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Variation at work: alternations between physically and mentally demanding tasks in blue-collar occupations

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ABSTRACT

The aims of this questionnaire study were to describe the occurrence and desired number of alternations between mental and physical tasks in industrial and non-industrial blue-collar work, and determine to which extent selected personal and occupational factors influence these conditions. On average, the 122 participating workers (55 females) reported to have close to four alternations per day between mental and physical tasks, and to desire more alternations than they actually had. They also expressed a general preference for performing a physical task after a mental task and vice versa. In univariate regression models, the desired change in task alternations was significantly associated with gender, age, occupation, years with current work tasks and perceived job control, while occupation was the only significant determinant in a multiple regression model including all factors. Our results suggest that alternations between productive physical and mental tasks could be a viable option in future job rotation.

Practitioner Summary: We addressed attitudes among blue-collar workers to alternations between physically and mentally demanding tasks. More alternations were desired than those occurring in the job, and workers preferred performing a physical task after a mental and vice versa. Alternating physical and mental tasks could, thus, be a viable option in job rotation.

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Cognitive task; job rotation; pause; physical variation; repetitive work

1. Introduction

Musculoskeletal disorders, as well as burnout and other stress-related mental conditions are common in today's working life (Eurofound 2015; Swedish Work Environment Authority 2016). Both physical and mental disorders are generally believed to be caused by excessive demands combined with insufficient restoration (McEwen 1998; Lundberg 2002). According to this allostatic model, restoration at work, even on a daily basis, is important to prevent fatigue on the short term, and even disorders in the long run.

The allostatic notion of good well-being and health requiring a proper balance between work demands and restoration leads to the need of identifying exposure timelines in which different physical and/or mental demands are combined so that they promote restoration from one another. This is consistent with the general notion in ergonomics that sufficient variation, defined as the change in exposure across time, is a necessary requirement for a job to be acceptable (Mathiassen 2006). Frequently proposed interventions aiming at improved restoration through increased variation are to allow for more rest breaks during work hours, or to change the distribution of breaks across time (Mital, Bishu, and Manjunath 1991; Konz 1998; Tucker 2003; Trougakos and Hideg 2009). Changing the occurrence or structure of passive breaks has not, however, proven to substantially reduce fatigue or discomfort in occupational tasks (Luger et al. 2014; Mathiassen and Lewis 2016). Replacing rest by light physical activities (Henning et al. 1997; van den Heuvel et al. 2003; Galinsky et al. 2007), or by short periods of mental activity (Sundelin and Hagberg 1989), has not appeared effective either (Luger et al. 2014; Mathiassen and Lewis 2016). One important restriction with these interventions is that the breaks/alternations have been implemented

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during working hours only to a limited extent because they compromise productivity.

Thus, sufficient variation in a job may only be feasibly obtained by alternating between productive tasks associated with predominantly physical demands and/or predominantly mental demands ('physical tasks' and 'mental tasks' below) that are sufficiently diverse to allow for mutual restoration (Mathiassen 2006; Straker and Mathiassen 2009); for example, that the body recovers from a physical task while the worker subsequently performs a mental task. This corresponds to the general idea of *job rotation* and *work enlargement* as effective interventions against musculoskeletal disorders (Rissén et al. 2002; Kuijer et al. 2004; Davis and Jorgensen 2005; Swedish Work Environment Authority 2012). The concept of job rotation emphasises that restoration after a particular task can be achieved not only by rest but also by performing another task with different demands. This notion is consistent with common views of effective practices for restoration during non-work time (Bodin and Hartig 2003; Hartig et al. 2003; Staats et al. 2016).

Very few high-quality studies, however, have addressed job rotation in natural settings (Mathiassen 2006; Leider et al. 2015; Mathiassen and Lewis 2016; Padula et al. 2017). Available studies primarily consider alternations between physical tasks. Only one addresses a job enlargement introducing administrative tasks into a physically demanding job, in this case industrial assembly (Christmansson, Fridén, and Sollerman 1999).

However, alternations between physical and mental tasks appear to be a particularly intriguing concept for further research and implementation in the field. Some controlled experiments suggest that mental 'breaks' interspersed between repeated bouts of a fatiguing physical task may accelerate recovery, compared with passive rest breaks (Asmussen and Mazin 1978; Stock, Beck, and DeFreitas 2011; Mathiassen et al. 2014). In contrast, a controlled study of lifting alternated with a working memory task suggested that the biomechanical load during lifting increased when the mental task got more difficult (Davis et al. 2002). Recently, Mehta (2016) emphasised the need in ergonomics to examine and understand combinations of physical and mental tasks, rather than their separate properties. To our knowledge, no study has explored the occurrence and time pattern of physical and mental tasks in occupations containing both, or opinions among the workforce regarding actual and desired alternations. Accordingly, the extent to which attitudes and preferences associated with task alternations are influenced by factors related to the individual, such as age and gender, and to the work, such as occupation and company, has not been examined either.

The overall aim of the current study was to determine the extent to which alternations between physical and mental tasks occur among blue-collar workers, and how these alternations are perceived by the workers. We addressed the following specific questions:

(1) How often are alternations between physical and mental tasks reported to occur by blue-collar workers; and how often do workers desire to alternate between tasks during a typical work day?
(2) To which extent is the actual number of alternations between physical and mental tasks and the desired change in alternations (i.e. the difference between desired and actual alternations) associated with gender, age, occupation, years with current work tasks and perceived job control?
(3) What kind of task (physical or mental) do workers prefer to perform directly after a physical task, and after a mental task?
(4) What kind of activity (i.e. physically demanding, mentally demanding or not associated with any particular demands at all) do workers prefer during breaks, and to which extent is this preference associated with the overall character of the job in terms of physical and mental demands?

2. Method

2.1. Selection of companies

We wanted to include companies where both physical and mental tasks were salient to a reasonable extent. Thus, we identified jobs that we expected to meet this criterion according to our own experience. We discussed our ideas with trade unions and the Swedish Work Environment Authority and representative companies in candidate sectors. We managed to recruit a convenience sample of four companies, which we considered to meet the requirement of at least one work team having a clear occurrence of both mental and physical tasks, as reported by a foreman at the company. In consultation with these foremen, we then constructed a list of the main work tasks, which we jointly categorised as either predominantly physical or mental. Company A was part of a supermarket chain. Jobs contained tasks associated with mainly physical demands, such as cashier work and goods picking, as well as mental tasks such as customer information and overseeing children in the mini-house. Company B was part of a furniture store chain where the jobs contained physical tasks, such as goods picking, cashier work,

Table 1. Characteristics of the respondents from the non-industrial (A and B) and industrial (C and D) companies.

	Company A	Company B	Company C	Company D	Total
Response rate (%)	41	36	39	50[a]	41.0
N	37	22	28[b]	35	122
Age mean, (SD)	33.4 (11.1)	30.0 (9.3)	50 (10.0)	39.2 (9.6)	38.1 (12.2)
Men (*n*)	4	4	27	32	67
Women (*n*)	33	18	1	3	55
Education (*n*)					
Junior High School	4		9	3	16
Senior High School	24	12	10	22	68
Vocational Education	5	4	4	4	17
University/University College	4	6	5	6	21
Type of employment (*n*)					
Full-time	27	22	28	35	112
Temporary	7				7
Other/not specified	3				3
Years with current tasks, mean (SD)	6.5 (0.8)	1.5 (0.2)	20.9 (2.4)	6.7 (1.0)	9.0 (9.9)

[a]Approximation since the total number of workers approached at Company D is not exactly known.
[b]Pooled data for three groups of workers; two operator groups and one group of truck drivers. For detailed information, see Section 2.1.

lifting and carrying goods, as well as mental tasks such as solving problems and searching information on computers. Company C was a pulp mill where recruited workers were either operators or truck drivers. The job as an operator contained mental tasks such as monitoring screens and processing optimisation/planning, as well as physical tasks such as hacking, cleaning, carrying and lifting equipment and materials. The truck driver job contained mental tasks such as wood optimisation, planning and wood transportations, as well as physical tasks such as hacking and maintenance work. Company D was a steel factory where recruited workers were operators. Jobs contained mental tasks such as monitoring screens, coordinating work and solving problems, as well as physical tasks such as maintenance work, handling scrap, hacking, lifting and carrying (see Appendix 1 for a detailed list of work tasks at each company).

2.2. Procedure

First, an email was sent out to all workers from the assigned person in charge of the study at each company, informing the workers about the upcoming study and about the responsible researchers of the study. After approximately one week, the researchers sent out an email containing more information about the study, such as details about its purpose, voluntary participation, how data would be processed and reported and how the recipient could unsubscribe from receiving further emails. The invitation was sent out once, and those who did not answer and had not subscribed from the mailing list (i.e. by sending a reply message of subscription) were reminded thrice. These emails also contained a link to a questionnaire (see below). Data collection (including all companies) took place during a period of seven months.

2.3. Participants

A total of about 293 workers were approached at the four companies; 122 (55 women, 67 men) agreed to participate (Table 1), i.e. an average participation rate of about 40%. At Company D, workers were recruited to the study by the company rather than by the researchers; thus, the total number of approached workers is an approximation. The workers were given a Swedish lottery ticket for participation in the study.

2.4. Questionnaire

We developed a web-based questionnaire containing general questions about individual and work-related factors, as well as specific questions addressing alternations between mental and physical tasks, and preferred activities during breaks. Prior to data collection, the questionnaire was tested on a group of four janitors at the University of Gävle that typically alternate between computer work and manual tasks such as moving, assembling and repairing furniture and delivering mail. This led to slight modifications of the questionnaire, mainly a change of some terms which were difficult to understand for some of the respondents.

Questions of specific relevance for the research questions in the present study are detailed below, and the full questionnaire (in Swedish) is available as supplementary material online. The questionnaire could be completed in about 20 min and the questions were answered in the same order by all the respondents.

2.4.1. General mental and physical demands in the job

One question addressed general perception of mental and physical demands during a workday: *Which of the*

following alternatives do you perceive best describe your work demands during a normal working day? The respondents were requested to mark one of the following alternatives: predominantly mental demands; predominantly physical demands; alternations between mental and physical demands; or concurrent mental and physical demands.

2.4.2. Actual and desired alternations between tasks

Respondents were requested to first identify the tasks occurring in their job from the complete list of possible tasks (cf. section 2.1). Thereafter, they responded to two questions addressing the number of alternations between tasks: *How many times a day do you normally alternate between the tasks that you previously selected? How often would you like to alternate between the different tasks if you could choose?* Both questions were answered on a scale with seven grades: never; once a day; 2–3 times a day; 4–5 times a day; 6–7 times a day; 8–9 times a day; or more than 10 times a day. Prior to further analysis, answers were recorded to appear on a continuous scale corresponding to the mid value in each category: 0, 1, 2.5, 4.5, 6.5, 8.5 and 10. We calculated three variables for each respondent: number of actual task alternations, number of desired task alternations and desired change in alternations, i.e. the difference between desired and actual alternations.

2.4.3. Preferred activities during breaks

Preferred activities during breaks from work were addressed in one question: *Which of the following activities would you prefer to perform during a break where you were not performing any work (besides drinking coffee)?*) The respondents were requested to mark one of the following alternatives: light physical activity (e.g. walking); intense physical activity (e.g. running); easy mental activity (e.g. reading a newspaper, surfing); challenging mental activity (e.g. solving a Sudoku); or rest (i.e. no particular physical or mental demands). Prior to further analysis, light and intense activities were pooled together, so that the resulting answer would fall in one of three categories: physical activity, mental activity and rest.

2.4.4. Determinants influencing alternations between tasks

2.4.4.1. Individual factors

2.4.4.1.1. Gender and age. Respondents were requested to state their gender (female/male) and year of birth; the latter was transformed to age prior to further analysis.

2.4.4.1.2. Education. The workers were requested to mark their highest educational level (*Junior high school, Senior high school, Vocational education or University/College*). Prior to further analysis, educational level was dichotomised into two categories: basic education (Junior high school, Senior high school and Vocational education) and higher education (University/College).

2.4.4.2. Factors related to work

2.4.4.2.1. Years with current work tasks. The respondents were asked to report how many years they had worked with their current work tasks on a nine-grade scale: *less than one year; 1–2 years; 3–5 years; 6–10 years; 11–15 years; 16–20 years; 21–25 years; 26–30 years; more than 30 years*. Prior to further analysis, answers were recorded to appear on a continuous scale corresponding to the mid value in each category: 0.5, 1.5, 4, 8, 13, 18, 23, 28 and 33.

Perceived job control was measured by one question, modified from Copenhagen Psychosocial Questionnaire version II (COPSOQ II; Berthelsen, Westerlund, and Søndergård Kristensen 2014), i.e. *How much influence do you have concerning the following aspects during a workday?* The respondents were requested to answer to this question regarding four aspects of work: *When to perform a physical task; When to perform a mental task; When to take a break; Which tasks to perform*. The scale ranged from 1 (no influence) to 6 (complete influence). Cronbach's alpha was high for the four control statements ($\alpha = 0.89$) and a mean of these four answers was computed to form an index of 'Perceived job control'.

2.4.4.2.2. Work ability. Two questions modified from 'The Work Ability Index' (Tuomi et al. 1998) were included in the questionnaire: *How do you judge your current work ability in relation to the physical demands of the job?; How do you judge your current work ability in relation to the mental demands of the job?*. For both questions, the response scale ranged from 1 (excellent) to 5 (poor).

2.4.4.3. Occupation. Prior to further analysis, the four companies were pooled into two occupational groups: non-industrial (Companies A and B) and industrial (Companies C and D). The four companies in our study were partly chosen for representing different kinds of work. Two of the companies retailed products (food and furniture) to customers and two companies manufactured products (paper pulp and steel). These two settings may carry with them quite different opportunities for alternations between work tasks. To probe this, we computed the difference score between how many task alternations workers desired and how many they actually had. At the two non-industrial settings, 1.42 and 1.00 more alternations were desired, respectively, than actually present, and the two industrial settings both showed negative scores, –0.43 and –41, indicating that workers desired fewer alternations than what they actually had. Thus, it appeared reasonable to pool companies A and B into one group, and C and D into another group. The non-industrial occupation was populated mainly by females (92.7%, cf. Table 1), while the industrial occupation

Table 2. Means (with SD) of actual and desired alternations between mental and physical tasks as well as their difference, stratified by the investigated determinants.

		Actual alternations	Desired alternations	Desired change in alternations
Stratification	*n*	*M* (SD)	*M* (SD)	*M* (SD)
Gender				
Women	55	3.21 (2.62)	4.48 (2.61)	1.27 (2.26)
Men	67	4.04 (2.87)	3.73 (2.62)	−0.31 (1.43)
Age[a]				
<30 years	37	2.73 (2.51)	4.16 (2.77)	1.43 (2.13)
31–44 years	48	4.08 (2.62)	4.27 (2.69)	0.19 (1.77)
>45 years	37	4.05 (3.08)	3.72 (2.45)	−0.34 (1.77)
Education				
Basic education	101	3.77 (2.96)	4.14 (2.63)	0.37 (1.91)
Higher education	21	3.14 (1.64)	3.71 (2.67)	0.57 (2.46)
Occupation				
Non-industrial	59	3.25 (2.59)	4.51 (2.65)	1.26 (2.15)
Industrial	63	4.06 (2.91)	3.66 (2.56)	−0.40 (1.47)
Years with current work tasks[a]				
<3 years	42	3.82 (2.82)	4.42 (2.97)	0.60 (2.21)
3–10 years	43	3.09 (2.44)	3.92 (2.36)	0.83 (1.90)
>10 years	37	4.15 (3.05)	3.85 (2.56)	−0.30 (1.73)
Perceived job control[a]				
Low (<3.5)	64	3.19 (2.73)	4.02 (2.58)	0.84 (2.10)
High (≥3.5)	58	4.19 (2.77)	4.12 (2.71)	−0.07 (1.79)
Workability – physical[b]				
Good (1–2)	100	3.76 (2.79)	4.21 (2.77)	0.45 (1.79)
Poor (3–5)	22	3.23 (2.78)	3.43 (1.79)	0.21 (2.84)
Workability – mental[b]				
Good (1–2)	104	3.60 (2.68)	4.00 (2.69)	0.39 (1.69)
Poor (3–5)	18	4.03 (3.39)	4.50 (2.26)	0.47 (3.34)
Total		3.66 (2.78)	4.07 (2.63)	0.41 (2.00)

[a]Treated as continuous variable in the statistical analyses; categorised here for the ease of reading.
[b]Analysed on its original scale ranging from 1 to 5; dichotomised here for the ease of reading.

comprised mainly males (93.7%).

2.5. Statistical analyses

In order to address the extent to which workers reported alternations between tasks, as well as their desired number of alternations, we calculated descriptive statistics and analysed the difference between actual and desired task alternations using a two-tailed t-test (research question 1). None of the variables deviated markedly from a normal distribution.

In order to test whether workers preferred a particular type of task (mental or physical) after having performed a mental or physical task (research question 3), we performed a Pearson's Chi-square test.

In order to determine the unique association of each of the candidate determinants (i.e. gender, age, education, occupation, years with current work tasks, perceived job control, physical work ability and/or mental work ability) with *actual alternations* and *desired change in number of alternations* (i.e. difference between desired and actual alternations; research question 2), we performed a set of univariate regression analyses. In order to understand the combined effect of all determinants on the same two dependent variables, we also performed multiple regression analyses. For each regression model, we obtained the unstandardised regression coefficient (B), with a 95% confidence interval (CI). The assumption of linearity was fulfilled for all regression models, the residuals were normally distributed and no major multicollinearity issues were detected for the independent variables (tolerance index >0.20 VIF values <5; O'Brien 2007).

3. Results

3.1. Alternations between physical and mental tasks during a typical work day

Forty-four per cent of the 122 workers answering the questionnaire reported that they predominantly alternated between physical and mental demands, 23% had jobs predominantly implying concurrent mental and physical demands, 21% had predominantly mental demands and 12% had predominantly physical demands.

On average, the workers reported that they alternated 3.7 times per day between mental and physical tasks, while they would prefer to alternate 4.1 times (Table 2). This difference of 0.4 between actual and desired task alternations was significant, t (121) = 2.24; 95% CI = 0.05–0.76 (lower bound–upper bound).

Table 3. Uni and multivariate regression analyses of the association between determinants and desired change in alternations.

	Univariate regression analyses					Multivariate regression analysis			
Determinants	*B*	*p*	95% CI Lower bound	95% CI Upper bound	R^2	*B*	*p*	95% CI Lower bound	95% CI Upper bound
Gender[a]	−1.58	0.001*	−2.24	−0.91	0.155	−0.41	0.482	−1.56	0.74
Age[b]	−0.05	0.001*	−0.08	−0.02	0.098	−0.02	0.235	−0.06	0.02
Education[c]	0.20	0.679	−0.75	1.15	0.001	0.36	0.440	−0.55	1.26
Occupation[d]	−1.66	0.001*	−2.32	−1.00	0.173	−1.21	0.043*	−2.38	−0.04
Years with current work tasks[e]	−0.04	0.039*	−0.07	0.00	0.035	0.02	0.443	−0.03	0.06
Perceived job control[f]	−0.32	0.017*	−0.59	−0.06	0.047	−0.16	0.265	−0.45	0.13
Work ability – physical[g]	0.15	0.472	−0.25	0.55	0.004	−0.35	0.248	−0.96	0.25
Work ability – mental[g]	0.17	0.431	−0.25	0.59	0.005	0.25	0.410	−0.35	0.86

*$p < 0.05$;
[a]Woman = 1, man = 2.
[b]Years.
[c]Low = 1, high = 2.
[d]Non-industrial = 1, industrial = 2.
[e]Years with current work tasks.
[f]No control = 1 to complete control = 6.
[g]Excellent = 1 to poor = 5.

Table 4. Task preferences after mental and physical tasks.

	Subsequent task	
Present task	Mental (*n*)	Physical (*n*)
Mental (*n* = 122)	46	76
Physical (*n* = 122)	88	34

3.2. Determinants of actual alternations between tasks

In the linear regression analyses, none of the determinants turned out to be significantly associated with actual alternations in the univariate (all $p > 0.10$), or multivariate (all $p > 0.34$) regression analyses.

3.3. Determinants of desired change in number of alternations between tasks

In the univariate regression models, gender, age, occupation, years with current work tasks and perceived job control were significantly associated with the difference between desired and actual alternations between physical and mental tasks (Table 3). In the multivariate regression model including all determinants, occupation came out as the only significant factor associated with desired change in alternations. Workers in the non-industrial settings desired more alternations than what they reported to actually have, while this was not the case for workers in the industrial setting (see also Table 2).

Occupation alone explained 17.3% of the variance ($R^2 = 0.173$) in desired change in task alternations. Adding all determinants together in the multivariate model did not result in any additional explained variance (Adjusted $R^2 = 0.163$).

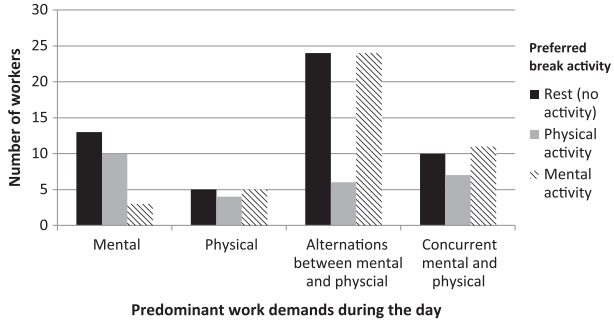

Figure 1. Preferred activity during breaks from work according to the workers' predominant work demands.

3.4. Preferred task after a mental or physical task

Most workers preferred a physical task directly after a mental task and a mental task after a physical task (Table 4). Chi-square tests confirmed the preference for a mental task after a physical task; χ^2 (1, $N = 122$) = 23.90, $p < 0.001$; and the preference for a physical task after a mental task; χ^2 (1, $N = 122$) = 7.38, $p < 0.01$.

3.5. Preferred activities during breaks

In total, 43% of the 122 workers preferred to rest (i.e. no particular physical or mental demands) during breaks, 35% preferred a mental activity and 22% preferred a physical activity (Figure 1).

Most of the workers reporting predominantly mental demands in the job preferred to rest or to perform a physical activity during their breaks, while few preferred a mental activity. Among the workers who mainly alternated between mental and physical tasks in their job, most preferred a mental activity or to rest during breaks. Among workers with jobs dominated by physical demands or concurrent physical and mental demands, the different break activities were preferred to similar extents.

4. Discussion

4.1. Alternations between mental and physical tasks – a viable source of variation at work?

To our knowledge, this is the first study to explore alternations between physical and mental work tasks in real occupational settings. We identified occupations in which alternations between physical and mental tasks do occur, and we found that workers, on average, reported to alternate between tasks about four times a day. In the two non-industrial (retail) companies, workers desired to alternate more between tasks than they actually did, while this was not the case in the two industrial companies. Workers in all four companies generally preferred to perform a mental task after a physical task, and vice versa.

Univariate regression analyses showed that occupation, gender, age, years with the current work tasks and perceived job control were significantly associated with the difference between actual and desired task alternations (cf. Table 3). Females and younger workers expressed a wish for more alternations than they had, while males and older workers were more satisfied with their current conditions. The longer time the workers had worked with their current work tasks, the less inclined they were to wish for more task alternations per day. Moreover, workers with low perceived control over their work desired a change towards more alternations, while those with high control did not (see Table 3). While these univariate results suggest the likely situation that workers with longer experience and better control are more satisfied with their job, possibly because they have advanced to better jobs than younger workers, the unique contribution of each of these determinants could not be disentangled in the present study due to lack of power. Thus, further research should examine the influence of, for example, gender and experience on attitudes, preferences and behaviour associated with different sources of physical and mental variation in the job. Also, determinants at the individual level deserve consideration, which may, in theory, influence these factors and thus explain differences between workers in the same occupation. Examples would be expectations on self-development and intrinsic motivation (Gallie 2007).

The independent variable occupation outperformed all other determinants in the multiple regressions. An obvious example of the ambiguity resulting from the properties of the available data material is the apparent lack of a gender effect in the multivariate model. However, the work force in the non-industrial, customer-oriented companies (i.e. a supermarket and a large furniture store) was grossly dominated by females (cf. Table 1), while men dominated in the industrial settings. Thus, the material did not allow a clear separation of the effects of gender and occupation, and the apparent importance of occupation may be confounded by gender. Still, the observed difference in task alternation preferences between occupations deserves to be examined further. Also, a unique gender effect within occupation is likely, considering that men and women may often have different tasks and working conditions, even within the same job and company (e.g. Messing et al. 1998; Nordander et al. 1999; Johansson and Lundgren 2015).

The fact that workers in the non-industrial companies desired more alternations between mental and physical tasks than they actually had, while the workers in the industrial companies did not, may also have been influenced by the available 'physical' and 'mental' tasks. In the industrial companies, the physical tasks were heavy, such as chopping, lifting and carrying materials, while in the non-industrial companies, the physical tasks consisted of cashier work and goods picking. This illustrates that the actual demands associated with physical and mental tasks will differ considerably between occupations and, thus, that specific analyses of these demands are required for any specific occupational setting in order to fully understand the potential for obtaining variation in jobs by combining available tasks. Alternating between mental and physical tasks has been suggested as a viable way of increasing variation (Straker and Mathiassen 2009; Mathiassen et al. 2014), since tasks in these two categories would likely show a considerable diversity (Mathiassen 2006) in both physical and mental demands. To this end, an important finding in the present study was that most workers preferred to perform a mental task after a physical task and a physical task after a mental. We also found that many workers had strong preferences for an 'opposite' activity during breaks.

In the present study, we categorised tasks at each company as being predominantly physically or mentally demanding only on the basis of the 'expert' opinion of the researchers and a foreman. Future research should aim at characterising physical and mental task demands using more accurate methods, such as direct measurements of physical demands, so as to get a detailed and objective profile of all tasks. We only measured attitudes and preferences associated with task alternations, while the eventual effects of these alternations, for example, on job

satisfaction, well-being, fatigue and disorders are also of major interest. While our study was cross-sectional, causal effects of task alternations on these outcomes would require long-term prospective study designs.

Our questionnaire proved to be useful, but it could be developed further, for instance to include additional aspects of work environment and work organisation. The validity of the questionnaire with respect to the occurrence and number of alternations between tasks needs be verified using, for instance, observations or objective registrations of the actual occurrence and order of tasks. Previous studies suggest that self-reported durations of tasks in the job can deviate considerably from data obtained by objective methods (e.g. van der Beek et al. 1994; Unge et al. 2005; Hunting et al. 2010). The questionnaire should also be assessed with respect to its psychometric properties.

Altogether, our findings suggest that alternations between mental and physical tasks can be an option for job rotation in occupations where tasks of both types are available. So far, research on job rotation and work enlargement has mainly focused on alternations between physically demanding tasks, both in observational studies (Rissén et al. 2002; Kuijer et al. 2004; Vogel et al. 2013) and in simulations (Carnahan, Redfern, and Norman 2000; Frazer et al. 2003; Yoon, Ko, and Jung 2016). We encourage future research to also consider combinations of physical and mental tasks. In jobs dominated by mental demands, such as administrative work, introduction of vigorous physical activities may, indeed, be necessary to achieve any major increase in variation (Barbieri et al. 2015). This proposed line of research includes investigations into the effects of different time patterns of alternations between tasks.

5. Conclusions

This study indicated that alternations between physical and mental tasks occur in real occupational work. Workers in non-industrial occupations desired 1.3 more alternations per day than they actually had, while the preference of industrial workers corresponded very well to the actual number of alternations (−0.4). Occupational sector was the strongest determinant of this desired change in task alternations, while gender, age, education, years in the job, job control and self-reported work ability did not reach significance in a multivariate regression model. In both occupational sectors, workers generally preferred to perform a physical task after a mental task and vice versa. Little less than half of the workers preferred breaks from work containing no particular physical or mental demands, while the rest preferred physical or mental activities. Workers reporting their jobs to be associated with predominantly mental demands preferred to do a physical activity during breaks.

The results of the present study indicated that alternations between productive physical and mental tasks could be a viable option in future job rotation. Our results encourage further research into physical and mental demands of tasks in different occupations, in the context of their potential to be combined into jobs with sufficient variation. To this end, we also encourage research devoted to understanding the effects of different task alternation schemes on individual preferences, well-being and health, as well as research devoted to individual and work-related factors that may predict these effects.

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Appendix 1. Work tasks

Company A	Company B
Predominantly mental tasks	Predominantly mental tasks
Take care of self-scanning checkouts	Seek for information in computer systems
Customer information	Give information/help customers
Oversee children in the mini-house	Handle failures/damages
Predominantly physical tasks	Problem-solving
Cashier work – right	Stocktaking
Cashier work – left	Get acquainted with new tasks
Goods picking	*Predominantly physical tasks*
Bakery	Lift and carry
Manual handling	Goods picking
Cold cut preparation	Truck driving
Bistro/café work	Reconstruction
	Maintaining the base of products in the store
	Cashier work
Company C	**Company D**
Predominantly mental tasks	Predominantly mental tasks
Coordination of work during operational problems	Coordination of work during operational problems
Surveillance	Monitoring screens
Problem-solving/decision-making	Allocation of staff
Routine check	Process optimisation/planning
Trend analyses	Problem-solving/decision-making
Process optimisation	Seek information
Managing operational disruptions	Meetings
Switch and lock	*Predominantly physical tasks*
Handle high inflow	Manual maintenance work
Set priorities	Pick up and carry materials
Wood optimisation	Cleaning
Predominantly physical tasks	Chopping
Cleaning of presses/machines	Truck driving
Pick up and carry materials	Crane operation
Switch and lock	Build cassettes
Chopping	
Manual maintenance work	
Fix plugs	
Routine checks	
Shutdowns	
Cleaning	
Truck driving	
Timber transport	
Oversight – truck driver	