests of triple-matches and double-matches of common kind interactions between demands and resources. One interaction model and two main-effect models were significant. Note that we did not show interaction effects in the case of significant main-effect models only. The interaction model concerns a triple-match for cognitive liveliness, which is graphically represented in Figure 1. Specifically, the interaction of cognitive demands and cognitive resources in prediction of cognitive liveliness was significant ($b = 0.13$, $p = 0.046$). Simple slope tests showed a significant slope for high cognitive resources. The triple-match interaction effect indicates that an increase in cognitive demands was related to more cognitive liveliness in the case of high cognitive resources (+1 SD; $t = 2.74$, $p = 0.007$). However, there was no significant association between cognitive demands and cognitive liveliness in the case of low cognitive resources (−1 SD; $t = 0.37$, $p = 0.715$).

The other two outcomes of vigor showed two main-effect models to be significant. Specifically, emotional resources were positively related to both emotional energy ($b = 0.55$, $p < 0.001$) and physical strength ($b = 0.31$, $p < 0.001$). As far as demands are concerned, emotional demands were negatively associated with physical strength ($b = -0.19$, $p = 0.012$), whereas physical demands were positively associated with physical strength ($b = 0.18$, $p = 0.014$). In general, the explained variance (R^2) was 0.26 for cognitive liveliness, 0.27 for emotional energy, and 0.19 for physical strength.

Predictors of Fatigue

Similar to vigor, we tested all demands and resources as well as their interactions as predictors of the three fatigue outcomes, controlled for demographic characteristics, too (see Table 2). Table 2 shows that all three interaction models with regard to fatigue were significant. First, the triple-match interaction of emotional demands and emotional resources in the prediction of emotional fatigue was significant ($b = -0.09$, $p = 0.041$). The graphical representation can be found in Figure 2, in which the simple slopes for both low and high emotional resources were significantly different from zero. As can be seen, an increase in emotional demands was associated with more emotional fatigue both at low levels of emotional resources (−1 SD; $t = 5.04$, $p < 0.001$) and at high levels of emotional resources (+1 SD; $t = 2.71$, $p = 0.007$). However, at high levels of emotional

Table 2. Multiple regression models of vigor and fatigue with triple-match and double-match of common kind interactions ($n = 317$).

	Dependent variable											
	Vigor						Fatigue					
	Cognitive liveliness		Emotional energy		Physical strength		Cognitive		Emotional		Physical	
Predictor variables	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
Control variables												
Age	−0.02 *	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.00	0.01	0.00	0.01
Gender	0.20	0.13	−0.17	0.14	0.00	0.14	−0.02	0.10	−0.11	0.10	−0.20 *	0.09
Education	−0.03	0.07	−0.09	0.07	−0.07	0.07	−0.02	0.05	−0.05	0.05	0.05	0.05
Nationality	0.27	0.18	−0.04	0.18	0.12	0.19	−0.34	0.13	−0.31 *	0.14	−0.12	0.13
Employee/Student	0.55 **	0.22	0.02	0.22	0.33	0.22	−0.30	0.16	−0.30	0.17	−0.10	0.15
Demands and resources												
Cognitive demands	0.17 *	0.07	0.05	0.07	0.05	0.07	−0.01	0.05	0.12 *	0.05	0.01	0.05
Emotional demands	−0.16 *	0.07	0.12	0.07	−0.19 *	0.07	0.25 ***	0.05	0.30 ***	0.06	0.14 **	0.05
Physical demands	0.04	0.07	0.00	0.07	0.18 *	0.07	0.02	0.05	0.03	0.05	0.13 **	0.05
Cognitive resources	0.25 **	0.08	0.04	0.08	0.13	0.08	−0.07	0.06	−0.03	0.06	−0.09	0.06
Emotional resources	0.25 ***	0.07	0.55 ***	0.07	0.31 ***	0.08	−0.11 *	0.05	−0.17 **	0.06	−0.15 **	0.05
Physical resources	−0.05	0.07	0.07	0.07	0.01	0.07	−0.05	0.05	−0.01	0.05	−0.02	0.05
Interaction effects												
Cogn. demands × cogn. resources	0.13 * T	0.06					−0.05 T	0.05	−0.07 D	0.05	0.02 D	0.04
Emot. demands × emot. resources	0.01 D	0.06					−0.08 * D	0.04	−0.09 * T	0.04	−0.08 * D	0.04
Phys. demands × phys. resources	0.01 D	0.08					0.02 D	0.06	−0.01 D	0.06	−0.06 T	0.05
Model test	$R^2 = 0.26$ F (14, 302) = 6.29 ***		$R^2 = 0.27$ F (11, 305) = 8.50 ***		$R^2 = 0.19$ F (11, 305) = 5.40 ***		$R^2 = 0.29$ F (14, 302) = 7.36 ***		$R^2 = 0.35$ F (14, 302) = 9.56 ***		$R^2 = 0.25$ F (14, 302) = 6.01 ***	
Delta R^2 interaction model	0.02						0.02		0.03		0.02	

Note. Six MRAs performed. Cogn. = cognitive; Emot. = emotional; Phys. = physical; T = triple-match; D = double-match. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed).

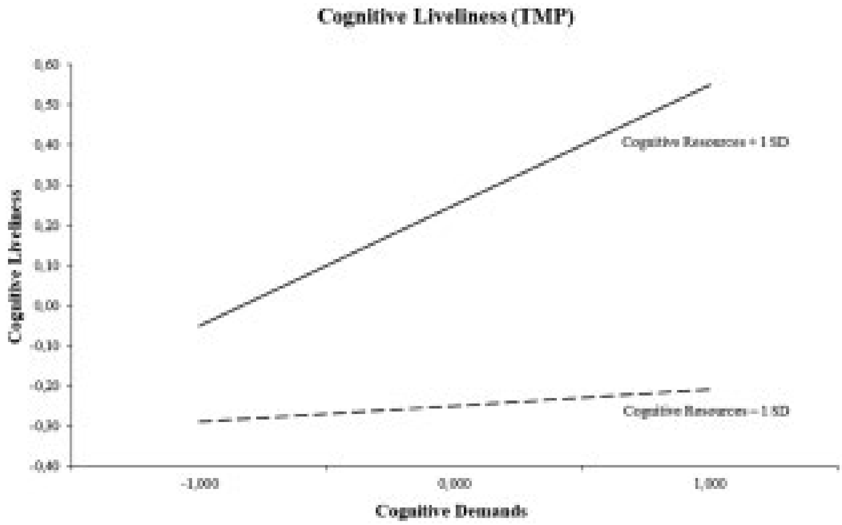

Figure 1. Triple-match interaction (TMP) between cognitive demands and cognitive resources for cognitive liveliness.

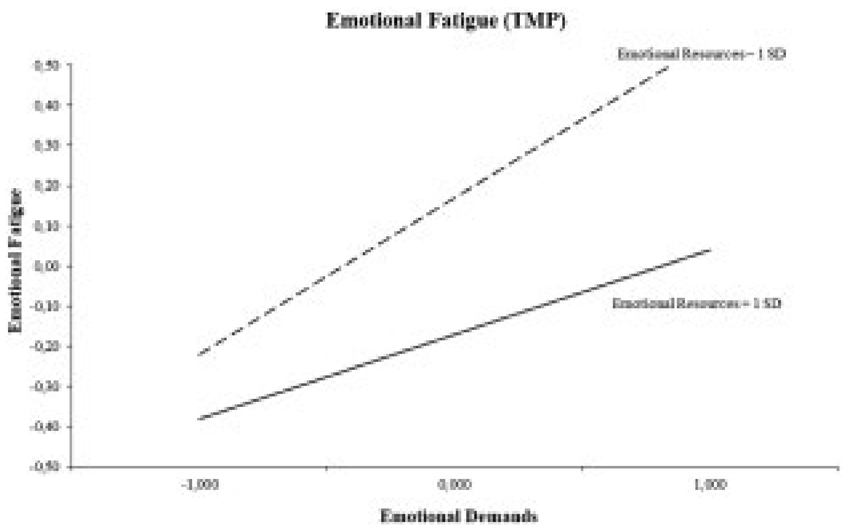

Figure 2. Triple-match interaction (TMP) between emotional demands and emotional resources for emotional fatigue.

resources, the positive association between emotional demands and emotional fatigue became weakened.

Second, a double-match of common kind interaction was significant; i.e. the interaction of emotional demands with emotional resources in the prediction of cognitive fatigue ($b = -0.08$, $p = 0.038$). Simple slope tests showed a significant slope for both low and high emotional resources. Figure 3 indicates that an increase in emotional demands was related to more cognitive fatigue particularly when emotional resources were at a low level (−1 SD; $t = 4.26$, $p < 0.001$). In the case of high emotional resources

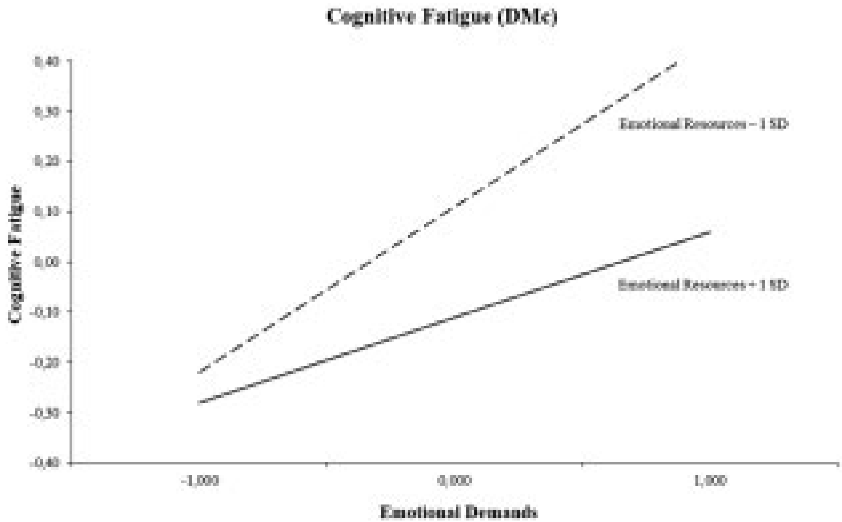

Figure 3. Double-match interaction of common kind (DMc) between emotional demands and emotional resources for cognitive fatigue.

(+1 SD; $t = 2.20$, $p = 0.029$), the positive association between emotional demands and cognitive fatigue was weakened.

Third, a double-match of common kind interaction occurred regarding physical fatigue. More specifically, the interaction of emotional demands with emotional resources in the prediction of physical fatigue was significant ($b = -0.08$, $p = 0.039$). Simple slope tests showed a significant slope for low emotional resources. Figure 4 indicates that high emotional demands were associated with high physical fatigue when emotional resources were low (−1 SD; $t = 2.84$, $p = 0.005$). Emotional demands were not related to physical fatigue when emotional resources were high (+1 SD; $t = 0.78$, $p = 0.439$).

According to Aiken and West (1991), main effects within interaction models could provide some meaningful information as well. Cognitive demands were positively related to emotional fatigue ($b = 0.12$, $p = 0.027$), while physical demands were positively related to physical fatigue ($b = 0.13$, $p = 0.009$).

Finally, the explained variances (R^2s) were 0.29, 0.35 and 0.25 for cognitive, emotional, and physical fatigue, respectively.

Double-Match of Extended Kind and Non-Match Interactions

To check all possible, alternative, conditions to enable a comprehensive test of the DISC Model, we tested all remaining double-match of extended kind and non-match interactions (De Jonge & Dormann, 2006). The six MRAs in Table 3 show one significant interaction model with regard to physical fatigue only. Specifically, one double-match of extended kind occurred, involving the interaction of physical demands and emotional resources in the prediction of physical fatigue ($b = 0.13$, $p = 0.032$). Simple slope tests revealed a significant slope for high emotional

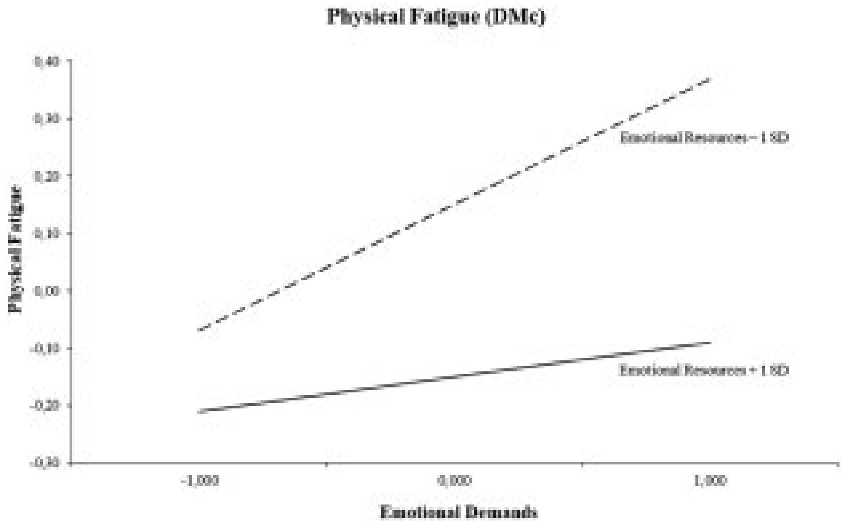

Figure 4. Double-match interaction of common kind (DMc) between emotional demands and emotional resources for physical fatigue.

resources. Figure 5 shows that an increase in physical demands was related to more physical fatigue in the case of high emotional resources (+1 SD; $t = 3.47$, $p = 0.001$). However, there was no association between physical demands and physical fatigue in the case of low emotional resources (−1 SD; $t = -0.14$, $p = 0.886$). In general, the shape of this double-match of extended kind interaction was against the DISC Model's assumptions. Therefore, it is characterized as a non-valid interaction effect.

Finally, the explained variances for these remaining tests ranged from $R^2 = 0.19$ (physical strength) to $R^2 = 0.32$ (emotional fatigue).

Interaction Patterns

With regard to the final hypothesis, Table 4 summarizes the comparison of the overall pattern of interactions with the degree of match. The last column of Table 4 shows the ratio of valid interactions (i.e. interactions that are in line with our model's assumptions) and interactions tested. Findings revealed 0 out of 12 non-match interactions (0.0% valid interactions), 1 (though non-valid) out of 24 tested double-match of extended kind interactions (0.0% valid interactions), 2 out of 12 tested double-match of common kind interactions (16.7% valid interactions) and finally 2 out of 6 significant triple-match interactions (33.3% valid interactions). It appears that this ratio of valid interaction effects/interactions tested was positively associated with the degree of match.

Discussion

This cross-sectional survey study investigated the moderating role of specific resources at work or study in the relation between demands, vigor and fatigue in academic life.

Table 3. Multiple regression models of vigor and fatigue with double-match of extended kind and non-match interactions ($n = 317$).

	Dependent variable											
	Vigor						Fatigue					
	Cognitive liveliness		Emotional energy		Physical Strength		Cognitive		Emotional		Physical	
Predictor variables	B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
Control variables												
Age	−0.02 *	0.01	0.00	0.01	0.01	0.01	−0.02	0.01	−0.00	0.01	0.00	0.01
Gender	0.18	0.13	−0.17	0.14	0.03	0.14	−0.02	0.10	−0.10	0.10	−0.22 *	0.10
Education	−0.02	0.07	−0.09	0.07	−0.07	0.07	−0.02	0.05	−0.05	0.05	0.04	0.05
Nationality	0.25	0.18	−0.04	0.18	0.12	0.19	−0.32 *	0.13	−0.30 *	0.14	−0.12	0.13
Employee/Student	0.51 *	0.22	0.02	0.22	0.33	0.22	−0.29	0.16	−0.28	0.17	−0.11	0.15
Demands and resources												
Cognitive demands	0.16 **	0.07	0.05	0.07	0.05	0.07	0.01	0.05	0.13 *	0.05	0.02	0.05
Emotional demands	−0.17 *	0.07	0.12	0.07	−0.19 *	0.07	0.27 ***	0.05	0.32 **	0.06	0.15 **	0.05
Physical demands	0.04	0.07	0.00	0.07	0.18 *	0.07	0.01	0.05	0.03	0.05	0.12 *	0.05
Cognitive resources	0.29 ***	0.08	0.04	0.08	0.13	0.08	−0.09	0.06	−0.06	0.06	−0.08	0.06
Emotional resources	0.25 ***	0.07	0.55 ***	0.07	0.31 ***	0.08	−0.12 *	0.05	−0.18 **	0.06	−0.14 **	0.05
Physical resources	−0.06	0.07	0.07	0.07	0.01	0.07	−0.05	0.05	0.00	0.05	−0.01	0.05
Interaction effects												
Cogn. demands × emot. resources											−0.03 N	0.04
Cogn. demands × phys. resources											0.09 D	0.05
Emot. demands × cogn. resources											−0.05 N	0.05
Emot. demands × phys. resources											−0.05 D	0.04
Phys. demands × cogn. resources											−0.06 D	0.05
Phys. demands × emot. resources											0.13 * D	0.06
Model test	$R^2 = 0.24$ F (11, 305) = 7.54 ***		$R^2 = 0.27$ F (11, 305) = 8.50 **		$R^2 = 0.19$ F (11, 305) = 5.40 **		$R^2 = 0.27$ F (11, 305) = 8.53 ***		$R^2 = 0.32$ F (11, 305) = 11.24 ***		$R^2 = 0.26$ F (17, 299) = 5.13 ***	
Delta R^2 interaction model											0.03	

Note. Six MRAs performed. Cogn. = cognitive; Emot. = emotional; Phys. = physical; N = non-match; D = double-match. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed).

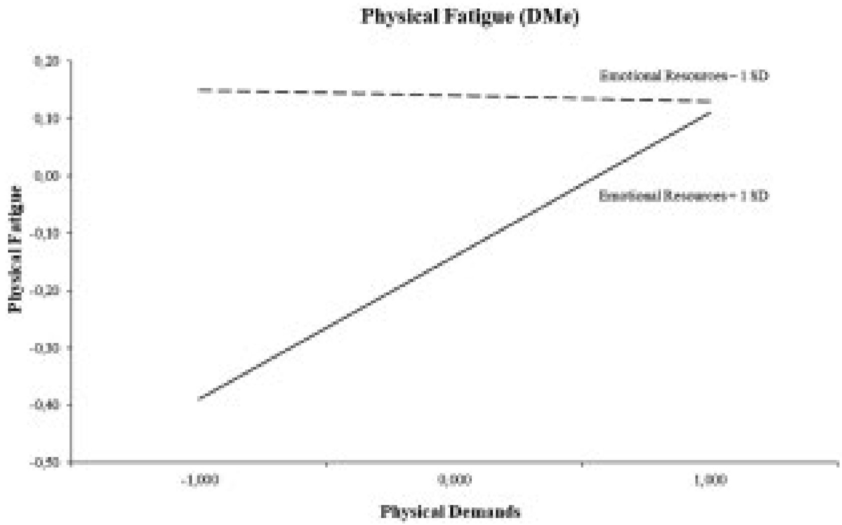

Figure 5. Double-match interaction of extended kind (DMe) between physical demands and emotional resources for physical fatigue.

Table 4. Valid interaction effects compared with patterns of match ($n = 317$).

Interaction pattern	Valid Interactions	Reversed Interactions	Interactions Tested	Ratio of valid interactions/ interactions tested (%)
Non-match (NM)	0	0	12	0.0%
Double-match of extended kind (DMe)	0	1	24	0.0%
Double-match of common kind (DMc)	2	0	12	16.7%
Triple-match (TM)	2	0	6	33.3%

Trying to replicate former research among all kinds of academics (e.g. De Jonge et al., 2019; Mudrak et al., 2018; Salmela-Aro & Read, 2017), we tested the Demand-Induced Strain Compensation (DISC) Model's triple-match principle (TMP) to study whether or not match between specific resources, demands and well-being/health outcomes does really matter.

With respect to vigor, our analyses showed only empirical confirmation for Hypothesis 1. An increase in cognitive demands was particularly associated with more cognitive liveliness in the case of high cognitive resources. This corresponds with the TMP of the DISC Model and its empirical evidence (e.g. De Jonge & Dormann, 2006; Van de Ven et al., 2008), with earlier research among academics (De Jonge et al., 2019), and with vigor research in general (e.g. Shirom, 2004, 2011). For example, De Jonge and his team (2019) detected a similar interaction effect between cognitive demands and recourses in the prediction of vigor in their subsample of nearly 500 university students. So, people are likely to experience cognitive liveliness (i.e. cognitive vigor) if they have sufficient cognitive resources at work of study (e.g. job or study autonomy, or access to information) to deal with cognitively demanding tasks (such as a complex computer problem or an assignment). Finally, these findings are also in line with the Job Demand-Control Model's active learning hypothesis which predicts active learning and vitality for individuals with both high job demands and high job control (Karasek & Theorell, 1990).

We did not find empirical support for Hypotheses 2 and 3 with regard to emotional energy and physical strength. The main-effect models however did show several predictors in line with the matching principle, but they were not able to show significant moderating effects of resources. Though potential power problems cannot be ruled out, it seems that demands and resources impact independently on emotional energy and physical strength. This could be explained by the fact that emotional and physical demands are largely considered to be hindrance demands, whereas cognitive demands are largely considered to be challenge demands (e.g. De Jonge et al., 2019; Han et al., 2020). In this respect, it might be that resources at work or study are explicitly helpful as adverse health buffers for emotional and physical demands, but not as learning, activity and growth enhancers.

With regard to fatigue, Hypothesis 5 was empirically confirmed. The triple-match interaction indicates that an increase in emotional demands was related to less emotional fatigue in the case of high emotional resources. To put it differently, people are likely to experience less emotional fatigue if they have sufficient emotional resources such as emotional support from other colleagues or fellow-students to deal with emotionally demanding tasks and interpersonal conflicts. This triple-match finding is in line with the TMP of the DISC Model, and with its empirical studies that highlighted this moderating role of emotional resources (e.g. De Jonge et al., 2008, 2019; De Jonge & Dormann, 2006; Van de Ven et al., 2013). Van de Ven and Vlerick (2013) found identical results in their cross-sectional study among 1,533 Belgian technology employees. They explained this as a self-regulation process where emotional resources such as emotional support by colleagues are used to diminish the negative effects of emotional demands (e.g. dealing with unrealistic expectations of supervisors) on employee health. Current findings also contribute to the literature on occupational burnout in academics (e.g. Watts & Robertson, 2011). Research on burnout has shown in general that emotional job demands may lead to emotional exhaustion (e.g. Leiter et al., 2014), but the question remains how the negative impact of emotional demands on health can be combated best. Based on our results, burnout (in terms of its key variable emotional exhaustion) seems to be a response to emotionally demanding tasks, which can be tackled in the case matching resources such as emotional support are present.

Hypothesis 4 (cognitive fatigue) and Hypothesis 6 (physical fatigue) were not empirically confirmed in the current study. We found two double-match interactions of common kind (i.e. emotional demands and resources) in the prediction of successively cognitive and physical fatigue. These findings reveal that a double-match interaction coming from another domain can also be useful for reducing cognitive and physical fatigue (Van den Tooren et al., 2011). Remarkably, a decent equilibrium between emotional demands (e.g. an aggressive customer) and emotional resources (e.g. emotional support from a supervisor, lecturer or study advisor) acted as some sort of panacea for all dimensions of fatigue. This is in agreement with psychological (e.g. Taylor, 2011) and epidemiological research (e.g. Reblin & Uchino, 2008) about the crucial role of emotional support for mental and physical health. In addition, Rigg et al. (2013) found also such an empirical link between advisor social support and students' emotional exhaustion. The more support students received from a study advisor, the less exhaustion they reported. Last but not least, main effects within our interaction models showed that the corresponding significant predictors are largely in line with the matching principle as well.

Finally, results showed that the ratio of valid interaction effects/interactions tested was positively associated with the degree of match. This means that Hypothesis 7 is confirmed, which is in agreement with earlier DISC review studies (e.g. see De Jonge & Dormann, 2017; Van den Tooren et al., 2011) and with recent research among academics (De Jonge et al., 2019). Moreover, our findings reveal that the valid percentages of significant interactions were a perfect linear function of the degree of match, which corroborates percentages of other studies (e.g. De Jonge et al., 2019; De Jonge & Dormann, 2006; Van de Ven et al., 2014). Generally, these matching processes could be explained by using self-regulation theory of behavior (De Jonge et al., 2014). Self-regulation theory applied to work or study proposes that people in general use self-regulation strategies whose function it is to cope with states of psychological imbalance induced by high demands. Transferred to the DISC Model, it is assumed that staff and students show functional self-regulatory behavior using specific resources in combating specific demands at work or study.

The explained variances (R^2s) for vigor and fatigue ranged between 0.19 for physical strength and 0.35 for emotional fatigue, which is in line with review studies (e.g. see Van den Tooren et al., 2011; Van de Ven, 2011). Across the board, the R^2s were somewhat higher in fatigue than in vigor. At the end, it seems that the DISC Model is a valid theoretical framework to study stress in academic life as well (see also De Jonge et al., 2019).

Study Limitations and Future Directions

While the present study revealed several interesting findings, some limitations should be noted. A first limitation relates to its cross-sectional research design which precludes causal reasoning, although our theoretical framework guided us in the expected direction of causality. For future research, it is recommended to use longitudinal survey or quasi-experimental studies to address causality and directionality of regression paths. Second, results are based on self-reports which could inflate associations between variables due to method variance. Future research may consider multi-source or multi-method studies (e.g. De Jonge et al., 2008). A third concern is that our study might suffer from power problems due to the relatively large number of predictors compared to sample size. Related to this is the modest amount of variance explained by the interaction terms (delta $R^2 = 0.02 - 0.03$). However, this does not mean that the interactive effects have little substantive significance. The results are important indeed because the size of any interaction effect is attenuated by measurement error when interaction terms are formed by multiplying variables to form cross-product terms in regression analysis (Aiken & West, 1991). It could be further argued that detecting statistically significant interactive effects in such a sample emphasizes the strength of the DISC Model. Fourth, we detected somewhat lower Cronbach's α's for cognitive resources and, to a lesser extent, cognitive demands. However, these scales showed higher α's in other studies ($\alpha\text{'}s > 0.70$), and could not be improved in the current study. So, we have decided to keep the current scales to make replication studies possible. Fifth, we were not able to control for nestedness of students under academic staff. In future research, it would be important to study whether staff burnout is associated with student burnout (cf. Madigan & Kim, 2021). Sixth, the current study was performed in a single, technological, university, which precludes its generalizability. Universities could be exposed to different demands and resources at work or study which could impact staff and student well-being and health (cf. Rigg et al., 2013). Further research may want to replicate the present study by extending it to other universities. A final limitation is that we were not able to control for students' paid employment next to their study. Future research about students' stress should include this confounding variable (Taylor et al., 2020).

Implications for Practice

Several recommendations to improve the academic working environment as well as to promote well-being and health of staff and students can be made. First, because demands at work or study can often not be diminished or altered, the idea of boosting specific resources instead is attractive to current academic life. Study findings revealed that it is important that university management provide academic staff and students with particular resources at work or study that correspond the type of demands concerned. This is particularly important if people are faced with demands that have an adverse impact on their well-being and health. Second, this study indicates that cognitive resources are of primary importance to deal with cognitive demands to improve cognitive vigor. So, providing staff and students with more and better cognitive resources at work or study is highly recommended. Examples of such resources are more job or study autonomy, better access to useful information, better rosters, and more administrative support. Furthermore, cognitive demands in academic staff and students could be identified as challenge demands rather than hindrance demands (cf. De Jonge et al., 2019; Han et al., 2020). Their positive impact on cognitive vigor seems to be particularly valid in the case of high cognitive resources. This stresses again the practical importance of providing adequate resources at work or study by university management.

Last but not least, findings also reveal that emotional resources are primarily important to deal with emotional demands to reduce emotional, cognitive, and physical fatigue. So, our final recommendation is to increase emotional resources of academic staff and students in particular. Examples of emotional resources are emotional support from colleagues or fellow-students, from university management and study advisors, and from relatives and friends. One should keep in mind, however, that not all staff and students are willing to seek and ask for emotional support. So, interventions in real-practice should not only focus on the presence of emotional resources, but also on strategies to stimulate people to call up empathy and comradeship from their network (Van de Ven et al., 2013).

Conclusion

Our key question was: does match really matter? The answer is yes, to some extent. This study reveals that matching resources at work or study are important in academic life, although this conclusion seems to be more valid for fatigue than for vigor. These findings are in line with a study among academics of De Jonge and his team (2019), and suggest that the DISC Model is a promising theoretical framework in the academic context. To conclude, it is about maintaining a decent balance between resources and corresponding demands to promote academic well-being and health.

Note

1 Although the subgroup test for cognitive liveliness showed significantly different regression models between staff and students, the separate regression models did not reveal many differences. Compared to the overall analyses in Tables 2 and 3, emotional demands were not a significant predictor for cognitive liveliness in the staff group, and the interaction between cognitive demands and cognitive resources did not reach significance in the (smaller) staff group.

Disclosure Statement

Authors declare no potential conflict of interest or competing financial interest.

Ethical Approval

All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional committee, with the ethical guidelines of the American Psychological Association, and with the 1964 Helsinki declaration and its later amendments.

Informed Consent

Informed consent was obtained from all individual participants included in this study.

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