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The effects of new dimensions of psychological job demands and job control on active learning and occupational health

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Abstract

The changes in the job content in the 1990's may have led to changes in job demands and general job control. The aim of this paper is to show how new dimensions of psychological job demands are related to two sets of outcome variables, employee health and active learning, and to show how these relationships are modified or interact with social support and types of job control. The study was part of the project: "Restructuring the electric energy industry: Work design, productivity and health" funded by the Norwegian Research Council as part of the "Health in Working Life" program. The study was carried out as a survey in 1999 in 13 electric energy companies in Norway with totally 3335 employees. Extended versions of measurement instruments of the demands-control model were used in the questionnaire. Lisrelanalysis was used to assess the fit of the proposed models. The findings confirm that different dimensions of demands are differentially related to the outcome variables. Skill discretion uniformly reduced the effect of the demands: for groups low in skill discretion there was a stronger relationship between demands and outcomes than for groups high in skill discretion. The interaction pattern for the remaining control- and support variables is however more complicated and warrants further studies as to the exact nature and form of the interactions. The practical implications of this study are that employers should carefully consider the quality of work. Special attention should be given to the quantitative demands of the jobs, since there seems to be few moderators for the relationship between those demands and job stress and subjective health complaints.

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1 Introduction

New trends in working life with deregulation and accelerated exposure to competitive market conditions have profoundly affected the structure of diverse industries. Restructuring, downsizing and unpredictable changes have caused turbulence within and between companies. New technology in production and communication increases the requirement for cognitive abstract qualifications such as decision-making, a more profound understanding of complex organizations and an ability to analyze and solve problems in unexpected situations. Surveys conducted in Europe indicate increases in time constraints and increased work intensity for the employees in the 90's (European Foundation, 2001). Increases in job control or autonomy between 1990 and 1995 have leveled off or have declined slightly during the 1995-2000 period. One third of workers say they have little or no control over their work (European Foundation, 2001).

Knowledge about the effects of these trends in working life has practical implication as to work redesign decisions and for organizational interventions to improve working life.

The aim of this paper is to show how new dimensions of psychological job demands are related to two sets of outcome variables: employee health measured by job stress and subjective health complaints; and active learning as measured by mastery of work and job satisfaction. We also want to show how these relationships are modified by (or interact with) social support and types of job control.

1.1 Job characteristics models

Several theoretical models exist on the relationship between job design, job characteristics and occupational health. In early research the effect of job content on employee reactions had been studied with independent variables as cycle time, pacing, repetition and the job content of different tasks undertaken (Jackson et al., 1993). During the 1960's, the perspective expanded and job completeness, feedback, and control were introduced as additional key job features (Hackman & Lawler, 1971). In the job-redesign tradition (e.g. Hackman & Oldham, 1976) focus has been on job characteristics, especially job autonomy. Work should be redesigned so that job autonomy increases. However, this tradition did not include worker health outcomes. Their main outcomes were motivation, job satisfaction and commitment. The redesign tradition was further developed by the demands-control model developed by Karasek (1979, 1981). Karasek included health outcomes and combined the focus on autonomy and job satisfaction of the industrial and organizational psychology tradition with the focus on demands or stressors by the "stressful life events" (SLE) researchers. In the JDC model there are two sets of predictions. First, excessively high psychological demands are adverse to health when decision latitude is low. In addition, social support

from superiors and co-workers can be seen as a buffer against the combination of high demands and low decision latitude (Johnson & Hall, 1988, 1994; Johnson, Hall & Theorell, 1989).

In the other set of predictions in the JDC model a combination of higher levels of demands and decision latitude develops more active learning, greater internal locus of control, enabling individuals to develop greater range of coping strategies, motivation and job satisfaction. In general, control provides the opportunities for individuals to adjust to demands according to their needs and circumstances (Karasek & Theorell, 1990).

1.2 Health effects of job characteristics

The relationship between job characteristics and a diverse set of health complaints and psychological well being have been documented in a large number of studies. Van der Doef and Maes (1999) reviewed 20 years of empirical research on the demands-control-support model and psychological wellbeing, and 86 studies showed significant results. In the same period (1981-1999) 27 studies were published on the relationship between job strain and coronary heart disease (Belkic et al., 2000; Brisson, 2000). Twelve of these studies showed significant positive associations between job strain and CVD, and eleven studies showed mixed or null associations. Other studies have reported a clear relationship between low decision latitude and elevated coronary heart disease risk, and that excessive psychological demands and low support may add to this risk (Kristensen, 1995; Landsbergis, 2000; Schnall et al, 1994; Theorell & Karasek, 1996). With regard to functional gastrointestinal disorders there is also limited empirical evidence of a relationship between job strain and lack of social support on the one hand and risk of illness on the other hand (Westerberg & Theorell, 1997). In the case of muskuloskeletal disorders, some studies indicate relationships between illness and excessive psychological demands while others show relationships between illness and low decision latitude, depending on the samples studied (Theorell & Wahlstedt, 1999). Bongers et al. (1993) concluded that monotonous work, high perceived work load, and time pressure were related to musculoskeletal symptoms. Mikkelsen et al. (1999) found that psychological job demands were associated with job stress, subjective health complaints, anxiety and lack of job satisfaction. Decision authority had no significant impact on subjective health complaints. Otherwise learning opportunities and social support were associated with lower levels of stress, anxiety and health complaints.

The DCS model distinguishes itself from other job stress models by its simplicity and the extent to which it has gained a paradigmatic function in the research field and predictions for two different types of outcomes – ill health and behavior. In spite of this and convincing empirical evidence, there has been substantial critique of the dimensionality of the job content questionnaire (JCQ) and related instruments used to measure the JDC model. The increasing demands of working life make it necessary to consider the dimensionality of the demands and control concepts (de Jonge & Kompier, 1997; de Jonge et al., 2001).

1.3 New dimensions of demands and control and occupational health

Recent research on employee job design for advanced manufacturing technology (AMT) illustrates that a number of specific features of job demands or job control are not measured by the existing JCQ (Karasek et al., 1985) and other existing measurement instruments of the DCS model (i.e. Theorell et al., 1991). In the JCQ, demands are measured by only 5-9 items, and the JCQ does not have sub-scales for types of demands, for example, the cognitive demands needed for work with computer numerically controlled machine tools and the sensorial demands required by new monitor systems or the emotional demands in service or customer work.

The dominance established by the job characteristic model in industrial and organizational psychology and the demands-control model in stress research may have limited the development of the area. By focusing attention on the generic theoretical specified factors some researchers may have neglected more specific measures of demands. The need for scales that can be completed quickly by volunteers in research studies in working life has been another reason why short generic scales have been used.

During the 1970's and 80's the Job Characteristics Model (JCM) was criticized as to dimensionality. In a review and meta-analysis, Fried and Ferris (1987) concluded that the dimensionality of job characteristics best seemed to be represented by more than one dimension. However, a number of studies had failed to support the five-factor solution proposed by the model (skill variety, task identity, task significance, and feedback from the job itself) (Hackman & Oldham, 1976), and there was less agreement on the exact number of dimensions.

In the 80's and 90's the conceptualization and operationalizing of the demands-control model has been criticized (Ganster & Fusilier, 1989; de Jonge, Janssen & Breukelen, 1996; Kasl, 1989, 1996; Perrewe & Ganster, 1989; Wall et al.,1996). The main critique has been that the JCQ scales do not include specific sub-scales measuring types of psychological demands or control as several job characteristics or dimensions are involved in the constructs (Kristensen, 1995; de Jonge & Kompier, 1997). De Jonge, Janssen and Breukelen (1996) also emphasize the need to operationalize the concepts in job stress research more accurately and extensively than what is done in the DCS model. In particular, the scales measuring demands have not distinguished between qualitative and quantitative demands. In various new studies the demands and control measurement instruments are expanded and new items are included (e.g. de Jonge et al. 2001; Kristensen & Borg, 2001; Mikkelsen et al., 1999; Stansfeld et al., 1999). In the National Danish Psychosocial study, an attempt was made to resolve this problem by constructing five different scales for psychological demands at work: quantitative demands, emotional demands, cognitive demands, responsibility demands and sensorial demands (Kristensen & Borg, 2001).

These five dimensions are related to the five common changes in job content identified by Parker and Wall (1996): Increased work interdependence, increased demands on operational knowledge, increased customer interface, increased demands on cognitive and abstract knowledge and increased demands on social competence (Table 1).

Information and Communication Technology (ICT), for instance, transforms marketplace competition, organizational boundaries, inter-organizational relations and cooperative practice (Kosnynski, 1993). New technologies in production and communication increase the requirements for cognitive abstract qualifications, e.g., in decision-making, more profound understanding of complex organizations, and the ability to analyze and solve problems in unexpected situations (Parker & Wall, 1996).

Surveys conducted in Europe indicate increasing time constraints and increased work intensity for the employees (Cappelli, 1997; European Foundation, 2001). Companies exposed to high market competition are greatly influenced by the external environment and customer demands. Due to stronger focus on quality, service and productivity, for the individual worker, this will mean higher time pressure and work intensification that may be detrimental to health (Landsbergis, Cahill & Schnall, 1999). The customer focus also leads to flatter organizations which to the individual employee may mean a higher degree of flexibility and increased decision authority, learning opportunities and skill discretion in some jobs (Reilly, 1998). This may lead to an increase in the cognitive and perceptual demands, like having to take difficult, big or rapid decisions, or having to be more innovative and creative and live with more job insecurity and lower paid jobs (Tregaskis et al., 1998). Some employees may also have their decision authority reduced due to centralization of strategic functions in the company. Job based flexibility may mean increased cognitive job demands on multitasks. The good side of this is opportunities to develop new skills, and opportunities for the employees to use their knowledge and skills, but it may also lead to changes in work location that reduces the social network's support. The harder and unpredictable the market competitions, the greater pressure for flexibility on the part of the work force. This may reduce the employees' vertical control over the work - to be able to change the rules of the game and the structure of situation (Aronsson, 1989), and the amount of predefined work tasks that they can quantitatively and qualitatively regulate. If this development is balanced by increased teamwork, employees' the task control may be maintained or even improved. The dependency on one another in teamwork and the need for collaboration in the execution of work, also create the need for more immediate reliance on the performance of other individuals or work groups. This will increase the demands on social competence, but work design based on teams may also increase social support. Pearson (1992) found in a longitudinal study that autonomous workgroups improved perceived decision making, role clarity, job satisfaction, productivity, attendance, and led to a safer work climate. With high competition in the market, customer orientation and customer service social skills will be as important for some workers as technical skills and knowledge. Organizations, particularly those relying on team-based structure and output-based control, tend to place a stronger emphasis on what is referred to as the "cultural fit" of the candidate (Barrick & Mount, 1991). The new demands on social competence underline the need for such personal qualities as punctuality, loyalty, creativity, customer orientation and co-operation with people who differ from your own group by gender, educational level, profession and race. Stalk, Evans and Schulman (1992) focus on "strategic capabilities" that are organizational and operational rather than technical in nature. Low-cost operation, learning, innovation and customer focuses are examples of these kinds of capabilities. The demands on strategic capabilities may be rewarding and increase the employee's control, but it certainly increases the

perceptional and emotional demands of the work and increases demands on social competence.

Due to companies' stronger emphasis on employees' competence , this may lead to increased job control, but it also means increased quantitative, cognitive, perceptual, and emotional demands. Research in the organizational sciences has treated control either in a very general sense or as specific task characteristic (job autonomy) (Ganster, 1989). Karasek defined job decision latitude as "the working individual's potential control over his tasks and his conduct during the working day" (Karasek, 1979, pp. 289-290) and specifically defined it as the sum of decision making authority and skill discretion. With data from different countries both Karasek et al. (1998) and Landsbergis et al. (2002) have reviewed cross-cultural data on the decision latitude scale and subscales in the demands control model. The decision latitude scale and the two subscales decision authority and skill discretion had good psychometric properties. Ganster (1989) speaks for a multidimensional measure that is broad enough to tap the important aspects of control in almost any occupation and mention a categorization as work tasks, work pacing, work scheduling, psychical environment, decision making, interaction and mobility. A broader multi-dimensional measurement approach would allow researchers to address some other questions about the effects of specific control dimensions and their interaction.

In addition to the differentiation of task control in skill discretion and decision authority, the distinction between horizontal (task control) and "vertical" control (Aronsson, 1989) seems of special importance in the new working life where so much emphasis is placed on participation and work place democracy. Task (horizontal) control is more limited to a specific situation or job tasks connected to a specific position. Changes in horizontal task control could be accomplished by job rotation and job enlargement. The individual still sets the goals, structures these goals, plans, reflects and evaluates different ways of action and their consequences (Aronsson, 1989). Vertical work dimensions may be used when analyzing different types of organizational change, and means influence over departmental decisions as planning and production (Aronsson, 1989). Both "horizontal" and "vertical" level control may have benefits for employees' health. For example, adding measures of organizational influence to the task level decision latitude variable, and combining this broader measure of control with job demands (job strain), led to a stronger association between job strain and hypertension, than the standard job strain construct (Landsbergis et al., 1994).

Using a metaanalytical technique Spector (1986) surveyed 101 samples from 88 studies and found a mean correlation of -.26 between participation and autonomy and psychological and emotional distress. Landsbergis et al. (2002) found a significant predictive power of decision authority and skill discretion on several outcome variables (i.e. CVD and HPT). The experience of the Norwegian researchers with participatory interventions in community health care institutions shows that it is possible to manipulate the elements in decision latitude to increase employees' control (Mikkelsen & Saksvik, 1998, 1999; Mikkelsen, Saksvik & Landsbergis, 2000).

1.4 Interaction

In the original demands-control model the relationship between demands and control was presented as an interaction effect (Karasek & Theorell, 1990). The model proposed that high demands act as stressors eliciting stress reactions. If the exposed individual also has low job control the result is overload and development of strain that later, through various pathways, contribute to ill health. The interaction, that one of the components in the model may influence or modify the effect on ill health risk of the other component, can take various forms. Usually the hypothesis about interaction effects predicts that high demands have negative health effects for low levels of decision latitude, but also on the interaction between demands and latitude and how different combinations produce more positive effects on both health and learning. Kasl (1996) proclaims that the nature of the interactions are unclear, several authors point to the fact that the empirical evidence of the interaction effects are inconsistent (Kristensen, 1995; Landsbergis et al., 1994; Jonge & Kompier, 1997). Landsbergis (1988) found no interaction between demands and decision latitude in predicting job satisfaction, depression, reported physical strain or sleep disturbance. In the review of demand-control-support and psychological wellbeing van der Doef and Maes found support for an interaction (for job strain) in 56 out of 83 studies. Landsbergis et al. (1994) found in a review of CVD studies that two of four studies were supportive of an interaction term. Warr (1990b) obtained no support for the demand-control interaction in an investigation of job-related anxiety, job-related depression and job satisfaction. Dwyer and Ganster (1991) found that interaction between perceived workload and control predicted job satisfaction and absence. Parkes et al. (1994) found that the interaction between demands and discretion predicted job satisfaction, and Mikkelsen et al. (1999) found a significant interaction effect of demands, decision authority, and learning opportunities on subjective health.

In their criticism of the demands-control model, de Jonge and Kompier (1997) conclude that research has provided very little evidence for an interaction effect of demands, control, and support on physical and mental health. The negative or contradictory findings may be an empirical reality in some cases or result from small sample size. The first aspect is the operationalization of the demands control relationship and mathematical formulation of the interaction term.

It is of considerable practical importance to know if it is true that there is an elevation of risk for ill health only when a demanding job appears or when the demands occur in interaction with low control on the job. This would mean that demands can increase (at least up to a certain point) with little or no threat to psychological strain as long as decision latitude is also enhanced. In this case, it will also be important to know how the different dimensions of demands interact with the control and social support dimensions. Success in developing and implementing organizational interventions to improve occupational health may be dependent on knowledge about these relationships.

The hypothetical structural model for this article is presented in Figure 1. Different dimensions of psychological demands and dimensions of control and support will have main effects and interaction effects of two sets of outcome variables, both employee health and variables related to active learning behavior and personal growth.

We hypothesize (H1) that the extended demand and control conceptualizations will explain job outcomes, and H2 that the different job demand dimensions are differentially related to job stress and subjective health complaints (ill health) and to job satisfaction and mastery of work (active jobs). We also hypothesize that job control (H3) and social support (H4) moderate the relationships between job demands and the outcome variables job stress, subjective health complaints, mastery of work and job satisfaction.

2 Methods

2.1 Research design

This study was part of the project: "Restructuring the electric energy industry: Work design, productivity and health" funded by the Norwegian Research Council as part of the "Health in Working Life" program. The study was carried out in 1999 in 13 electric energy companies in Norway with a total of 3335 employees. The survey response rate was 73%.

The branch organizations established contact with the companies. In each company the project had a contact-person to help with the practical administration of the project.

2.2 Research setting

During the 1990s the electricity producing industry was deregulated in many countries in Europe. In Norway, a new Energy Act became law in 1991. This new law changed the market situation of the electrical power industry in Norway, taking it from the status of a regulated local monopoly to that of a deregulated, highly competitive national (and international) market. The competitive position of the companies became highly dependent on their capacity to restructure the organization in order to reduce operating costs and meet market demands.

Entry into electricity marketing still remains regulated by the Norwegian government. In accordance with the 1990 Energy Act, the Norwegian Water Resources and Energy Administration (NVE) issues permits for all companies wishing to produce, transmit, or distribute energy. Such a permit is – with few exceptions - a prerequisite for all companies who wish to be engaged in electricity supplies.

An increasing number of the utilities are being vertically integrated into corporations featuring a holding company which retains controlling equity in a set of local or regional companies, each holding their own permit obtained from the NVE. The number of mergers and acquisitions in the Norwegian electricity sector totaled 115 in the wake of the new Energy Act in the period 1991-1999.

In 1996 and 1997 the NVE imposed new efficiency and profitability requirements on the monopoly activities (transmission and distribution) of the electricity utilities. These

requirements were introduced in order to reduce transaction costs, and have been the subject of extensive monitoring by the water resources and energy authorities (Langset & Torgersen, 1997). Electricity companies are thus required to adjust their strategic orientations towards renewed focusing on customer requirements, cost reductions, and benchmarking with respect to available organizational and economic efficiency measures. These newly imposed objectives have repercussions with respect to stress and to individual and collective learning at the work group and organizational levels in the Norwegian energy sector.

2.3 Measurement instruments

Extended versions of measurement instruments of the demands-control model are used to test the relationships between the different demands and control dimensions on the outcome variables.

The demands dimensions were measured by a questionnaire developed by Theorell, Michélsen and Nordemar (1991), a short version of the "Job Content Questionnaire" (Karasek et al., 1985). The demands dimension in this instrument consisted of five items (work fast, work hard, excessive work, enough time, conflicting demands). In addition to these items in this study we also included ten items on psychological job demands from an early version of the Copenhagen Psychosocial Questionnaire (COPSSOC) (Kristensen & Borg, 2001). The same four-point response scale is used for all demand questions. The scale ranges from 1 "yes, often" to 4 "no, hardly ever". Standard measurement validation techniques (exploratory factor analysis and Cronbach's alpha) confirmed a factor pattern consisting of six psychological job demands dimensions. The factor solution was reliable and showed good convergent and discriminant validity. The overall results of the analyses are presented below, and a summary of scale properties is presented in Table 2.

Quantitative demands were measured by four items. Items include: "Do you have enough time for your work tasks?" and "Do you have to work very hard?" Cronbach's alpha for this scale was .72.

Cognitive learning demands were measured by three items: "Does your work require a wide knowledge?" "In your job, - do you have to acquire new knowledge and skills?" and "Does your job require inventiveness and creativity?" Cronbach's alpha was .67.

Cognitive decision demands was measured by three items: "Does your work require you to make quick decisions," "Does your work require you to make difficult decisions?" and "Do you have to make decisions of great importance to your place of work?" Cronbach's alpha was .78

Sensorial demands were measured by two items: "Does your work demand your constant attention?' and "Does your work require a high level of precision?" Cronbach's alpha was .65.

Emotional demands were measured by two items: "Is your work emotionally demanding" and "Do you get emotionally involved in your work?" Cronbach's alpha was .83.

Risk demands was measured by two items: "Could it injure other people if you make mistakes in your work?" and "Could it cause financial losses if you make mistakes in your work?" Cronbach's alpha for this scale was .62.

One item in the original demand scale (Theorell, Michélsen & Nordemar, 1991) was deleted since it was not systematically related to any of the psychological job demands dimensions: "Are you often facing conflicting demands in your work?"

In this study task *control* was measured by 14 items. These items were taken from the Swedish version of the job content questionnaire (three items) (Theorell, Michélsen & Nordemar, 1991), the learning climate questionnaire (three items) (Bartram et al., 1993) and from Stansfeld et al. (1999) (seven items) and one item from the NIOSH stress questionnaire (NIOSH, 1997). All the items were measured with response scales that ranged from 1 "yes, often" to 4 "no, hardly ever." In addition to these task control items three items on *vertical control* from Michela, Lukaszewski and Allegrante (1995) were included. To validate the dimensionality of the control concept with the new items included, a factor analysis was carried out. The factor analysis gave four dimensions and was named: Skill discretion, decision authority, vertical control and empowerment. *Skill discretion* was measured by 7 items, including items like: "I have a great deal of say in planning my work environment", "I have opportunities to develop my best skills," "If I want to try something new I have the opportunity to do so," "How often can you use the skills from your previous experience and training?" Cronbach's alpha for this dimension was .84.

Decision authority was assessed by three items: "I have freedom to decide how to perform the work," "I have freedom to decide what to do in my work," and "I have a good deal of say in decisions about my work." Cronbach's alpha was .76.

Empowerment was measured by four items: "I have a say in choosing with whom I work," and "I can decide when to take a break," "My working time can be flexible," **"**I have a say in my own work speed." Cronbach's alpha for this scale was only .55. In the factor analysis (principal components, varimax rotation), the first factor accounted for 44% of the variance while the three following factors had about equal eigenvalues (.86, .75 and .64), and mostly accounted for item-specific variance. The shared variance ranges from 37% to 53%. As Cronbach's alpha can not be improved by deleting items, the empowerment scale was included in the analyses.

Vertical control included the three items: "In my department we are included in decisions concerning job quality standards," "I often have the opportunity to influence the goals or actions of my department," and "All members of the department are involved making important decisions that affect them". The vertical control instrument had a five-item response scale that ranged from 1 "Disagree strongly' to 5 "Strongly agree." Cronbach's alpha for this scale was .87.

Social support was measured by the General Nordic Questionnaire (QPS Nordic) (Nord, 1997). Items included for example "If needed, can you get support and help with your work from your co-workers?", and If needed, can you get support and help with your work from your immediate superior?" A 1-5 response scale was used were 1 is "Very seldom or never" and 5 is "Very often or always." Cronbach's alpha was .83.

Job satisfaction was measured by Quinn and Shepard (1974), and four items was used. Job satisfaction was presumed to be a global construct where the various job dimensions, both events and agents are aggregated into an overall orientation termed job satisfaction. Cronbach's alpha was .79.

Perceived job stress was measured by Cooper's Job Stress questionnaire (Cooper, 1981). This instrument consists of 22 questions and each answer is rated on a six-point scale ranging from zero to five. In this study two items were added to the original instrument: Stress connected to the implementation of new technology and stress due to lack of learning and developing opportunities. A high score indicates high experience of stress in the work situation. A summated scale of all the 24 items, "Job stress," gave a Cronbach's alpha of .92.

Subjective health complaints was measured by the Subjective Health Inventory (SHC). The instrument consists of 29 items and describes subjective and psychological health complaints experienced during the previous 30 days (Ursin, Endresen & Ursin, 1988; Eriksen, Ihlebæk & Ursin, 1999). The dimensions in the instrument are: pseudoneurological problems (sadness/depression, anxiety, sleep problems, tiredness, dizziness), (8 items), muscle pain (6 items) cold/influenza (2 items), allergy (3 items) and gastrointestinal problems (7 items). The complaints were scored on a scale from 0 (no complaints) to 3 (severe complaints). A sum score for all the complaints was computed and the scale had a Cronbach's alpha of .79.

Mastery was measured by five items from the General Nordic Questionnaire (QPS Nordic) (Nord 1997). Items included are for example "Are you content with the quality of the work you do?"; "Are you content with your ability to solve problems at work," and "Do you get information about the quality of the work you do?" Cronbach's alpha was .71.

Demographic variables can be expected to confound relationships between job characteristics and outcome variables (Jonge et al., 1999; Theorell & Karasek, 1996). In this study gender and age are included as control variables.

2.4 Data analysis

Covariance structure analysis was used to assess the fit of the proposed models. However, the analyses were simplified by assuming that the latent constructs were related to the average of the score of items purported to measure them, and no further measurement model was specified in the analyses. As indicated in the preceding section, traditional construct validation techniques (i.e. factor analysis, Cronbach's alpha) indicated that the measurement models for the constructs were reliable and valid.

The large number of variables and resulting complexity of the models allowed only one of the moderating control- and support variables to be introduced into the demand-control relationship at a time. Separate models were specified for each control- and support variable. Gender and age were controlled for in the structural model by introducing them as exogenous variables (Bollen, 1989) that were related to all endogenous variables except interaction terms. Interactions of job demands and control

and support variables were included as the product of the mean-centered variables (Jaccard, Turrisi & Wan, 1990; Aiken & West, 1991).

For each control and support variable two structural models were fitted to the data. First, a model without interaction effects (M1) was specified followed by a model with interaction effects (M2). These are nested models and a significant chi-square difference can be taken as evidence that (H_0) that there are no significant interaction terms can be rejected (Jøreskog & Sørbom, 1993). The estimated models included numerous relationships that were not significant, and modification indices indicated that model fit could be improved by further model refinement. We did however choose not to embark on model modifications. Our main concern here was not to obtain the best empirical fit for a number of job-demands-control models, rather to evaluate the impact of interaction effects of demands and control, and also to evaluate the differential effects of a number of demand dimensions. To improve the validity of these analyses, we chose to apply a standard, unmodified model structure to all demand/control conditions (Figure 1). Main effects reported are based upon analyses of the interactive model.

2.5 Model fit

Full information maximum likelihood was used to assess model parameters. The overall results of the nested models that address the direct and interaction effects of introducing five moderating variables into the model are presented in Table 3. Model parameter estimates for the interaction models (M2) are presented in Table 4[1]. Chi-square statistics presented in Table 3 indicated that M1 and M2 did not fit the data perfectly, but AGFI, RMSEA, and NNFI all indicated that the models were fairly well fitting for practical purposes. The ECVI values further indicated that both models appear to be fairly stable within the present sample.

As reported in Table 4, the R^2 of the outcome variables ranged from .08 for mastery to .32 for job stress depending on which control and support variable was included in the models. Job satisfaction (11-28% explained variance, with an average of 20%) and job stress (22-32% explained variance, average 26%) were well explained within our models, while subjective health complaints (9-13%, average 10%) and mastery (8-12%, average 9,3%) were to a lesser degree explained with our predictors.

For the model including *skill discretion* as moderating variable, the chi-square difference between M1 (direct effects model) and M2 (interaction model) was 106.74 that with 24 degrees of freedom was clearly significant. The interactive model (M2) fitted the data better than the model without interactions included. R^2 of M1 and M2 did, however, not differ much.

The overall findings for skill discretion were more or less replicated when the other control and support variables were introduced into the model. All models were for

1 Table 6 presents direst effects of models without interaction effects (M1).

practical purposes fairly well fitting and the chi-square difference between the M1's and M2's indicated that the interaction models (M2) fitted the data slightly better than the respective M1's. Chi square differences were 52.42 for decision authority, 48.77 for social support, 44.97 for empowerment, which at 24 degrees of freedom all were significant at the .05 level. The chi-square difference for vertical control was however only 34.15 which is not significant at .05. The amount of explained variance in outcome variables did not differ between M1 and M2 by more than one percentage point.

2.6 Main effects

Table 5 reports the aggregated findings for main effects (standardized LISREL estimates), while Table 4 includes details. The results are based on the analyses of the five interaction models.

The average main effects of the different dimensions of demands on the two sets of outcome variables varied between 0 (not significant) and .32, in magnitude (Table 5).

The different demand dimensions were positively as well as negatively related to outcome variables. Quantitative demands, emotional demands and risk demands were uniformly positively associated with subjective health complaints and stress, (Table 4 and Table 5) and negatively associated with job satisfaction and mastery. Effect sizes did however vary widely. Cognitive learning demands, sensory demands and sensorial demands had more complicated effects on outcomes, but did quite frequently have positive effects on outcomes (i.e. are associated with better health and higher satisfaction). Cognitive learning demands and sensorial demands were for example positively related to mastery, and cognitive learning demands and cognitive decision demands were positively related to job satisfaction. Cognitive decision demands did however also relate positively to stress.

More specifically, Table 5 reveals that emotional demands were the best predictor of poor job satisfaction (-.14, standardized LISREL estimate) while cognitive (.17) perceptual (.16) and emotional demands (-.13) were the most important predictors of mastery. Subjective health and job stress were both best predicted by quantitative demands (.11 and .32 respectively), and emotional demands (.12 and .21 respectively).

The main effects of demand dimensions were only slightly sensitive to which of the moderating variables that were included in the analysis. Most standard deviations of the standardized mean main effects were below .02 (Table 5).

The main effects of the *moderating* variables are also listed in Table 4. With one exception (skill discretion was not significantly related to mastery), the moderators all were significantly and quite often strongly related to outcome variables. Standardized path coefficients quite often were considerably larger than the main effects of demands. The explained variances of three of the outcome variables (subjective health, job stress and mastery) were only moderately sensitive to which control and support variable that were included in the model, while the explained variance of job satisfaction differed considerably between models. 27% of the variance of job satisfaction was explained in

the model when social support (and no interaction effects) was included, but only 10% were explained when empowerment was included (Table 3 and Table 4).

2.7 Interaction effects

Table 4 reveals that there were a number of significant interaction terms. Most notable was the interaction effect of .14 of cognitive decision demands and skill discretion on mastery. Counting significant interaction effects by column (by type of demand) revealed that while we observed only two significant interactions out of 20 possible for the relationship between *quantitative* demands and outcomes, the moderators most heavily influenced the relationships between cognitive decision demands and outcomes. 8 out of 20 possible interactions were significant. The numbers of significant interactions for the remaining demands were: cognitive learning demands (3), sensorial demands (4), emotional demands (4) and risk demands (3). If we investigate interaction effects by moderator variable (by rows), the most important moderating variable was skill discretion (9 of 24 significant interaction terms), social support (6) and vertical control, decision authority and empowerment each moderating 3 out of 24 relationships. Across all the models, 24 interaction effects were significant at $p \leq .05$. With altogether 120 possible interactions included in the models, the ratio of significant interactions was 19%, thus the majority of these are not likely due to chance.

If we look at the individual outcome variables, the relationships between job satisfaction and job stress on one hand and demands on the other, both had 8 significant interaction effects. Furthermore, there were 6 significant interactions for subjective health and only 2 for mastery.

Notable results were that the relationship between quantitative demands and job stress was not modified by any of the moderating variables included in the models, and that skill discretion was the most important moderator of emotional demands.

The significant interaction terms were more closely analyzed in accordance with the method described by Aiken and West (1991). Cases with predictor variable values one standard deviation or more above and one standard deviation or more below the mean were selected into two groups, and simple regression lines were then generated for each group. Regression coefficients for the 23 significant interaction terms are reported in Table 6.

Skill discretion did uniformly reduce the effect of the demands: for groups with low skill discretion there was a stronger relationship between demands and outcomes than for groups high in skill discretion. The interaction patterns for the remaining control- and support variables were, however, more complicated. *Social support* and *empowerment* seemed to cancel out some of the negative influence of *quantitative demands* on subjective health and job satisfaction. High social support groups quite often had a positive relationship between demands and the outcome variables. This was not observed in the low social support group. For example the relationship between cognitive learning demands and job stress was not significant for the group with low social support group, but was positive and significant for the group with high social support.

2.8 Discussion

The purpose of this study was to elaborate the dimensionality of the demand and control concepts of Karasek's job demands control model and to evaluate the Karasek model with a broader formulation of job demands as well as a broadened set of control and support variables (Karasek, 1979). We tested the model comprehensively by using covariance structure modeling. Significant interaction effects of demands and controls were further evaluated with sub-group linear regression analysis. It was hypothesized that different dimensions of job demands would be differentially related to and explain different occupational health outcome variables, and that the different dimensions of job demands in combination with job control and social support variables have interaction effects with respect to occupational health outcome variables.

Main effects of a broader formulation of job demands

The different dimensions of job demands explained more of the variance in job stress (26%) and job satisfaction (20%) than in subjective health complaints (10%) and mastery (9%). The findings support hypothesis 1 that different dimensions of demands are associated with different occupational health outcome variables. Quantitative demands and emotional demands best predicted job stress, subjective health complaints and job satisfaction, while mastery was best predicted by cognitive, emotional and sensorial demands. It is an interesting finding that emotional and sensorial demands predicted mastery and quantitative demands did not. Cognitive learning demands are highly correlated with high skill, and it thus makes sense that cognitive learning demands are associated with active learning and mastery, but not with stress. Quantitative demands are not associated with skill. Cognitive learning demands are most closely associated with jobs in the "active" quadrant, while quantitative demands are common in both active and high strain jobs and there are more closely associated with stress and not with active learning.

The present study was carried out in the electric energy branch that is dominated by men and by the logic of engineering. In spite of this, and a rather small variance on emotionally demands, there were consistent, strong and negative effects of emotional demands on all the outcome variables. This is consistent with recent research on the effect of emotional demands on emotional exhaustion from the human services (Schaufeli & van Dierendonck, 1993; Söderfeldt et al., 1997), and suggests that emotional demands may be important also outside the human services.

To effective change management the different effects of the qualitative differences in workload exposure are notable. The big main effect of quantitative demands on job stress demonstrates the need for conducting primary interventions in working life. Primary level interventions are concerned with modifying or eliminating sources of stress inherent in the workplace in order to adapt the environment to fit the individual. This study supports a focus on interventions related to the amount of work and time pressure.

Interaction effects

The interaction terms improved the explanatory power of the models. The control and the social support variables had a moderating effect on several relationships (H3 and

H4). The improvement in overall model fit was however marginal, the number of significant interaction terms was relatively small (19%), and the individual interaction terms were modest in magnitude. This finding was well in line with the findings of de Jonge et al. (1999) that with a similar single-occupation study found 25% significant interactions. The interaction hypothesis was thus only partially supported. In this regard the results were in line with earlier studies (Kristensen, 1995; Parkes et al., 1994 and Schnall et al., 1994) and failed to demonstrate a *consistent* pattern of interaction to support the central hypothesis of the demands control model.

In spite of this, the interaction hypothesis should not be discarded. This study has demonstrated specific new knowledge about significant interactions – and in some cases lack of such interactions - between job demands and moderating variables as control and social support that are important for practitioners in order to succeed with health promotion and change management. For example, in the present study, the relationship between quantitative demands (similar to work intensification and increased work pressure, which have been increasing) and job stress was not modified by any of the moderating variables included in the model. With increased customer orientation and therefore also increased emotional demands in many professions, it is useful to know that skill discretion may moderate the relationship between emotional demands and adverse health effects. As Karasek pointed out in 1979, it has practical implications if high demands give rise to adverse health effects only when combined with low discretion. The results in the present study imply that different actions should be taken depending on the type of workload the employees are exposed to. Health status could potentially be improved by an increase in discretion without reduction in output for some type of demands, but not for others. It is not always possible to alleviate work-related distress by enhancing discretion as is the case in high risk work with rigidly controlled safety regulations as in the present power supply industry. It is therefore important to establish whether enhancing work-related support (or reducing work load) can serve as an alternative means of alleviating distress in high strain jobs. Using knowledge about specific effects of specific exposure, it will be easier to conduct practical health promotion work.

Study limitations

Several weaknesses of the present study should be taken into account. Firstly, by the cross-sectional data presented here, it was not possible to determine whether the assumed causal paths were present. Secondly, the study might be criticized from a common method variance point of view. The positive relationship between cognitive learning demands and the outcome variables raise the question whether "have to acquire new knowledge" is a dimension of demands or the job characteristic skill discretion. In spite of no item overlap, the terminology of some of the demands item and some of the control item, was rather similar. This may be illustrated by "the learning demand". The idea behind including learning demands as one dimension in psychological job demands has been to capture the demands on flexibility and increased cognitive and abstract knowledge. Future research should give more attention to whether huge learning demands may be too overwhelming and lead to ill health, or if learning demands have a positive effect on health independent of degree. Thirdly, although the sample in this study was large, and selected from several companies, only one industry was covered.

Further research should include a bigger variation, especially on cognitive and emotional demands. Finally the interaction patterns for *vertical control* and *decision authority* are also complex and the nature of the interactions do not always seem to be captured by the simple linear analysis. Warr (1990a, 1994) postulated curvilinear relationships between job characteristics and employee health, with optimal levels at the middle of the range. This study supports the need for further studies as to the exact nature and form of the interactions. With several dimensions of demands and several moderators that also have direct effects, it is difficult to present a fair and easily understood overview. The simplicity of the original demands control model is sacrificed by trying to more deeply understand how different psychosocial factors within a changed working life are related and interact. Future research should keep the dynamic of this model, but at the same time capture the complicated pattern of changing nature of work and its effects on health and well-being.

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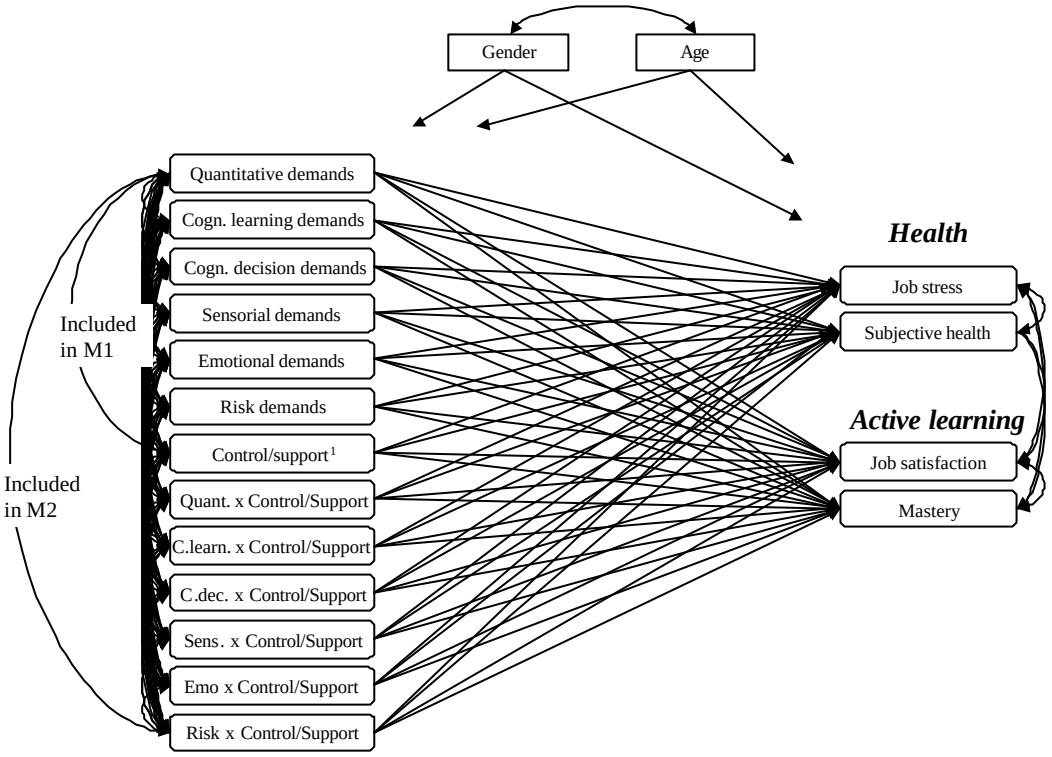
Appendix

Table 1: Changes in job content in the new working life and relevant new dimensions of psychological job demands and job control

Changes in job content (Parker & Wall, 1996)	Dimensions of psychological job demands (Kristensen & Borg, 2001)	Dimensions of control
Increased work interdependence	Cognitive	Vertical control
	Perceptional	
Increased relevance of operational knowledge	Quantitative	Skill discretion
	Sensorial	
Increased customer interface	Quantitative	Decision authority
	Emotional	
Increased demands on abstract and cognitive qualifications	Cognitive	Empowerment
Increased demands on social competence	Emotional	Skill discretion

Figure 1: Basic hypothetical structural model



[1] Control and support variables include: Skill discretion, vertical control, decision authority, empowerment and social support. They are included in the model one at a time.

Table 2: Means, standard deviations, Cronbach's α, and Zero order correlations of variables[1]

	Mean	SD	α	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 Gender	1,19	,39	-	1,00																	
2 Age	43,44	10,32	-	-,08	1,00																
3 Job satisfaction	11,47	1,95	.79	,05	-,03	1,00															
4 Subjective health	6,57	5,96	.79	,16	,06	-,23	1,00														
5 Job stress	24,79	16,92	.92	-,09	-,06	-,41	,27	1,00													
6 Mastery	19,88	2,28	.71	,05	,00	,20	-,05	-,20	1,00												
7 Skill discretion	19,88	4,06	.84	-,05	-,09	,42	-,21	-,13	,04	1,00											
8 Quantitative dem.	10,51	2,10	.72	,05	,00	-,07	,14	,38	-,02	,10	1,00										
9 Cog. Learn. dem.	10,36	1,44	.67	-,13	-,05	,11	-,03	,14	,13	,39	,33	1,00									
10 Cog. Dec. dem.	8,11	1,92	.78	-,22	,08	,06	-,02	,25	-,01	,34	,44	,50	1,00								
11 Sensorial dem.	6,24	1,35	.65	-,03	,01	,01	,07	,14	,13	,12	,32	,41	,40	1,00							
12 Emotional dem.	4,11	1,54	.83	-,02	,16	-,12	,14	,30	-,11	,09	,32	,20	,42	,25	1,00						
13 Risk. demand	4,95	1,82	.62	-,43	-,05	-,09	-,01	,13	-,03	-,06	,04	,14	,23	,18	,04	1,00					
14 7 x 8	,83	9,35		,01	-,02	,02	-,07	-,04	,00	,02	-,06	-,08	,02	-,06	-,01	-,03	1,00				
15 7 x 9	2,29	7,70		,14	-,02	-,04	,03	-,07	,06	-,15	-,06	-,36	-,16	-,16	-,06	-,12	,28	1,00			
16 7 x 10	2,66	8,97		,09	,03	,03	,00	-,07	,13	-,11	,01	-,19	-,07	-,10	-,03	-,09	,38	,63	1,00		
17 7 x 11	,68	6,28		,11	-,04	,04	-,06	-,10	,05	-,05	-,05	-,18	-,10	-,16	-,09	-,12	,30	,48	,50	1,00	
18 7 x 12	,55	6,58		,02	,01	,06	-,06	-,09	,06	-,04	-,01	-,08	-,03	-,09	-,02	-,03	,32	,24	,44	,32	1,00
19 7 x 13	-,44	7,87		,12	,03	,01	,06	-,04	,00	-,04	-,03	-,15	-,10	-,13	-,03	-,11	,03	,25	,30	,32	,07

[1] n = 2 103

Table 3: Model fit and squared multiple correlations of demand-control models without (M1) and with (M2) interaction terms of moderating variables[1]

	Model fit						R^2 of dependent variables				Model improvement	
Moderating variable	χ^2	*df*	AGFI	RMSEA	NNFI	ECVI	Job satisfaction	Subjective health	Job stress	Mastery	χ^2-difference	*df* of difference
Skill discretion												
Without interaction (M1)	161.11	36	.96	.040	.93	.24	.23	.12	.25	.08	106.74	24
With interaction (M2)	54.37	12	.96	.041	.93	.21	.24	.13	.26	.09		
Social support												
Without interaction (M1)	66.19	36	.98	.020	.98	.20	.27	.09	.31	.12	48.77	24
With interaction (M2)	17.42	12	.99	.015	.99	.20	.28	.10	.32	.12		
Vertical control												
Without interaction (M1)	66.17	36	.98	.020	.98	.20	.21	.09	.25	.08	34.15	24
With interaction (M2)	32.02	12	.97	.028	.96	.20	.21	.10	.25	.08		
Decision authority												
Without interaction (M1)	107.47	36	.97	.030	.99	.20	.14	.09	.23	.09	52.42	24
With interaction (M2)	58.05	12	.95	.042	.91	.20	.15	.10	.24	.09		
Empowerment												
Without interaction (M1)	99.19	36	.97	.029	.96	.21	.10	.08	.21	.08	44.97	24
With interaction (M2)	54.22	12	.96	.041	.91	.21	.11	.08	.22	.08		

[1] n = 2 103

Table 4:

Direct effects and interaction effects of demands- and control- and support variables on job outcome variables[1].

Mode-rating Variable	Job outcome variable		Demands: Quantitative demands		Cognitive learning demands		Cognitive decision demands		Sensorial demands		Emotional demands		Risk demands		Direct effect of moderating variable
		R^2 %	Direct[2]	Interaction	Direct	Interaction	Direct	Interaction	Direct	Interaction	Direct	Interaction	Direct	Interaction	
Skill Discretion	Job sat.	24.3	-.09*	-.04	-.01	-.08*	.03	.08*	.04	.04	-.15*	.05*	-.03	.00	.45*
	Subj..hlt	13.0	.10*	-.02	.04	.05	-.03	.00	.04	-.08*	.13*	-.06*	.04	.06*	-.24*
	Job strs.	25.8	.31*	.03	.01	.03	.08*	-.05	.05*	-.07*	.21*	-.06*	.03	.01	-.24*
	Mastery	9.2	-.07*	-.06	.19*	.01	-.04	.14*	.16*	-.01	-.14*	.02	-.01	-.02	.04
Social Support	Job sat.	27.5	-.07*	-.01	.08*	-.08*	.12*	-.06*	.00	.05*	-.09*	.00	-.07*	.01	.46*
	Subj.hlt.	9.9	.11*	-.06*	-.03	.01	-.09*	.00	.06*	-.03	.11*	-.02	.07*	.02	-.14*
	Job strs.	31.9	.29*	.02	-.01	.07*	.05	-.09*	-.02	-.03	.16*	.01	.04*	.02	-.34*
	Mastery	12.3	-.04	-.01	.16*	-.01	-.04	.00	.14*	.03	-.10*	.00	.00	.01	.23*
Vertical control	Job sat.	21.0	-11*	.00	.09*	-.04	.07*	.05	.03	-.01	-.15*	.03	-.04*	-.02	.38*
	Subj hlt.	9.7	.12*	.02	-.02	.00	-.06*	.00	.04	-.03	.12*	-.05*	.06	.05*	-.15*
	Job strs.	25.1	.33*	-.01	-.03	.03	.06*	-.04	-.04	-.03	.24*	-.02	.03	.04*	-.22*
	Mastery	8.2	-.06*	-.03	.18*	-.02	-.04	.04	.16*	.00	-.14*	.04	-.01	-.04	.06*
Decision authority	Job sat.	14.7	-.11*	.00	.10*	.02	.08*	.06*	.03	.01	-.15*	.04	-.06*	-.01	.28*
	Subj hlt.	9.5	.12*	.00	-.01	.03	-.06*	-.04	.04	-.04	.12*	-.04	.05*	.02	-.15*
	Job strs.	24.4	.33*	.02	-.02	.06	.07*	-.06*	-.04	-.06*	.21*	-.02	.03	-.01	-.19*
	Mastery	9.0	-.06*	-.03	.17*	.00	-.06*	.03	.16*	.01	-.14*	.03	.00	.00	.13*
Empower-ment	Job sat.	11.0	-.10*	.05*	.11*	-.03	.12*	.08	.02	.00	-.16*	.01	-.07*	.02	.16*
	Subj hlt.	8.5	.11*	-.03	-.02	.01	-.08*	.03	.05	-.02	.13*	-.04	.06*	.02	-.11*
	Job strs.	21.8	.32*	.01	-.03	.02	.03	-.06*	-.04	-.01	.21*	-.03	.05*	-.01	-.10*
	Mastery	8.0	-.06*	-.02	.17*	-.02	-.03	.06*	.16*	-.01	-.14*	.01	-.01	-.01	.06*

[1] Standardized LISREL estimates
[2] Direct effect estimates are based on M2, the model including interaction effects

Table 5: Main effects variation[1] between five models including one each of the five control- and support variables[2]

Relationship[3]	Minimum standardized regression coefficient	Maximum standardized regression coefficient	Mean standardized regression coefficient	Std. Deviation
JS-Q	-.11*	-.07*	-.10*	.02
SH-Q	.10*	.12*	.11*	.01
ST-Q	.29*	.33*	.32*	.02
M-Q	-.07*	-.04	-.06*	.01
JS-CL	-.01	.11*	.07*	.03
SH-CL	-.03	.04	-.01	.03
ST-CL	-.03	.01	-.02	.02
M-CL	.16*	.19*	.17*	.01
JS-CD	.03	.12*	.08*	.04
SH-CD	-.09*	-.03	-.06*	.02
ST-CD	.03	.08*	.06*	.02
M-CD	-.06*	-.03	-.04*	.01
JS-S	.00	.04	.02	.02
SH-S	.04	.06*	.05*	.01
ST-S	-.04	.05	-.02	.04
M-S	.14*	.16*	.16*	.01
JS-E	-.16*	-.09*	-.14*	.03
SH-E	.11*	.13*	.12*	.01
ST-E	.16*	.24*	.21*	.03
M-E	-.14*	-.10*	-.13*	.02
JS-R	-.07*	-.03	-.05*	.02
SH-R	.04	.07*	.06*	.01
ST-R	.03	.05*	.04*	.01
M-R	-.01	.00	-.01	.01

[1] Parameter estimates are from the M2's, the interaction models.
[2] Control- and support variables are: Skill Discretion. Vertical Control. Decision Authority. Empowerment and Social Support
[3] JS = Job satisfaction
SH = Subjective health
ST = Job stress
M = Mastery
Q = Quantitative demands
CL = Cognitive learning demands
CD = Cognitive decision demands
S = Sensorial demands
E = Emotional demands
R = Risk demands

*** = Significant at p £ .05**

Table 6: Closer evaluation of significant interactions among psychological job demands and moderating variables in the prediction of job outcomes[1]

Demands	Job outcome	Moderating demand- and support variable									
		Skill discretion		Social support		Vertical control		Decision authority		Empowerment	
		Low	High	Low	High	Low	High	Low	High	Low	High
Quantitative demands	Job satisfaction									-.234	-.025
	Subjective health			.214*	.020						
	Job stress										
	Mastery										
Cognitive learning demands	Job satisfaction	-.076	-.031	.169*	.066						
	Subjective health										
	Job stress			.096	.200*						
	Mastery										
Cognitive decision demands	Job satisfaction	-.213*	.042	.059	.121*			-.058	.176*		
	Subjective health										
	Job stress			.244*	.251*			.322*	.211*	.250*	.277*
	Mastery	-.169*	.056							-.064	.022
Sensorial demands	Job satisfaction			-.014	.101*						
	Subjective health	.116*	-.081								
	Job stress	.279*	.032					.146*	.136*		
	Mastery										
Emotional demands	Job satisfaction	-.292*	-.076								
	Subjective health	.233*	.118*								
	Job stress	.478*	.282*			.206*	.111*				
	Mastery										
Risk demands	Job satisfaction										
	Subjective health	-.085	.062								
	Job stress					-.104*	.119*				
	Mastery					.008	.129*				

[1] Standardized regression coefficients for groups with control- and support variable values less than – 1SD (Low) and higher than +1SD (High)

* Significant at $p \leq .05$