# Learning new behaviour patterns: a longitudinal test of Karasek's active learning hypothesis among Dutch teachers

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This investigation deals with the active learning hypothesis in Karasek and Theorell's (1990) job demands-control model. The active learning hypothesis holds that high levels of learning and self-efficacy will occur among incumbents of high job demands/high job control jobs, whereas low levels of learning and self-efficacy will be found in low demands/low control jobs. This study tested these notions in the context of a two-wave study conducted over a period of one year among 876 Dutch teachers. Regression analysis revealed that job demands had a lagged negative (rather than a positive) effect on learning and self-efficacy; as expected, job control had a positive effect. Thus, the highest levels of learning and self-efficacy were found among incumbents of high control/low demands jobs (and not among incumbents of high control/high demands jobs). Further, the effects of changes in work characteristics on changes in learning behaviour and self-efficacy were examined, providing additional evidence that especially the transition from a low demands/low control to a high demands/low control job is associated with a strong deterioration of learning and self-efficacy. It is concluded that future research should address the interrelationships between learning and strain, preferably using longitudinal designs.

## 1. Introduction

Karasek's (1979) Job Demands-Control model (JDC model) has been a leading work stress model in occupational health psychology since the 1980s. At the heart of the model lies the assumption that a psychological work environment can be characterized by a combination of the demands of the work situation and the amount of control employees have with which to cope with these demands. Whereas early formulations of the JDC model mainly focused on the effects of various combinations of job demands and job control on stress and health-related outcomes (Karasek, 1979), more recent formulations consider their

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implications for learning new behaviour patterns as well (the 'active learning' hypothesis, Karasek & Theorell, 1990; Karasek, 1998).

The JDC model distinguishes between four different job types. In low control/high demands (or 'high strain') jobs high levels of strain and relatively low levels of learning are predicted because the individual cannot respond optimally to situational demands (Karasek & Theorell, 1990). The label 'high strain job' is somewhat misleading, because it confounds the job content (high demands/low control) with one of its presumed outcomes (high strain). However, as low control/high demands jobs are commonly referred to as 'high strain jobs', we employ the latter term throughout this paper. Thus, here the term 'high strain job' is used to refer to the combination of high demands/low control, and *not* to the presumed outcome of this combination.

If high job demands occur in conjunction with high job control ('active' jobs; again, here the job content is confounded with the presumed outcome), employees are thought to be able to deal with these demands, protecting them from excessive strain. Learning and feelings of mastery may result. These, in turn, may help the person to cope with the inevitable strain-inducing situations of the job, resulting in reduced strain and even higher levels of productivity (Karasek & Theorell, 1990). Incumbents of low demand/low control jobs (or 'passive' jobs, referring to the presumed outcome of this particular work situation) will experience low levels of strain because the demands of the situation are low, in spite of the fact that those individuals have little opportunity to influence their work situation. Passive jobs are presumed to offer little opportunity for learning and personal development. According to Karasek (1998), such jobs even lead to ' "negative learning" or gradual loss of previously acquired skills' (p. 34.7). Finally, low job demands and high job control jobs ('low strain' jobs, in terms of the presumed outcome) are expected to lead to low levels of strain because incumbents have plenty of possibilities for coping with situational demands. Moderate levels of learning are expected for such jobs because incumbents can explore different ways of dealing with job demands, which is conducive to learning (Bandura, 1997).

Although the JDC model has generated an impressive body of research, to date almost all studies have concentrated on its predictions for employee strain and ill-health. According to Parker and Sprigg (1999), p. 926), 'Few, if any, investigations have tested the learning-related predictions of the [...] demands-control model put forward by Karasek and Theorell (1990)'. Virtually none of the longitudinal studies on the JDC model reviewed by De Lange, Taris, Kompier, Houtman, & Bongers (submitted for publication) explicitly considered learning-oriented concepts; the same applies to the studies included in other reviews on the JDC model (Van der Doef & Maes, 1999). The paucity of research addressing learning-oriented outcomes is striking, even more so because many current management practices and philosophies promote the development of self-managing and development-oriented employees (Parker & Sprigg, 1999).

The current study was designed to shed more light on the effects of job demands and job control on employee learning in the context of a two-wave study among 876 Dutch teachers. Below we first present a short review of studies on the learning hypothesis. Based on this review, a comprehensive set of hypotheses is developed and tested.

## 2. Demands, control, and the active learning hypothesis

Previous studies on the learning hypothesis of Karasek's JDC model were identified through a systematic literature search in the Medline and PsycInfo databases. Keywords used in this search were 'demands', 'control', 'work', 'employment', 'active', 'passive', 'activation', 'learning', and 'Karasek', in various combinations. Studies were considered relevant if the abstract revealed that measures of both job demands and job control were included in the study. Further, recent publications of known experts were scrutinized for possible relevance, as were the reference lists included in these publications.

### 2.1. *Active learning: what do we know?*

One problem with the active learning hypothesis in the JDC model is that Karasek and Theorell (1990) are not always clear about the concepts that should be used to test this hypothesis. For example, they speak of 'learning motivation to develop new behavior patterns' (p. 32), 'learning and increased motivation' (p. 38), 'effective learning' (p. 39, suggesting a link with productivity), 'new patterns of behavior and skills' (p. 51), 'labor motivation' (p. 51), 'active learning' (p. 53), 'additions to competence' (p. 92), 'the range of comfortable challenges' (p. 93), 'feeling of mastery' (p. 99), and so on. Owing to this conceptual ambiguity (are we talking about learning behaviour, motivation in general, motivation for learning in particular, breadth of skills, or feelings of mastery and efficacy?) it is quite hard to judge whether a particular outcome is suitable for testing the active learning hypothesis. Further, some of the concepts suggested by Karasek and Theorell (1990) are difficult to operationalize. Most importantly as yet there is no well-established instrument that taps the central concept in the active learning hypothesis, namely the *motivation for learning new behavioural patterns*. The literature search revealed that previous research on learning in the JDC model largely focused on four clusters of outcomes: (1) job satisfaction; (2) job involvement and job commitment; (3) self-efficacy and mastery; and (4) job challenge.

2.1.1. *Job satisfaction:* Overall job satisfaction is one of the most frequently examined outcome variables in work and organizational psychology. It usually refers to an affective judgement of the content and/or the circumstances of one's job. *If* job satisfaction can be construed as a measure reflecting employee learning, one would expect the highest levels of satisfaction (or, conversely, the lowest levels of *dis*satisfaction) to occur in active jobs, and the lowest (highest) levels of satisfaction (or dissatisfaction) in passive jobs.

The evidence for this hypothesis is mixed. De Jonge, Van Breukelen, Landeweerd & Nijhuis (1999), De Jonge, Dollard, Dormann, Le Blanc & Houtman (2000) and Dollard, Winefield, Winefield & De Jonge (2000) found in three studies among health care and human service workers that active jobs produced the highest levels of job satisfaction. The results of two other studies are not entirely consistent with the learning hypothesis. Landsbergis, Schnall, Deitz, Friedman and Pickering (1992) reported that levels of job *dis*satisfaction were the lowest in low strain jobs (and not in active jobs), while Dollard and Winefield (1998) found that the highest levels of *dis*satisfaction occurred in high strain jobs (and not in passive jobs).

Thus, there is no conclusive evidence that the highest levels of job satisfaction occur in active jobs. The answer to the question as to whether further research that addresses job satisfaction in the context of the learning hypothesis is needed, however, depends on the validity of the job satisfaction construct for testing the active learning hypothesis. Parker and Sprigg (1999) argue that being satisfied with one's job may actually be a quite passive state of mind (i.e. a state of 'resigned satisfaction', Feldman, 1981). Moreover, it is difficult to see how job satisfaction relates to the motivation for learning new behaviour patterns. Thus, studies in which the learning hypothesis of the JDC model is investigated using job satisfaction are largely irrelevant to this hypothesis: the construct validity of job satisfaction in the context of the active learning hypothesis is low.

2.1.2. *Job involvement and commitment:* Two other frequently examined outcome variables are organizational (or job) involvement and job commitment. In the context of Karasek and Theorell's (1990) learning hypothesis, the highest levels of commitment/involvement are expected among incumbents of active jobs; the lowest levels are expected for passive jobs. Consistent with the active learning hypothesis, Landsbergis *et al*. (1992) found that levels of job involvement were highest in active jobs. However, De Jonge, Janssen and Van Breukelen (1996) and Demerouti, Bakker, De Jonge, Janssen, & Schaufeli (2001) reported that job involvement varied positively with control; no main or interaction effects with job demands were found.

To some degree, the remarks made for the construct validity of job satisfaction as a measure of active learning apply to job commitment and involvement as well. One may argue that the combination of high job demands and high job control 'activates' various forms of commitment, but it is unclear how commitment relates to the motivation for learning new behaviour patterns or, indeed, to 'activation' in general. Further, it appears that items such as 'I tell my friends and family that my organization is a pleasurable organization to work for' (Mowday, Steers, & Porter, 1979; cf. Demerouti *et al*., 2001) reflect Feldman's (1981) resigned satisfaction at least as strongly as Karasek and Theorell's (1990) active learning. Thus, it is—again—questionable whether studies examining job involvement as a measure of learning are relevant for testing the active learning hypothesis.

2.1.3. *Efficacy and mastery:* Self-efficacy and feelings of mastery seem conceptually much more appropriate for testing the active learning hypothesis. These concepts refer to feelings of self-confidence, having effective coping strategies and adequate performance at work. High scores on these concepts are expected for incumbents of active jobs; conversely, low levels of efficacy and mastery should occur among employees in passive jobs.

Consistent with this reasoning, Demerouti *et al*. (2001) and Dollard *et al*. (2000) reported that jobs combining high demands with high control produced the highest levels of personal accomplishment (a subscale of the Maslach Burnout Inventory (Maslach and Jackson, 1986) that reflects feelings of competence and successful achievement in one's work). In a carefully designed study, Parker and Sprigg (1999) found main effects of job control and job demands on perceived mastery (a measure tapping whether one felt able to resolve selected job-related problems) and role breadth self-efficacy (a concept reflecting one's confidence regarding carrying out a range of proactive or interpersonal tasks). As expected, the highest levels of role breadth self-efficacy were found in active jobs. However, levels of perceived mastery were highest in low strain jobs (and not in active jobs). Finally, Holman and Wall (2002) reported main effects of demands and control on self-efficacy, such that incumbents of active jobs experienced the highest levels of self-efficacy. All in all, it appears that current evidence is largely in line with Karasek and Theorell's (1990) predictions.

2.1.4. *Job challenge:* The fourth cluster of outcome variables concerns job challenge, loosely defined as the degree to which employees perceive their jobs as challenging, intrinsically motivating and stimulating—all conditions that are conducive to learning. If the learning hypothesis applies, incumbents of active jobs should report the highest levels of challenge, motivation and stimulation. This hypothesis was confirmed in the studies of Dollard and Winefield (1998) and De Jonge *et al*. (1999, 2000). Further, Van Yperen and Hagedoorn (in press) reported that the highest levels of intrinsic motivation occurred for high levels of job demands and job control, combined with low levels of social support. In contrast to these findings, De Jonge *et al*. (1996) found only a main effect of job control and no main or interaction effect of job demands. All in all, this evidence largely supports the assumption that the highest levels of challenge and stimulation are found among incumbents of active jobs.

2.1.5. *Other outcomes—Seeking feedback, active coping, and leisure activities:* Finally, our literature review revealed three studies that employed other outcome variables. One of the outcome variables in Dollard and Winefield's (1998) study was the degree to which participants *sought feedback*. One would expect that incumbents of active jobs would report the highest levels of seeking feedback, as feedback may help them in developing adequate task behaviours. Dollard and Winefield's (1998) study supported this reasoning. Meijman, Ulenbelt, Lumens, and Herber (1996) argued that employees in active jobs will have developed adequate ways of dealing with possible adverse effects of harmful work conditions. Their study among two worker populations exposed to lead revealed that incumbents of active jobs worked in environments with the lowest levels of lead dust in ambient air at the workplace (which supports the reasoning that active jobs offer much room for active coping): however, lead levels in the blood were highest among these workers (thus contradicting the hypothesis). Finally, Karasek (1981) examined whether incumbents of active jobs were also more active regarding their leisure time activities, measured as community-level participation in recreational and political activities. Essentially, this is a test of the spillover hypothesis that argues that activities in one life domain (e.g. work) will generalize to other domains (for example the family, cf. Geurts & Demerouti, 2002). Karasek (1981) found some evidence that workers who reported having high demands/high control spent more time on active leisure activities than others, which supported his hypothesis that having an active job increases overall activation level.

### 2.2. *Evaluation of previous research on the learning hypothesis*

Although the results discussed above are reasonably consistent with the learning hypothesis, it should be noted that this research suffers from several limitations. Two problems stand out as being especially important. First, it appears that some of the studies on the active learning hypothesis have employed conceptually poor measures of employee learning. The construct validity of job satisfaction and job involvement/commitment as measures of active learning seems low. Earlier research (Parker, 2000) made a similar distinction between satisfaction/commitment and learning outcomes, showing that satisfaction and commitment are empirically distinct from self-efficacy and other such learning-oriented outcomes. Interestingly, the strongest support for the active learning hypothesis was found for job challenge/motivation and efficacy/mastery, i.e. the outcomes that best reflect the motivation for learning new behaviour patterns.

Second, virtually all the studies discussed above employed cross-sectional designs, meaning that these studies could not examine the *across-time development* of learning-related concepts (but see Holman & Wall, 2002, for a notable exception). Whereas cross-sectional studies provide information regarding the levels of active learning across the four Karasek job types, they cannot provide any evidence regarding the development of learning across time, i.e. in relation to across-time change in levels of job demands and job control. If work characteristics indeed affect worker learning, changes in learning should covary with changes in work characteristics. A change from one job type to another (e.g. from a passive job to an active job) should thus be associated with a corresponding change in terms of learning. In this context it is interesting to note that Karasek (1998) argues that excessive job strain limits the opportunities for learning; conversely, incumbents of active jobs develop feelings of mastery and confidence. The latter 'helps the person to cope with the inevitable strain-inducing situations of the job. The result is reduced residual strain and thus increased capacity to accept still more learning... *ad infinitum*' (Karasek & Theorell, 1990, p. 103; italics ours). Thus, changes in learning may be due to the accumulation of exposure to particular job characteristics—even *lack of* change in these characteristics may result in changing levels of learning. To date no study has tested this theoretically interesting and practically important prediction.

Taking these limitations into account, it seems fair to conclude that the evidence for Karasek and Theorell's (1990) active learning hypothesis is actually quite weak. Few studies have explicitly addressed this hypothesis; the outcomes employed in these studies are not always the best conceivable representatives of active learning; and researchers have almost exclusively relied on cross-sectional designs, meaning that no causal inferences can be made and that potentially interesting questions regarding the across-time development of learning have not been addressed.

### 2.3. *Hypotheses*

The issues outlined above were addressed using data from a two-wave study among 876 Dutch teachers. On the basis of the notions outlined above, two sets of hypotheses were developed. The first set of hypotheses deals with the across-time effects of Time 1 job demands and job control on Time 2 learning. After controlling for the effects of Time 1 learning and background variables such as age and gender, it is expected that the combination of high job demands and high job control at Time 1 will lead to high levels of learning at Time 2, in the form of two main effects of job demands (a positive effect, *Hypothesis 1a*) and job control (a positive effect, *Hypothesis 1b*). Further, it is expected that the combination (i.e. multiplicative interaction) of high levels of job demands and high levels of job control will lead to higher levels of learning than would be expected on the basis of the main effects of demands and control alone (*Hypothesis 1c*).

The second set of hypotheses is concerned with changes in learning as a function of stable or changing job characteristics (i.e. from one Karasek job type to another). By examining changes in learning more insight may be gained in the effects of being an incumbent of a particular type of job. As this study employed a two-wave design, 16 different trajectories (or Demand-Control Histories (DCHs), cf. De Lange, Taris, Kompier, Houtman, & Bongers, 2002a) could be distinguished. For each DCH a separate hypothesis was formulated on the basis of the theoretical notions discussed above (Hypotheses 2a–2p). These are summarized in the first four columns of Table 1, together with the changes in learning that are expected for these trajectories.

According to Karasek and Theorell (1990), the lowest levels of learning are expected for incumbents of passive jobs. This implies that any transition away from the passive job type will be associated with an increase in learning (cf. Table 1, 4th column), irrespective of the designation of the job (i.e. a high strain job, Hypothesis 2b; a low strain job, Hypothesis 2c; or an active job, *Hypothesis 2d*). By the same token, any transition towards the passive job type should result in lower levels of learning, irrespective of the origin of the job (i.e. a high strain job, *Hypothesis 2e*; a low strain job, *Hypothesis 2i*; or an active job, *Hypothesis 2m*).

Karasek and Theorell (1990) further argue that the highest levels of learning will occur among incumbents of active jobs. This implies that any change towards the active job type

Table 1. Means and standard deviations of Learning motivation and Personal accomplishment for the 16 Demand-Control Histories (DCH)

| | | | | | Learning motivation | | | | | | Personal accomplishment | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Time 1 | | Time 2 | | | | Time 1 | | Time 2 | | | |
| Hypothesis/ DCH | Position Time 1 | Position Time 2 | Expected effect | *N* | M | SD | M | SD | $F^{\dagger}$ | Hypothesis confirmed? | M | SD | M | SD | $F^{\dagger}$ | Hypothesis confirmed? |
| 2a | Passive | Passive | – | 90 | 3.65 | .42 | 3.54 | .44 | 4.01* | Y | 4.15 | .76 | 4.28 | .77 | .77 | N |
| 2b | | High strain | + | 38 | 3.54 | .46 | 3.53 | .49 | .03 | N | 4.07 | .88 | 3.64 | .73 | 10.21* | N |
| 2c | | Low strain | + | 49 | 3.75 | .59 | 4.01 | .44 | 7.36* | Y | 4.28 | .70 | 4.39 | .67 | .10 | N |
| 2d | | Active | + | 13 | 3.87 | .40 | 3.82 | .61 | .21 | N | 4.39 | 1.01 | 4.09 | .92 | 1.72 | N |
| 2e | High strain | Passive | – | 40 | 3.58 | .57 | 3.55 | .58 | .24 | N | 3.97 | .76 | 4.08 | .86 | .38 | N |
| 2f | | High strain | 0 | 153 | 3.22 | .56 | 3.25 | .59 | .79 | Y | 3.59 | .90 | 3.56 | .86 | 1.09 | Y |
| 2g | | Low strain | + | 27 | 3.56 | .49 | 3.60 | .44 | .30 | N | 4.13 | .64 | 4.20 | .71 | 1.01 | N |
| 2h | | Active | + | 73 | 3.50 | .50 | 3.59 | .48 | 2.96 | N | 3.74 | .78 | 3.85 | .86 | .97 | N |
| 2I | Low strain | Passive | – | 33 | 3.83 | .48 | 3.85 | .43 | .05 | N | 4.33 | .81 | 4.24 | .86 | .55 | N |
| 2j | | High strain | – | 15 | 3.94 | .66 | 3.50 | .47 | 10.42* | Y | 4.26 | .82 | 3.78 | .79 | 4.41* | Y |
| 2k | | Low strain | 0 | 110 | 4.05 | .49 | 3.98 | .46 | 3.92* | N | 4.66 | .67 | 4.60 | .65 | 1.93 | Y |
| 2l | | Active | + | 43 | 3.97 | .52 | 3.85 | .53 | 2.62 | N | 4.53 | .58 | 4.21 | .71 | 14.34* | N |
| 2m | Active | Passive | – | 12 | 3.86 | .59 | 3.83 | .60 | .11 | N | 4.19 | .63 | 4.05 | .88 | .11 | N |
| 2n | | High strain | – | 43 | 3.73 | .53 | 3.51 | .56 | 4.15* | Y | 3.78 | .77 | 3.70 | .76 | 1.55 | N |
| 2o | | Low strain | – | 41 | 3.98 | .47 | 3.98 | .51 | .00 | N | 4.24 | .82 | 4.33 | .72 | 1.95 | N |
| 2p | | Active | + | 96 | 3.70 | .60 | 3.71 | .55 | .13 | N | 4.18 | .75 | 4.10 | .77 | 1.10 | N |

– = decrease across time; + = increase across time; 0 = no change across time.

†The number of degrees of freedom equals (1, $N-1$) for this comparison. *F*-values are adjusted for age, gender, experience, and type of contract.

*$p < .05$

will be associated with an increase in learning, be it from a passive job (*Hypothesis 2d*), a high strain job (*Hypothesis 2h*), or a low strain job (*Hypothesis 2l*). Conversely, any change away from the active job type should result in lower learning (i.e. changes towards a passive job, *Hypothesis 2m*; changes towards a high strain job, *Hypothesis 2n*; and changes towards a low strain job, *Hypothesis 2o*).

If the lowest levels of learning occur among workers holding a passive job and the highest levels of learning among incumbents of active jobs, it follows that intermediary levels of learning will be found among incumbents of high strain and low strain jobs. However, Karasek and Theorell (1990); Karasek, 1998) argue that high levels of strain inhibit learning. If this is correct, incumbents of low strain jobs will report higher levels of learning than incumbents of high strain jobs. This suggests that a transition from a low strain to a high strain job will be associated with a decrease in learning (*Hypothesis 2j*), whereas the opposite applies for transitions from an high strain to a low strain job (*Hypothesis 2g*).

What happens if incumbents of a particular job remain in the same job for a longer period? What are the cumulative effects of exposure to a particular combination of job demands and control? Karasek and Theorell (1990), p. 38) state that

> The passive job setting is [a] major psychosocial problem... lost skills, lack of job challenges, and environmentally rigid restrictions preventing workers from testing their own ideas for improving the work process can only mean an extremely unmotivating job setting and result in long term loss of work motivation and productivity.

Thus, a prolonged stay in this job type would lead to a lower level of learning (Hypothesis 2a). For active jobs the opposite prediction is made: the combination of high demands with high levels of control is expected to result in even higher levels of learning across time ('ad infinitum', Karasek & Theorell, 1990, p. 103) (Hypothesis 2p).

Karasek and Theorell (1990) did not explicitly address the implications of a prolonged stay in low and high strain jobs for learning. As argued earlier on, for these job types intermediary levels of learning are expected, with somewhat higher levels for the low strain jobs. There seems to be no reason to expect across-time changes in learning for incumbents of low strain jobs (Hypothesis 2k) and high strain jobs (Hypothesis 2f).

## 3. Method

### 3.1. *Sample*

The data were collected as part of a two-wave study. Names and addresses of 2500 primary and secondary Dutch school teachers were randomly drawn from the files of the organization that collects social security contributions from all teachers in the Netherlands. Initially intended participants received a written questionnaire that addressed psychological and physical well-being (including motivational variables), job demands and job control, and several biographical variables. After 4 weeks some 1309 questionnaires had been returned (52.3% response rate; mean age = 43.6 years, SD = 8.0 years, 51% female, mean number of years of teaching experience was 19.1 years, SD = 8.3 years, mean number of years employed at the current school was 13.6 years, SD = 8.3 years). Comparison of the sample characteristics with those of the population (as known from the files of the organization) revealed no differences in age, gender or school type. The majority of the Time 1 sample also co-operated in the second wave of the study which was conducted one year later, yielding a 76.2% response rate in relation to the original sample ($N = 998$). The one-year interval between the waves of the study was chosen because it was necessary to control the fluctuations in teachers' workload across the school year. A longer time interval (e.g. a two-year interval) was deemed to be undesirable due to higher attrition rates.

Multivariate analysis of variance revealed that the mean scores on the study variables of those who dropped out of the study did not differ from those who remained in the study, $F(11, 1298) = 1.48$, ns. Thus, dropout was not selective. Participants who changed jobs during the Time 1−Time 2 interval were excluded from the sample. Finally, listwise deletion of missing values resulted in a final sample of 876 teachers.

3.2. *Measures*

3.2.1. *Job demands:* Many studies on the effects of job demands and job control employ general measures of these concepts (e.g. the scales of Karasek's Job Content Instrument (1985)). The disadvantage of global measures is that they are not tailored towards the specific demands of particular professions, meaning that the effects of these global measures on the outcome variables may be underestimated. Occupation-specific measures may improve the predictive power of measures (De Jonge *et al.*, 2000). Previous research has shown that the interaction with students is the most demanding aspect of a teacher's job (Van Horn, Schaufeli & Taris, 2001). Therefore, job-specific demands were measured using a subscale of Kamphuis and Van Poppel (1994) School Health Questionnaire, tapping the degree to which the participants felt burdened by 13 aspects of the interaction with the students. Exemplary aspects were 'students showing lack of interest and motivation' and 'misbehavior among students' (1 = 'not at all', 5 = 'very much'). The reliability of this scale (Cronbach's alpha ($\alpha$) was .88 at Time 1 and .89 at Time 2. Previous research (Nyklicek, Vingerhoets, Van Heck, Kamphuis, Van Poppel, & Van Limpt, 1997; Taris, Peeters, Le Blanc, Scheurs, & Schaufeli, 2001) has demonstrated the validity of this scale.

3.2.2. *Job control:* The degree to which the participants could influence the content of their tasks was measured with a 7-item scale that was partly based on the work of Warr (1990), complemented with items that tapped specific aspects of the work situation of teachers. Sample items are 'I can influence things that happen at school', 'The school management determines to a large degree how I do my job' (reversed), and 'At school I make my own decisions' (1 = 'completely disagree', 5 = 'completely agree'). Exploratory factor analysis revealed that at both occasions a single-factor solution emerged, explaining 40.2% (Time 1, item loadings ranging from .47 to .72, median loading .66) and 39.4% (Time 2, loadings ranging from .47 to .75, median loading.63) of the variance in the items. The reliability of this scale ($\alpha$) was .73 and .74 at Time 1 and Time 2, respectively.

3.2.3. *Active learning:* Given the fuzzy conceptualization of active learning, the present study employed two measures that reflected different aspects of this concept. According to Karasek and Theorell (1990), active learning results in feelings of self-efficacy and mastery. Self-efficacy was measured using a Dutch adaptation of the 7-item Personal Accomplishment (PA) scale developed by Maslach, Jackson and Schwab (1996) for use by teachers. Typical items are 'I know how to deal with my students' problems effectively' and 'I have accomplished many worthwhile things in this job' (0 = 'never', 6 = 'every day'), $\alpha$ was .87 at Time 1 and .89 at Time 2, respectively. Analogues of the PA scale for use in other professions were employed by Demerouti *et al*. (2001) and Dollard *et al*. (2000) in their studies addressing the active learning hypothesis.

Further, Karasek and Theorell (1990, p. 32) define worker learning in terms of the 'motivation to learn new behavior patterns'. Consistent with this definition, a new 3-item

Learning Motivation scale (LM) was developed to measure the motivation for learning new behaviour patterns. Two items tapped the degree to which participants were actively looking for situations in which they could expand their skills ('I am constantly looking for new challenges in my job', and 'I spend much energy in keeping up with recent developments', 1 = 'strongly disagree', 5 = 'strongly agree'). The third item measured whether the participants were willing to invest time and effort in dealing with difficult situations, which is a precondition for acquiring new skills ('When things seem to go wrong, I increase my efforts and keep on trying'). Exploratory factor analysis revealed that 56.9% (Time 1) and 56.7% (Time 2) of the variance among the items of the LM scale was accounted for by the first factor. The item loadings ranged from .71 to .80 (median item loading = .75), and the reliability ($\alpha$) of the LM scale was .62 and .61 for Time 1 and Time 2, respectively.

Both measures of active learning were moderately correlated (.47 at Time 1 and .43 at Time 2, respectively; average correlation = .45, all $p$s $< .001$). Although this implies that tests employing these two variables are not statistically independent, the percentage of shared variance was (on average) only 21%, suggesting that they tap related, but different, dimensions of learning.

3.2.4. *Background variables:* Apart from the variables mentioned above, the current study included measures of participant gender, age, number of years of teaching experience, and average number of hours worked per week. These variables served as control variables, and no hypotheses concerning their effects were formulated.

Table 2 presents the means, standard deviations, and intercorrelations for the variables used in this study.

3.2.5. *Confirmatory factor analyses:* As three of the four main scales used in this study had not been validated extensively elsewhere (with the exception of PA), two confirmatory factor analyses (CFAs, Jöreskog & Sörbom, 1993) were conducted to see whether these scales could be distinguished from each other. In CFA a particular *a priori* model that can reasonably be expected to account for the relations among the items is specified and fitted to the data. The fit of this model can be assessed using various fit indexes. If the fit of the model is acceptable, it is accepted as a reasonable candidate for the latent structure that generated the data. Fit indexes employed here are the Non-Normed Fit Index (NNFI), the Adjusted Goodness-of-Fit Index (AGFI) and the Root Mean Square Error of Approximation (RMSEA). Values of .90 or better indicate acceptable fit for the NNFI and AGFI; for RMSEA, values of .08 and lower are acceptable (Byrne, 2001).

For both waves of the study, CFA of all of the items of job demands, job autonomy, learning motivation and personal accomplishment showed that a 4-factor solution in which the 30 items of these four scales loaded on the expected latent constructs fitted the data quite well (Time 1 chi-square ($\chi^2$) with 399 degrees of freedom was 2440.23, NNFI was .98, AGFI was .94, RMSEA was .076; Time 2 $\chi^2$ with 399 degrees of freedom was 2384.71, NNFI was .98, AGFI was .95, RMSEA was .075). In both cases, a one-factor model in which the items of these four scales loaded on the same latent factor did not fit the data well: for both occasions $\chi^2$ values with 405 degrees of freedom exceeding 8440.33 were obtained, with NNFIs and AGFIs lower than .90 and both RMSEAs higher than .15. These results show that the four main concepts employed in this study can be distinguished well from each other, thus supporting their construct validity.

Table 2. Means, standard deviations and intercorrelations for the variables in this study ($N = 876$)

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Age | 1.00 | | | | | | | | | | | |
| (2) Gender† | −.19 | 1.00 | | | | | | | | | | |
| (3) Experience (years) | .81 | −.24 | 1.00 | | | | | | | | | |
| (4) Number of hours worked | .03 | −.49 | .17 | 1.00 | | | | | | | | |
| (5) Time 1 Learning motivation | −.02 | .17 | −.04 | −.04 | 1.00 | | | | | | | |
| (6) Time 1 Personal accomplishment | −.18 | .17 | −.11 | .01 | .47 | 1.00 | | | | | | |
| (7) T1 Job demands | .12 | −.17 | .09 | .09 | −.26 | −.40 | 1.00 | | | | | |
| (8) T1 Job control | −.02 | .08 | −.02 | −.06 | .32 | .32 | −.27 | 1.00 | | | | |
| (9) Time 2 Learning motivation | −.02 | .16 | −.03 | −.05 | .60 | .39 | −.22 | .27 | 1.00 | | | |
| (10) Time 2 Personal. accomplishment | −.14 | −.18 | −.08 | −.03 | .41 | .66 | −.36 | .26 | .43 | 1.00 | | |
| (11) T2 Job demands | .14 | −.15 | .09 | .05 | −.24 | −.33 | .71 | −.22 | −.24 | −.43 | 1.00 | |
| (12) T2 Job control | −.06 | .04 | −.04 | −.05 | .24 | .27 | −.22 | .61 | .37 | .32 | −.23 | 1.00 |
| *M* | 43.91 | .51 | 19.15 | 31.44 | 3.81 | 4.12 | 2.31 | 3.57 | 3.78 | 4.10 | 2.33 | 3.52 |
| SD | 7.91 | .50 | 8.31 | 8.78 | .59 | .82 | .93 | .56 | .58 | .85 | .95 | .55 |

Correlations of .066 and over are significant at $p < .05$.
†High = female.

### 3.3. *Statistical analysis*

In the remainder of this study two sets of results are presented, corresponding with our two sets of hypotheses. Each set of hypotheses was tested twice, for PA and LM separately.

3.3.1. *Lagged linear and interaction effects of demands and control:* The first set of hypotheses concerned the lagged main and interaction effects of job demands and job control on Time 2 learning measured at Time 2, controlling Time 1 learning and several background variables. These hypotheses were tested using hierarchical stepwise regression analysis. Three blocks of variables were created. In the first step the background variables (age, gender, teaching experience, and number of hours worked) and learning behaviour as measured at Time 1 were entered (i.e. either Personal accomplishment or Learning motivation). The second block concerned the main effects of Time 1 Job demands and Time 1 Job control on Time 2 learning (either the PA scale or the LM scale, dependent on the outcome involved). The third block included the Time 1 Job demands × Job control interaction effect. To create this interaction, first $Z$-scores were obtained for Time 1 job demands and Time 1 job control. The demand-control interaction was formed by multiplying these $Z$-transformed variables. This analysis thus allows for a systematic examination of the contribution of the linear and interaction effects of job demands and job control on Time 2 learning, relative to each other and net of the effects Time 1 learning and background variables.

3.3.2. *Learning as a function of changes in demands and control:* The second set of hypotheses focused on across-time changes in learning as a function of the development of job demands and job control across time. First the variables measuring job demands and job control at each of the two waves of the study were dichotomized using a median split procedure. Consistent with the ideas of Karasek (1979), for each wave four job demands/job control combinations were formed (low strain jobs vs. active jobs vs. passive jobs vs. high strain jobs). Then 16 separate Demand-Control Histories (DCHs) were created on the basis of the participants' scores on both waves (see De Lange *et al*. (2002a) for a similar approach). Four of these DCHs (a, f, k and p in Table 1) were temporally stable, in that the participants in these groups held a similar position at both occasions. The remaining 12 DCHs present trajectories in which a change of Karasek job type was observed. The data were analysed 2 (Time: Time 1 Learning vs. Time 2 Learning) × 16 (DCH: 16 DCH types) Analysis of Covariances (ANCOVA—one for each outcome variable), with Age, Gender, Experience and Number of hours worked as covariates, and repeated measures on Time.

## 4. Results

### 4.1. *Lagged linear and interaction effects of demands and control*

The first set of results focuses on the prediction of learning across time. Table 3 presents the standardized ordinary least-squares (OLS) regression estimates for various stepwise regression equations, for learning motivation and personal accomplishment separately.

4.1.1. *Learning motivation:* As Table 3 (Model 1) shows, the variables included in the first block account for 36% of the variance in Time 2 Learning motivation. The overall $F$-value is significant, $F = 109.7$, $p < .001$, meaning that the variables in the regression equation explain a significant proportion of the variance in the outcome variable. Inspection of the separate estimates reveals that this is fully due to the effect of Time 1 Learning (a

Table 3. Hierarchical regression analyses on Time 2 Learning motivation/Personal accomplishment, standardized Ordinary Least Squares (OLS) regression estimates

| | Learning motivation | | | Personal accomplishment | | |
|---|---|---|---|---|---|---|
| Independent variables | Model 1 | Model 2 | Model 3 | Model 1 | Model 2 | Model 3 |
| Age | .002 | .013 | .012 | −.020 | −.016 | −.017 |
| Gender | .058 | .053 | .052 | .069* | .062* | .062* |
| Experience | .007 | .001 | .002 | .014 | .014 | .011 |
| Number of hours worked | .000 | .005 | .007 | −.006 | .003 | .005 |
| Time 1 Learning† | .592*** | .555*** | .556*** | .647*** | .595*** | .596*** |
| T1 Job demands | | −.056* | −.056* | | −.105*** | −.105*** |
| T1 Job control | | .075** | .070* | | .056* | .034 |
| T1 Demands × T1 Control | | | .163 | | | .023 |
| $R^2$ | .36 | .37 | .37 | .44 | .45 | .45 |
| Overall *F* | 109.70*** | 81.43*** | 71.42*** | 150.68*** | 112.35*** | 98.40*** |
| $R^2$(change) | .36*** | .01*** | .00 | .44*** | .01*** | .00 |

*$p < .05$, **$p < .01$, ***$p < .001$.
†'Learning' measured as either Learning motivation or Personal accomplishment, dependent on the outcome variable studied.

standardized effect of .59, $p < .001$); the other variables in this block do not add significantly to the prediction of Time 2 Learning motivation.

Inclusion of the main effects of Time 1 Job demands and Time 1 Job control improves the prediction of Time 2 Learning motivation slightly but significantly by 1%. Contrary to our expectations, teachers who reported high job demands tended to report *lower* rather than higher levels of learning at Time 2 (a standardized effect of −.056, $p < .05$, Hypothesis 1a rejected). A high level of control is positively associated with Time 2 Learning (an effect of .075, $p < .01$, Hypothesis 1b supported). Inclusion of the Time 1 Job demands × Job control interaction (Model 3) does not significantly improve the prediction of Time 2 Learning (Hypothesis 1c rejected).

4.1.2. *Personal accomplishment:* Table 3 shows that the results for Personal accomplishment were virtually indistinguishable from the results obtained for Learning motivation. Thus, they will not be discussed in detail. Again, the first block of variables accounted for a significant proportion of the variance in the outcome variable, as evidenced by a significant overall *F*-value; the Time 1 measure of the outcome variable was the most important predictor by far. Inclusion of the main effects of job demands and job control increased the amount of explained variance slightly but significantly. Whereas teachers with high levels of control were more likely to report high levels of PA than others (Hypothesis 1b supported), those reporting high job demands were less likely to report high levels of PA than others (Hypothesis 1a rejected). Inclusion of the demand × control interaction did not add significantly to the prediction of Personal accomplishment (Hypothesis 1c rejected).

### 4.2. *Learning as a function of changes in demands and control*

Whereas Hypotheses 1a–c were concerned with the effects of Time 1 Job demands and Time 1 Job control on Time 2 Learning, the aim of the second set of analyses was to investigate the effects of particular *changes* in job characteristics on the development of learning. According to Karasek and Theorell (1990), the highest levels of learning (i.e. PA and LM) should be found in high demand/high control ('active') jobs, and the lowest levels in low demand/low control ('passive') jobs. For the other two job types, intermediary levels of learning are assumed. If this reasoning is correct, a transition from one job type to another should be accompanied by a corresponding change in learning. The expected direction of these changes has already been presented in Table 1 (i.e. Hypotheses 2a–p). Table 1 further presents the means and standard deviations for both learning variables as a function of time and Demand Control History.

4.2.1. *Learning motivation:* ANCOVA revealed a main effect of DCH, $F(15, 856) = 15.63$, $p < .001$, and a Time × DCH interaction effect, $F(15, 860) = 3.19$, $p < .001$. No significant main effect of Time was observed, $F(1, 860) = 3.53$, ns. Thus, LM varied across and within DCHs. As the Time × DCH interaction was significant, it is useful to inspect the effects of Time for each separate DCH. Table 1 (columns 6–11) presents the relevant means, standard deviations and $F$-values, testing the difference between the Time 1 and the Time 2 measure of learning for each separate DCH.

Participants who held a low demands/low control (or 'passive') job at both occasions (DCH a) reported a slight decrease in learning across time (from 3.65 to 3.54, $F(1, 89) = 4.01$, $p < .05$). Thus, consistent with the ideas of Karasek and Theorell (1990), a prolonged stay in a passive job had adverse effects on worker learning (Hypothesis 2a supported). Further, a transition from a passive job to a low strain job (DCH c, involving an increase of job control) was associated with an increase of learning, means were 3.75 and 4.01, respectively, $F(1, 48) = 7.36$, $p < .001$ (Hypothesis 2c supported).

Earlier on we argued that incumbents of low strain jobs would report more learning than incumbents of high strain jobs. This idea was supported by the finding that a transition from low strain to high strain (DCH j, corresponding with higher demands and lower control) was associated with a strong decrease in learning, means were 3.94 and 3.50 for Time 1 and Time 2, respectively, $F(1, 14) = 10.42$, $p < .001$. This suggests that low strain is a favourable condition for learning. However, our results are not entirely consistent with this reasoning: a prolonged stay in the low demands/low control ('low strain') condition (DCH k) was associated with slightly lower levels of learning, means were 4.05 and 3.98, respectively, $F(1, 109) = 3.92$, $p < .05$ (Hypothesis 2k rejected).

According to Karasek and Theorell (1990), there is no reason to expect that a prolonged stay in the high demands/low control ('high strain') condition (DCH f) would lead to a change in learning. Table 1 shows that this expectation was supported; level of learning did not change across time, means were 3.22 and 3.25 for Time 1 and Time 2, respectively, $F(1, 152)$ $p < 1.00$, ns (Hypothesis 2f supported).

Finally, we expected that a transition from an active job to a high strain job (DCH n, involving a decrease of job control) would lead to a lower level of learning. In support of this reasoning, a transition from an active job to a high strain job was associated with a strong decrease of learning, means were 3.73 and 3.51, respectively, $F(1, 42) = 4.15$, $p < .05$ (Hypothesis 2n supported). For the other DCHs no significant changes in learning were observed (Hypotheses 2b, 2d–e, 2g–i, 2k–m, 2o–p rejected).

4.2.2. *Personal accomplishment:* ANCOVA revealed main effects of Time, $F(1, 811) = 9.63$, $p < .01$, and DCH, $F(15, 811) = 11.74$, $p < .001$, and a Time × DCH interaction effect, $F(1, 811) = 2.56$, $p < .001$. The participants reported slightly higher levels of PA at Time 1 than at Time 2, means were 4.12 (SD = .82) and 4.10 (SD = .85), respectively. The Time × DCH interaction effect suggests that the main effect of Time is moderated by Type of DCH. The main effect of DCH signifies that the 16 DCHs differ regarding their average level of PA.

Inspection of Table 1 (columns 12–17) reveals that (absence of) change in work characteristics was rarely accompanied with the expected (absence of) change in PA. In two cases no change in PA was predicted, namely for teachers holding a high demands/low control ('high strain') job on both occasions and for teachers with a low demands/low control ('low strain') job on both occasions; in both cases no significant change in PA was observed (Hypotheses 2f, 2k supported). A change from a low strain job to a high strain job (i.e. lower job control in conjunction with higher job demands) resulted in a decrease of PA (means were 4.26 and 3.78, respectively, Hypothesis 2j supported). All other hypotheses (2a–e, 2g–i, and 2l–p) had to be rejected. Note that for two DCHs unexpected changes in PA were observed. Teachers who held a passive job at Time 1 and a high strain job at Time 2 (i.e. teachers who reported low levels of control on both occasions but for whom job demands increased across time) reported considerably lower levels of PA across time (means were 4.07 and 3.64, respectively). Further, the transition from a low strain job to an active job coincided with a decrease in PA, means were 4.53 and 4.21 for Time 1 and Time 2, respectively. Quite remarkable is that here, too, the level of job demands increased across time.

## 5. Discussion

The present study was designed to examine the active learning hypothesis in Karasek's (1979) Job demands-Control model. A literature review revealed that some of the outcome variables used to examine Karasek and Theorell's (1990) active learning hypothesis were not well suited for testing this hypothesis, as they reflected active learning behaviour (defined as the motivation to learn new behaviour patterns) only distantly. Interestingly, support for the active learning hypothesis was more consistent for outcome variables that represented the learning dimension better (e.g. job challenge, motivation, mastery, efficacy). Furthermore, virtually all studies used a cross-sectional design, meaning that potentially interesting questions regarding the across-time development of learning could not be addressed.

These issues were addressed in a two-wave study among 876 Dutch teachers. A longitudinal regression analysis revealed lagged main effects of job demands and job control on two measures of learning (learning motivation and personal accomplishment), such that lower demands and higher levels of job control were associated with higher levels of learning. The lagged demand × control interaction effect was not statistically significant. Further, the effects of the presence or absence of changes in job demands/job control on learning motivation and personal accomplishment were studied. Most of our hypotheses concerning the effects of work characteristics on the across-time development of learning were not confirmed.

Our findings hardly support the views of Karasek and Theorell (1990). While our results largely confirmed the beneficial effect of high job control on learning behaviour, high job demands were *not* associated with high levels of learning. Instead, our analyses revealed negative effects of job demands on learning, such that higher levels of job demands were associated with lower levels of learning. As only few studies have been explicitly designed to test the learning hypothesis in the JDC model, it is difficult to ascertain the degree to which this finding replicates results of earlier research. It is noteworthy, however, that Parker and Sprigg (1999) found results that were virtually identical to ours for their measure of Mastery (a measure of efficacy). They reported moderate levels of mastery for low demands-low control ('passive') *and* high demands-high control ('active') jobs, a low level of mastery for high demands-low control ('high strain') jobs, and the highest levels of mastery for low demands-low control ('low strain') jobs (Parker & Sprigg, 1999, p. 936, figure 4). Although Parker and Sprigg (1999), p. 925) conclude that their results show that 'demands and control can influence learning as proposed in the dynamic version of the demands-control model' (p. 925), it appears that this part of their results—like ours—supports the well-known *strain* hypothesis rather than the *learning* hypothesis of the JDC model.

### 5.1. *Study limitations*

Several limitations of this study are worth mentioning. First, all variables measured in this research were obtained via self-reports. This means that the magnitude of the effects reported here may have been biased due to common-method variance or the wish to answer consistently (Conway, 2002). It would seem, however, that these processes will especially influence cross-sectional correlations; their effects are likely to be less pronounced for the across-time correlations, as few participants will recall their Time 1 scores during the second wave of the study.

A second limitation derives from the fact that the current study employed a sample of teachers, thus the sample was more or less homogeneous regarding their tasks. Although the teachers in our sample worked at different schools, there may well be some variation in their tasks, but it is unlikely that their tasks differed greatly. This will probably have led to a restriction of the range of the independent variables (job demands and job control), implying that the effects of the variables on learning have been estimated conservatively. Further, note that the work characteristics of the present sample were quite favourable. As Table 2 shows, this sample obtained relatively high scores on job control (3.5 on a 5-point scale) and moderate scores on job demands (2.3) on both occasions. This underlines the need for further validation and replication of our findings using different samples with less favourable work circumstances.

A third limitation concerns the interval between the waves of the study. The present study employed a 1-year time lag. This lag may or may not correspond with the 'true' causal interval for the process under study, meaning that effects of (changes in) job demands and job control on learning and personal accomplishment reported here may have been underestimated. Stated differently, the lagged effects work on the assumption that demands and control will have their effect on personal accomplishment and learning over a 1-year period, but this may not be the period over which effects occur. Unfortunately, as yet it is unknown how long this underlying causal lag is (Taris & Kompier, 2003). Relevant to this issue, it should be noted that *post-hoc* cross-sectional analyses also revealed that on both occasions incumbents of low demands-low control jobs and high demands-high control jobs reported similar levels of learning and personal accomplishment, while the highest (lowest) levels of learning/personal accomplishment were found for incumbents of low demands/high control (high demands/low control) jobs. This suggests that similar conclusions would have been drawn, had a shorter time lag been used.

Another issue that is also related to the length of the interval between the waves concerns the question of the magnitude of the changes occurring in job demands and job control over the observed interval. This study drew heavily on the assumption that differences in Time 1/Time 2 job demands and job control reflect real changes in work characteristics, not just measurement unreliability or similar methodological artefacts. From the means in Table 2 it can be inferred that the Time 1−Time 2 difference in the mean scores of LM and PA was small (.03 and .02, respectively, on a 5-point scale). Thus, at the group level there was little change in either LM or PA. To examine this issue on the level of the individual participants, additional extreme-groups analyses were performed. Time 1–Time 2 change scores were computed for job demands and job control. The variance in these difference scores was considerable (SD = .72 for job demands and.49 for job control; in both cases about one-third of the participants reported a Time 2-score that was at least 1 SD lower or higher than their Time 1-score, as would be expected for normally distributed variables). These scores, in turn, were trichotomized with about 33% of the participants in each category, yielding a group of participants who reported about the same score on job demands/job control on both occasions, a group who reported considerably higher job demands and/or job control, and a group reporting considerably lower job demands/job control. Crossing these two dimensions resulted in 9 groups. Four of these reported major across-time changes in job demands and job control; the other 5 categories reported either no change, or change in 1 category only. The results of a multivariate analysis of variance with the Time 1–Time 2 scores of these groups on LM and Personal accomplishment as within-participant factors did not lead to substantially different insights than the analyses reported earlier on. Thus, it seems unlikely that our results were strongly influenced by the possibility that there was insufficient real change in job characteristics.

A final limitation of the present research concerns the measurement of the concepts employed here. The present study used job-specific measures of demands and control, rather than the general scales proposed by Karasek (1985). Although this should improve the predictive power of these measures (De Jonge *et al*., 2000), they may measure different aspects of demands and control than Karasek's original scales. Replication of our results using the Karasek scales would therefore seem to be desirable. A related problem applies to the learning scales employed in this study. Two outcome variables were employed that represented different facets of the learning concept. One of these (personal accomplishment) has been used in other research on the learning hypothesis as well, reflecting a possible outcome of active learning. The other outcome (learning motivation) was especially developed for the present study, tapping participant motivation for seeking situations that offer opportunities for learning. Unfortunately, as yet no other research corroborates the validity of this newly developed scale. This is an important limitation, as our literature review suggested that support for the learning hypothesis partly depended on the outcome variable under study. Further, the reliability of the LM scale was only barely above the.60 threshold. This low reliability implies that the effects of job demands and job control on LM will have been estimated conservatively; it is likely that more significant effects (and, perhaps, more support of the active learning hypothesis) would have been found had a more reliable measure of learning motivation been used. This underscores the need for further validation of our measure of learning motivation, as well as replication of the present study among other occupational groups using the current and other measures of worker learning.

### 5.2. *Practical and theoretical implications*

Despite these limitations, the authors feel that the present study has important implications for both theory and practice. From a practical point of view, it is important to note that the highest levels of learning and efficacy were *not* found for high demands/high control jobs, but rather for low demands/high control jobs. Thus, similar to earlier findings for the strain hypothesis in the JDC model (De Lange *et al*., submitted for publication) the adverse effects of excessively high demands on learning *cannot* be offset by increasing job control. One practical recommendation in job redesign is therefore not only to maximize job control, but also to prevent excessive job demands as far as possible. In this way one minimizes strain while maximizing learning behaviour at the same time.

The theoretical implications of the present results are at least as interesting. Perhaps the most remarkable finding was that our findings were more consistent with the predictions generated by the strain hypothesis of the JDC model than with the learning hypothesis: the lowest levels of learning were found for high demands/low control jobs, and the highest levels for low demands/high control jobs. This pattern of results suggests that the link between strain and learning may be much tighter than would be expected on theoretical grounds. Granted, Karasek and Theorell (1990); Karasek, 1998) maintained that strain inhibits learning and that learning inhibits strain; but they still treated these concepts as relatively independent concepts, and most other researchers have followed their lead (with the notable exceptions of Parker & Sprigg, 1999, and Holman & Wall, 2002). The present set of results, however, suggests that it might be illuminating to consider the interrelations between strain and learning in the same analysis. The question, then, is *how* strain and learning are interrelated. One possibility that would seem to be consistent with both Karasek and Theorell's (1990) ideas and our data is that the combination of high job demands/low control leads to high levels of strain; high strain may inhibit learning; less learning leads to higher levels of (perceived) demands, and, thus, higher levels of strain; and so on. Such a process would lead to a strong negative association between strain and learning. Holman and Wall (2002) provide an extensive discussion of possible linkages between learning and strain, providing some longitudinal evidence for the assumption that strain and learning mutually influence each other. Further research, preferably longitudinal, on this both scientifically and practically important issue is clearly needed.

Another interesting theoretical implication derives from the finding that a transition from a high demands/low control job towards a high demands/high control or to a low demands/low control job did *not* result in higher levels of learning. These findings are consistent with those of De Lange *et al*. (2002a), who found in a nationally representative sample among 824 Dutch employees that a transition from a high demands/low control job to a low demands/low control job did *not* lead to an improvement in health. They suggest that prolonged exposure to high strain harms an individual's potential for recovery, i.e. that a mere change of work characteristics is not sufficient for health improvement (Sluiter, Frings-Dresen, Van der Beek, & Meijman, 2001).

As the present study was among the first to examine Karasek and Theorell's (1990) learning hypothesis in a longitudinal context, it is difficult to verify to which degree our results match earlier findings. This points to the need for replication of the current results in different populations of workers: as yet our results should not be taken for granted. Further, we believe that future research should go beyond studies examining either the strain or the active learning hypothesis. The link between the concepts of learning and strain is currently ill-understood, and research examining the relationships between these concepts and work characteristics is badly needed.

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