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An Experience Sampling Study of Learning, Affect, and the Demands Control Support Model

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Abstract

The demands control support model (R.A. Karasek & T. Theorell, 1990) indicates that job control and social support enable workers to engage in problem-solving. In turn, problem-solving is thought to influence learning and well-being (e.g, anxious affect, activated pleasant affect). Two samples ($N = 78$, $N = 106$) provided data up to four times per day for up to five working days. We assessed the extent to which job control was used for problem-solving by measuring the extent to which participants changed aspects of their work activities to solve problems. We assessed the extent to which social support was used to solve problems by measuring the extent to which participants discussed problems to solve problems. Learning mediated the relationship between changing aspects of work activities to solve problems and activated pleasant affect. Learning also mediated the relationship between discussing problems to solve problems and activated pleasant affect. The findings indicated that how individuals use control and support to respond to problem-solving demands is associated with organizational and individual phenomena such as learning and affective well-being.

An Experience Sampling Study of Learning, Affect, and the Demands Control Support Model

Karasek and Theorell's (1990) demands control support model (DCSM) is one of the most influential theories of work design. One central idea is the active learning hypothesis: Control and support used for problem-solving are hypothesized to promote learning and, in turn, learning promotes well-being. Another central idea of the DCSM is the strain hypothesis: Control and support are hypothesized to prevent the accumulation of strain induced by demands.

The main contribution of this paper is to provide a direct test of the active learning hypothesis. Therefore, the contributions of this paper are relevant to debates on proactivity and work performance (Griffin, Neal, & Parker, 2007; Parker, Williams, & Turner, 2006; Parker, 2007) and cognitive processes in contemporary work environments (Hodgkinson & Healey, 2008; Morgeson & Humphrey, 2006). The paper also begins to redress the balance of research on the DCSM that has largely left the active learning hypothesis untested (de Lange, Taris, Kompier, Houtman, & Bongers, 2003; van der Doef & Maes, 1999).

Karasek and Theorell (1990) indicate that people use job control and social support for specific purposes. However, most tests of the DCSM infer rather than assess directly the purposes for which people use control and support (see de Lange et al., 2003). We used measures that map onto the theoretical processes outlined by Karasek and Theorell. By assessing specific purposes for which people use job control and social support, we were able to overcome theoretical ambiguities inherent within other tests of the active learning hypothesis. To examine the active learning hypothesis, we used measures that assess the extent to which workers change aspects of their work activities to solve problems and discuss problems with others to solve problems. These measures were indicators of the extent to which workers use job control for problem-solving and support for problem-solving. By taking into account the purposes for which

people use the beneficial job characteristics of control and support, the paper draws links between the DCSM and recent arguments that people actively shape their jobs (Clegg & Spencer, 2007; Wrzesniewski & Dutton, 2001).

The Demands Control Support Model

The DCSM is based on three major components: job demands, job control, and social support (Johnson & Hall; 1988; Karasek & Theorell, 1990). Demands have many components, but are primarily related to expending psychological effort. Examples include time pressures and difficult work. The DCSM originally contained the concept of decision latitude, comprising job control and use of skills. The job control component, the extent of authority to make decisions concerning the job, appears to be more important than the skills component (Wall, Jackson, Mullarkey, & Parker, 1996). Social support is characterized by helpful interactions with supervisors and coworkers. The active learning hypothesis is one of the central hypotheses of the DCSM (Karasek & Theorell, 1990). The hypothesis relates to the processes by which demands, control, and support influence learning and well-being. The other central hypothesis of the DCSM is the strain hypothesis, which relates to how control and support prevent the accumulation of strain caused by high demands.

Karasek and Theorell (1990) provide detailed descriptions of dynamic processes that underpin the active learning hypothesis. However, these detailed descriptions have been largely ignored in the empirical literature (for reviews, see e.g., de Lange et al., 2003; van der Doef & Maes, 1999). Most research on the DCSM has assessed workers' levels of demands, control, and support, or imputed them from occupational classifications (de Lange et al., 2003). Typically, the active learning hypothesis is expressed as the expectation that the combination of high demands, high control, and high support cause on-the-job learning. Expressed in this way, the active learning hypothesis can be operationalized either as main effects or interactions between demands and

control and/or support. The strain hypothesis is typically expressed as the expectation that the combination of high demands, low control, and low support reduce well-being. This too can be operationalized as main effects, or interactions in which control and/or support buffer the detrimental effects of high demands. However, tested in these ways, the DCSM has only received modest support from the most methodologically rigorous longitudinal studies of levels of demands, control, and support (de Lange et al., 2003). Moreover, simply assessing levels of demands, control, and support cannot provide a precise test of the processes outlined by Karasek and Theorell. It is necessary to examine closely the processes that are thought to underpin the DCSM to provide a thorough examination of the model (van Vegchel, de Jonge, & Landsbergis, 2005).

In Karasek and Theorell's detailed descriptions, workers are portrayed as active agents that use control and support to regulate work demands for the benefit of their well-being and the pursuit of learning opportunities. Therefore, in the DCSM, it is not the levels of demands, control, and support that are important for learning and well-being. Rather, it is how workers use control and support that is important for the regulation of demands, learning, and well-being. In a small, experience sampling study of workers in a single organization ($N = 36$), Daniels, Beesley, Cheyne, and Wilmarisiri (2008) indicated the feasibility of using measures that assess the purposes for which people use job control and social support. Although Daniels et al. did not test the specific hypotheses of the DCSM nor did they assess learning, they made links between such measures and a number of dependent variables, including affect.

The Active Learning Hypothesis

The active learning hypothesis indicates that control and support enable workers to solve problems caused by high work demands (Karasek & Theorell, 1990, p. 36, pp. 69-70, pp. 92-93, pp.172-3). It is proposed that this problem-solving promotes incremental learning as workers find

solutions to problems, which leads to enhanced motivation, feelings of mastery, and well-being (Karasek & Theorell, 1990, p. 99). There are studies that provide evidence for these relationships. Studies have found an association between the availability of job control and on-the-job learning (Bond & Flaxman, 2006; Taris & Feij, 2004; Taris, Kompier, de Lange, Schaufeli, & Schreurs, 2003). Another study found that problem-solving moderates the impact of the availability of job control on well-being (de Rijk, Le Blanc, Schaufeli, & de Jonge, 1998). An intervention designed to facilitate mutually supportive problem-solving reduced levels of burnout (Le Blanc, Hox, Schaufeli, Taris, & Peeters, 2007).

The active learning hypothesis makes it explicit that work demands cause specific problem-solving demands, and learning happens when control or support is used to solve these problems. Karasek and Theorell consider that a range of work demands pose problems and challenges, which are overcome through problem-solving. However, problem-solving demands can also be characterized as demands in their own right (Humphrey, Nahrgang, & Morgeson, 2007). Therefore, as our central focus is the active learning hypothesis, we focused on responses to problem-solving demands.

To test the active learning hypothesis, we operationalized job control used to solve problems as the extent to which workers change aspects of their work activities to solve problems. This reflects the definition of job control as the extent to which workers have the authority to make decisions concerning how they work, including control over schedules and objectives (Breugh, 1985). For example, changing work objectives may allow a worker to prioritize solving a problem over other tasks. This operational definition also makes an explicit link between problem-solving demands and the use of job control to solve those demands. In support of this procedure for exploring the DCSM, one study has found that changing aspects of work activities

to solve problems was related to well-being (Daniels et al., 2008). We operationalized social support used for solving problems as the extent to which workers discuss problems with others to solve problems. This definition makes an explicit link between problem-solving demands and the use of support to solve problems. This definition reflects the instrumental and informational aspects of support that are oriented to problem-solving rather than regulating affect (House, 1981). Two studies have found associations between discussing problems with others to solve problems and well-being (Daniels et al., 2008; Daniels & Harris, 2005). Both definitions for control and support used for problem-solving map closely onto the processes underpinning the active learning hypothesis.

We focused on affect as the outcome of learning. Affective experience is a central aspect of psychological well-being (Warr, 1990). Affective experience also can mediate the influence of work processes on aspects of physical well-being (Schwartz, Pickering, & Landsbergis, 1996). Of the major dimensions of positive and negative affect (Watson & Tellegen, 1985), we focused on the anxiety component of negative affect and the motivated hedonic component of positive affect. These are the major aspects of negative and positive affect that underpin affective well-being at work, where affective well-being is characterized by activated pleasant affect and the absence of anxious affect (Warr, 2007).

The active learning hypothesis indicates job control and social support used for problem-solving cause on-the-job learning. In turn, learning improves well-being through enhanced skills and capability to deal with further problems.

Hypothesis 1: the positive relationship between changing aspects of work activities to solve problems and affective well-being will be mediated by learning.

Hypothesis 2: the positive relationship between discussing problems with others to solve problems and affective well-being will be mediated by learning.

The Present Study

Figure 1 summarizes the operational definitions and relationships hypothesized. This figure indicates that job control and social support are used for different purposes, specifically in response to problem-solving demands. Figure 1 also indicates that the operational definitions of constructs map directly onto theoretical processes outlined in the DCSM, rather than having theoretical processes inferred from the presence or absence of job control, social support, and demands.

An electronic experience sampling methodology (ESM) was used to collect data four times per day over one working week in two separate samples. The DCSM considers phenomena that can change rapidly: variation in work demands, the enactment of job characteristics, problem-solving, and affect (e.g., Daniels & Harris, 2005; Fritz & Sonnentag, in press; Parkinson, Briner, Reynolds, & Totterdell, 1995; Totterdell, Wood, & Wall, 2006). Electronic ESM allows data capture close to changes in these dynamic phenomena (Bolger, Davis, & Rafaeli, 2003), so providing greater accuracy than can be obtained through daily, weekly, or other retrospective reports (Tennen, Affleck, Larsen, Coyne, & DeLongis, 2006). ESM also allows for statistical control of previous levels of dependent variables and stable factors (Bolger et al., 2003). We controlled for lagged levels of the dependent variables and trait or typical levels of the dependent variables. In one sample, we controlled for typical levels of job control and support. Linear and quadratic terms for demands were used in the analyses because demands can have curvilinear relationships with well-being (Warr, 2007).

Job control and social support could be used for affective expression as well as or instead of problem-solving. Affective expression refers to attempts to directly deal with the affective

consequences of stressors (Gross & Thompson, 2007). Daniels et al. (2008) have found relationships between both changing aspects of work activities to express affect and talking to others to express affect on the one hand, and indicators of cognitive performance and affect on the other. It is a common assumption in the coping literature that stressors can elicit various intraindividual and interindividual affective regulation processes (e.g., Folkman, Lazarus, Dunkel-Schetter, DeLongis, & Gruen, 1986). It is a reasonable assumption that problem-solving demands do so in the same way as other stressors. Problem-solving demands are a component of psychological demands (Jackson, Wall, Martin, & Davids, 1993). Positive associations between job demands and affect regulation processes have been demonstrated (Daniels, 1999). Therefore, we also controlled for changing aspects of work activities to express affect and talking to others to express affect. This was so that our measures of changing aspects of work activities to solve problems and discussing problems with others would not be confounded with the use of job control or social support for affective expression.

Method

Samples and Procedure

Participants came from two samples, one of workers in three large organizations (Sample 1) and one of workers in 15 small and medium size enterprises (SMEs, Sample 2). Participants were recruited by senior managers' requests for volunteers at specific organizational locations.

In Sample 1 ($N = 78$), requests were made for up to 40 volunteers in two organizations and 30 volunteers in one organization. In Sample 1, participants consisted of scientists working at a government research facility ($n = 31$), civil engineers working for a multinational construction company ($n = 21$), and design engineers working for a multinational automotive design company ($n = 26$). The average age of the sample was 37.19 years ($SD = 9.99$), the average tenure in their job

was 3.94 years ($SD = 4.46$), and the average tenure in their organization was 7.61 years ($SD = 7.65$). The majority of the sample was male (78.2%). Participants reported working an average of 41.36 hours per week ($SD = 6.60$).

In Sample 2 ($N = 106$), requests were made for between 3 and 10 volunteers, depending on the size of the organization. Organizations employed an average of 26.30 people ($SD = 29.41$). Organizations provided between 2 and 22 volunteers. Four of the organizations were in the IT sector, four in the services sector, three in the manufacturing sector, two in the biomedical sector, and two in the professional services sector. The average age of the sample was 37.12 years ($SD = 11.74$), the average job tenure was 4.10 years ($SD = 5.33$), and the average organizational tenure was 5.89 years ($SD = 6.25$). The majority of the sample was male (64.2%). Participants reported working an average of 41.29 hours per week ($SD = 5.00$).

The same procedures were used for both samples. Data were collected using personal digital assistants (PDAs). The PDAs administered questionnaires four times daily over one working week (Monday to Friday). The PDAs' alarm signaled when the questionnaire was to be completed. Participants had 60 seconds to respond to the alarm and 60 seconds to respond to each question. If these times elapsed, the PDA shut down and set off the alarm at the next measurement occasion. Participants completed questionnaires at 10.30 a.m., 12.30 p.m., 2.30 p.m., and 4.30 p.m. The PDAs were distributed to participants between 8.30 and 9.00 a.m. on the first day of the ESM period (a Monday). On the next Friday, following the last alarm, the PDAs were collected from participants.

In the week preceding the ESM period, participants were given a presentation on how to use the PDAs. A background questionnaire was also distributed at this time. This questionnaire assessed demographics and some control variables. All participants returned this questionnaire before commencement of ESM data collection.

In Sample 1, participants provided data on 935 out of a possible 1,410 occasions (after taking into account absence, scheduled leave, etc.). This gave an overall compliance rate of 66.3%. The average number of responses was 12.15 (minimum of 4, maximum of 20). In Sample 2, participants provided data on 1,439 out of a possible 2,021 occasions. This gave an overall compliance rate of 71.2%. The average number of responses was 14.20 (minimum of 4, maximum of 20). These rates of compliance are comparable with other ESM studies (Hektner, Schmidt, & Csikszentmihalyi, 2007).

PDA measures

Learning. Participants rated their learning over the previous hour on three items (e.g., “Have you learnt anything in the past hour that would help your work performance?”). Appendix A shows the items in this new scale. A 4-point fully anchored scale was used (1 = *nothing*, 2 = *something that might be useful*, 3 = *something useful*, 4 = *something very useful*). Item scores were summed and divided by 3 to form an overall score ($\alpha = .87$ in both samples).

To validate this measure, a comparison was made between a sample of 32 workers in a University human resources department undertaking their normal work activities (modal age = 31 to 40 years, range 21 to 60, sample was 84.4% female) and a sample of 20 managers on a one-day management development course (average age = 34.16 years, $SD = 7.02$, sample was 45.0% female). The human resource professionals were assessed three times per day for five days (10–10.15 a.m., 12.30–12.45 p.m., 15–15.15 p.m., Monday to Friday) and provided 279 observations. Data were collected using PDAs. The managers were assessed at the beginning of assigned breaks three times during the course (10.45 a.m., 12.45 p.m., 3.15 p.m.) and provided 60 observations. Data were collected in class using a paper and pencil questionnaire. Internal consistency in these samples was good ($\alpha = .83$ for human resource professionals, $\alpha = .79$ for managers). The comparison between samples was made using multilevel modeling (HLM6,

Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2004). As expected, the mean level of hourly learning was higher in the managerial sample undergoing executive development than in the human resource sample in their normal work environment ($B = 1.19, p < .01$; for human resource professionals, $M = 1.60, SD = 0.69$; for managers, $M = 2.78, SD = 0.69$). In the samples used in the main study and the two samples used in these validation analyses, principal components analyses conducted on each sample separately indicated the first component accounted for between 70% and 81% of the variance. Items' factor loadings ranged between 0.80 and 0.91.

Affect. We assessed affect by asking participants how they felt at that moment in time. Momentary anxious affect was assessed with the items “anxious” and “worried”. Momentary activated pleasant affect was assessed with the items “motivated” and “enthusiastic”. These items have been validated as indicators of anxious and activated pleasant affect in work contexts (Daniels, 2000). The items used to assess anxious affect reflect the high weighting given to synonyms for anxiety in the well known PANAS measures of negative affect (Watson, Clark, & Tellegen, 1988) and models of work-related well-being (Warr, 1990, 2007). Similarly, the items used to assess activated pleasant affect are similar to those used to assess positive affect in PANAS (e.g., the item “enthusiastic” is also used in PANAS). A 5-point scale was used (1 = *not at all*, 5 = *very*) and scores calculated by summing item scores and dividing by two. Internal consistency was acceptable for both anxious affect ($\alpha = .86$ in Sample 1, $\alpha = .85$ in Sample 2) and activated pleasant affect ($\alpha = .92$ in both samples).

Problem-solving demands. We assessed problem-solving demands with the question “In the past hour, how many issues without an obvious answer or solution have you had to deal with?”. Demands were rated on a 6-point scale (0, 1, 2, 3, 4, 5 or more). A single-item measure was considered acceptable because of the very specific, unemotive nature of the question, the

limited time-frame over which participants were asked to recall incidences of demands, and the use of specific anchors for each scale point (Frese & Zapf, 1988). In one study, this measure of problem-solving demands was positively associated with anxious affect (Daniels, Hartley, & Travers, 2006). Further evidence for the validity of this scale was obtained from the sample of human resources workers used in the validation of the learning scale. Using each worker's job title, we ranked participants according to seniority (5 = senior manager; 1 = clerical assistant). As expected, a multilevel regression revealed that staff with more senior roles reported higher levels of problem-solving demands in the week studied ($B = 0.42, p < .05$). The intraclass correlation (ICC1) was .46 for the human resources workers. The intraclass correlations for Samples 1 and 2 of the main study were .42 and .39. These results indicate some variability in individuals' level of problem-solving demands. The size of the intraclass correlations also indicates a degree of consistency in how individuals rated their levels of problem-solving demands across a week.

Problem-solving and affective expression. Participants rated how they responded in the past hour to the level of problem-solving demands they had experienced. Ratings were made on a 6-point fully anchored scale (1 = *not at all*, 6 = *to a large extent*) and each scale consisted of two items. If a participant reported no problem-solving demands in a given hour, the problem-solving and affective expression items were not presented and participants automatically given scores of 1 (*not at all*) for all these items. Scores were calculated by summing item scores and dividing by two. The scales were changing aspects of work activities to solve problems ($\alpha = .85$ in both samples), discussing problems with others to solve problems (Sample 1, $\alpha = .95$; Sample 2, $\alpha = .93$), changing aspects of work activities to express affect (Sample 1, $\alpha = .79$; Sample 2, $\alpha = .77$), and talking to others to express affect (Sample 1, $\alpha = .83$; Sample 2, $\alpha = .86$). Example items are "In the past hour, did you change your work objectives for the hour to solve the issues?" for

changing aspects of work activities to solve problems; “In the past hour, did you discuss the issues to help you solve them?” for discussing problems with others to solve problems; “In the past hour, did you change the order in which you normally do work tasks to get your emotions off your chest?” for changing aspects of work activities to express affect; and “In the past hour, did you confide in other people about the issues to get your emotions off your chest?” for talking to others to express affect. Appendix A shows the items in these scales.

We were able to check the interpretability of these items with participants in both samples by providing opportunities for participants to discuss problems with data collection with us. We provided participants with telephone and email contacts, and visited each organization three times after distributing the PDAs. Two visits were made during data collection and one visit was made some months after data collection to debrief participants. In no instance did participants report they could not understand the questions.

Daniels et al. (2008)¹ found the hypothesized four-factor structure of the items in these scales had a better fit to their data than two alternative two-factor structures. Daniels et al. also found each scale has differential relations with a range of affective and cognitive variables. This evidence suggests utility in differentiating changing aspects of work activities for problem-solving, discussing problems to solve problems, changing aspects of work activities to express affect, and talking to others to express affect.

We examined the factor structure of the items, and made comparisons with a more extensive set of alternative models. We used multilevel confirmatory factor analysis (CFA) implemented through the EQS program (Bentler, 2006). Multilevel confirmatory factor analysis takes into account both within- and between-person variability in responses. The expected four-factor solution was compared to six alternative factor structures. The first was a two-factor

model, in which all problem-solving items loaded on one factor and all affective expression items on the other. The second was a two-factor model, in which all control items loaded on one factor and all support items on the other. The third was a three-factor-model in which all problem-solving items loaded on one factor but the affective expression items were differentiated as hypothesized. The fourth was a three-factor model in which the problem-solving items loaded on their hypothesized factors, but all affective expression items loaded on one factor. The fifth was a three-factor model in which all changing aspects of work activities items loaded on one factor, but there were separate factors for discussing problems to solve problems and talking to others to express affect. The sixth was a three-factor model in which the changing aspects of work activities items loaded on their hypothesized factors, but discussing problems to solve problems items and talking to others to express affect items loaded on one factor.

CFAs indicated that a four-factor model had the best fit in both samples. Only the four-factor model had fit indices in the ranges suggested as acceptable in both samples (Byrne, 2006, pp. 97-100, i.e., Normed Fit Index, NFI > .90, Non-normed Fit, NNFI > .90, Comparative Fit Index, CFI > .95, Root Mean Square Error of Approximation, RMSEA < .08). For the four-factor model, the NFI, NNFI, and CFI exceeded .97 in both samples. The RMSEA was less than .07 in both samples. Apart from the fourth alternative model, no other model had more than two fit indices in the acceptable range in either sample. The fourth alternative model had the NFI, NNFI, and CFI within the acceptable range in both samples (NFI, NNFI > .92, CFI > .95), but the RMSEA was not in the acceptable range (>.08 in both samples). A comparison between the fourth alternative model and the hypothesized four-factor model indicated that the hypothesized model provided better fit (Sample 1 $\Delta\chi^2 = 144.05$, $df = 2$, $p < .01$; Sample 2 $\Delta\chi^2 = 138.12$, $df =$

2, $p < .01$). For the four-factor model in both samples, all items loaded in expected direction for both within- and between-individuals components of the model ($p < .01$).²

Control Variables

The analyses controlled for each individual's compliance rate, time of day, day of week, and lagged values of each dependent variable and independent variable from the time period on the same day but immediately preceding assessment of the dependent variable. The analyses also controlled for linear and quadratic terms for problem-solving demands, changing aspects of work activities to express affect, and talking to others to express affect each measured at the same time as the dependent variable and in the time period on the same day but immediately preceding assessment of the dependent variable. Time of day was represented by two dummy codes (12.30 p.m. = 1, other time = 0; 2.30 p.m. = 1, other time = 0). A third dummy code was not needed, because inclusion of same day lagged dependent variables in the analyses meant hourly learning, anxious affect, and activated pleasant affect assessed at 10.30 a.m. could not be used as dependent variables. Day of week was represented by four dummy codes for each day from Monday through Thursday.

In Sample 1, two dummy codes were used to control for membership of one of the three organizations sampled. In Sample 2, three organizational level variables were controlled: size assessed by the number of people working in the organization, whether the organization offered a product or a service (1 = product, 0 = service), and technological level (1 = high technology operations, 0 = low technology operations). An interview lasting 30 to 60 minutes with a senior manager in each organization provided data on size, markets, and operations. Sector and technological level were decided upon by four members of the research team in discussion and

following consideration of interview data and company websites. The remaining control variables were assessed by the questionnaire completed before the ESM period.

Typical levels of learning. Three questions assessed the extent to which participants typically learnt new things at work. These were modified from those used to assess hourly learning (e.g., “How often do you learn things that help your work performance?”). Appendix A shows the items in this new scale. Items were rated on a 5-point scale (1 = *never*, 5 = *very often*), summed, and divided by 3 to provide a score (Sample 1, $\alpha = .86$, Sample 2, $\alpha = .79$). Principal components analyses indicated a large first component accounting for 79% of the variance in both Sample 1 and Sample 2. Items’ loadings on this factor ranged from 0.80 to 0.90 in these analyses. Using the sample of human resources workers assessed for other preliminary analyses, a comparison was made between those who had been working in their current job for less than one year and the rest of the sample. As expected, those who had been working in their current job for less than a year reported higher typical levels of learning (Mann-Whitney $U = 34.00$, $p < .05$, <1 yr experience $M = 3.67$, $SD = 0.38$, ≥ 1 year experience $M = 3.03$, $SD = 0.71$).

Trait affect. We assessed trait anxious and activated pleasant affect by asking participants to rate how they normally felt at work by rating affect adjectives on a 6-point scale (1 = *never*, 6 = *all of the time*). Six items were used for each affect (e.g., “worried” for anxious affect, “enthusiastic” for activated pleasant affect). The items used to index trait anxious and activated pleasant affect have been found to be valid indicators of these types of affect in work contexts (Warr, 1990; Daniels, 2000). Like the items used to assess state affect, the items used to assess trait affect have a degree of overlap with items used in the PANAS scales (Watson et al., 1988). Scores were calculated by summing item scores and dividing by six (for anxious affect, $\alpha = .89$ in Sample 1, $\alpha = .81$; in Sample 2, for activated pleasant affect $\alpha = .87$ and $\alpha = .75$).

Job characteristics. In Sample 2 only, we assessed typical levels of job control and social support by six and four items respectively. The six items for control were adapted from Breugh's (1985) nine-item measure and cover each of the three facets identified by Breugh (control over methods, schedules, and criteria, e.g., "Can you decide when to do particular work activities?"). The support items were adapted from an eight-item measure used by Daniels (2000, e.g., "Can you confide in other people at work?"). Items were rated on a 5-point scale (1 = *never*, 5 = *very often*), summed, and divided by the number of items in the measure to derive scores ($\alpha = .80$ for both job control and support).

Analyses

Multilevel regression was used to analyze the data (HLM6, Raudenbush et al., 2004). In Sample 1, a two-level model was used. Participants were drawn from three organizations, so intraclass correlations (ICC1) were calculated for each dependent variable (Bliese, 2000). For learning and anxious affect, the intraclass correlations were very close to zero ($ICC1 < .0001, p > .50$). For activated pleasant affect, the intraclass correlation was zero. These results indicated a two-level model was suitable for these analyses (Muthén, 1997). In Sample 2, with a greater number of organizations, a three-level model was used. The inclusion of lagged dependent variables meant that data from the first assessment on each day could not be used, nor could data for which the preceding time point was missing. This left 533 usable observations from Sample 1 ($N = 78$) and 847 from Sample 2 ($N = 106$).

Hypotheses 1 and 2 reflect strong expectations from the DCSM and there is evidence that supports the direction of these hypotheses. Therefore, asymmetric two-tailed tests were used to evaluate Hypotheses 1 and 2, symmetric two-tailed tests otherwise. Asymmetric tests are useful where there are strong theoretical expectations for a directional relationship. However, unlike

one-tailed tests, they allow a possibility of detecting a relationship in the opposite direction to that expected. Following recommendations by Nosanchuk (1978), we partitioned the probability of type I error so that 90% was placed in the expected direction of the relationship, and 10% in unexpected direction to allow detection of serendipitous relationships (i.e., for an overall probability of type I error of $\alpha = .05$, the probability of type I error for the hypothesized direction was set to $\alpha = .045$ and the probability of type I error for the unexpected direction to $\alpha = .005$).

To test the mediated effects stated in Hypotheses 1 and 2, we used two strategies (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). First, we evaluated the significance of paths from the independent variables to the mediator (learning) and from the mediator to affect. Second, we used the Sobel formula (1982) but assessed its significance against the distribution of the product of two random variables. This maximizes power and accuracy of type I error rates (MacKinnon et al., 2002). In these analyses, this was acceptable because the slopes of the independent variables related to learning were found to be invariant across individuals and organizations (Kenny, Korchmaros, & Bolger, 2003, p.121).

Dummy variables representing days of the week and time of day were left in their raw metric. Demands were standardized and the resulting z-scores squared to represent linear and curvilinear terms for demands. Other control and the independent variables were centered at the grand mean for the sample (Hofmann & Gavin, 1998). Centering decisions should reflect theoretical processes (Enders & Tofghi, 2007; Snijders & Bosker, 1999, p.81). In this case, the DCSM provides an explanation of interindividual differences in learning and well-being, rather than intraindividual differences. To separate between-person from within-person variance, each individual's average levels of hourly learning, standardized score for demands, problem-solving, and affective expression were entered as person-level variables (Kenny, Bolger, & Kashy, 2002).

Each individual's average standardized demands' score was squared to represent the curvilinear term for demands at the person-level.

To check for significant variation in regression slopes between individuals or organizations, an incremental, stepwise approach was taken to analyze the data (Snijders & Bosker, 1999). Where slopes did not show significant variation, they were fixed to be invariant across participants or organizations as appropriate. Further details of our approach to modeling are described in Appendix B.

Results

Tables 1 and 2 show the means, standard deviations, internal consistencies, and correlations among the ESM measures and questionnaire measures. Some correlations are worth noting. Table 2 shows that in Sample 2, job control was not correlated with changing aspects of work activities to solve problems ($r = -.10, ns$) and social support was not correlated with discussing problems to solve problems ($r = .04, ns$).

Table 3 shows the results of the multilevel regression analyses on hourly learning, activated pleasant affect, and anxious affect. Table 4 summarizes significant mediated effects.

Table 3 shows initial support for Hypotheses 1 and 2 in relation to activated pleasant affect only. Changing aspects of work activities to solve problems was associated with hourly learning assessed at the same time in both samples (Sample 1 $B = 0.05, p < .05$; Sample 2 $B = 0.06, p < .05$). Discussing problems with others to solve problems was also associated with hourly learning assessed at the same time in both samples (Sample 1 $B = 0.05, p < .01$; Sample 2 $B = 0.06, p < .01$). There were associations between hourly learning and momentary activated pleasant affect assessed at the same time in both samples (Sample 1 $B = 0.24, p < .01$; Sample 2 $B = 0.16, p < .01$). These associations provided support for the second parts of Hypotheses 1 and 2. Direct tests of mediation

effects (table 4) indicated support for Hypotheses 1 and 2 in relation to activated pleasant affect. For changing aspects of work activities to solve problems, the mediated effects on activated pleasant affect came to 0.01 in both samples ($p < .01$). For discussing problems with others to solve problems, the mediated effects also came to 0.01 in both samples ($p < .01$). Table 3 shows that there was no relationship between learning and momentary anxious affect (Sample 1 $B = -0.02$, *ns*; Sample 2 $B = 0.02$, *ns*), indicating that learning does not mediate any effects of changing aspects of work activities to solve problems or discussing problems to solve problems on anxious affect.

We also tested the Hypotheses by running exactly the same models shown in Table 3, but with the affective expression scales omitted. The results with respect to the Hypotheses were replicated in both samples in these analyses. Changing aspects of work activities to solve problems was associated with hourly learning assessed at the same time (Sample 1 $B = 0.05$, $p < .05$; Sample 2 $B = 0.07$, $p < .05$). Discussing problems with others to solve problems was associated with hourly learning assessed at the same time (Sample 1 $B = 0.04$, $p < .01$; Sample 2 $B = 0.07$, $p < .01$). Hourly learning was associated with momentary activated pleasant affect assessed at the same time (Sample 1 $B = 0.25$, $p < .01$; Sample 2 $B = 0.13$, $p < .01$). Direct tests of mediation effects provided support for both Hypotheses in relation to activated pleasant affect (all the mediated effects came to 0.01, $p < .01$). There were no associations in either sample between hourly learning and momentary anxious affect assessed at the same time (Sample 1 $B = 0.00$, *ns*; Sample 2 $B = 0.03$, *ns*). When the affective expression variables were omitted from the analyses, some relationships between the problem-solving variables and momentary anxious affect became significant. In Sample 1, changing aspects of work activities to solve problems was associated with anxious affect assessed at the same time ($B = 0.07$, $p < .05$). In Sample 2, changing aspects of work activities to solve problems was inversely associated with anxious

affect assessed two hours later ($B = -0.07, p < .05$), and discussing problems with others to solve problems was associated with anxious affect assessed at the same time ($B = 0.06, p < .05$). For each of these relationships with anxious affect, Table 3 shows the corresponding affective expression scale had a significant association with anxious affect (Sample 1, changing aspects of work activities to express affect on anxious affect assessed at the same, $B = 0.28, p < .05$; Sample 2, changing aspects of work activities to express affect on anxious affect assessed two hours later, $B = -0.17, p < .01$, talking to others to express affect on anxious affect assessed at the same time $B = 0.23, p < .01$).

Discussion

Summary and Implications for Research and Theory

The primary contribution of this study is that it is an attempt to directly address the underpinning processes of the active learning hypothesis. This study examined whether learning mediated the relationships between changing aspects of work activities to solve problems and discussing problems with others to solve problems on the one hand and aspects of well-being on the other. Although relationships between job characteristics and various attitudinal, performance, and affective outcomes are well established (Humphrey et al., 2007), the present study reinforces the value of understanding how job characteristics are enacted (Clegg & Spencer, 2007; Wrzesniewski & Dutton, 2001), the intrapsychic processes that mediate between the work environment and various outcomes (Hodgkinson & Healey, 2008), and measurement practices that match the purposes for which individuals use job control or support to react to work demands (de Jonge & Dormann, 2006).

The results indicated support for Hypotheses 1 and 2 only in relation to activated pleasant affect, namely that learning mediated relationships between both changing aspects of work

activities to solve problems and discussing problems with others to solve problems on the one hand and activated pleasant affect on the other. Importantly, because the multivariate analyses included both changing aspects of work activities to solve problems and discussing problems to solve problems, the results indicated the unique relationship of each method of problem-solving on learning and activated pleasant affect. These results are consistent with the DCSM, a related model of job control and learning (Wall, Cordery, & Clegg, 2002), and previous findings that job resources such as control and support were related to positive motivational and growth experiences (Demerouti, Bakker, Nachreiner, & Schaufeli, 2001).

There was no support for Hypotheses 1 and 2 in relation to anxious affect. In another study, learning did not predict levels of an indicator of depression and anxiety (Taris & Feij, 2004). Learning seems to be more closely related to activated pleasant affect than anxious affect. As learning is concerned with development and personal growth, it may be more closely aligned with the cognitive systems that are concerned with approaching goals and that also produce positive affect (Brockner & Higgins, 2001; Carver, Sutton, & Scheier, 2000). Although learning had no relationship with anxious affect in this study, the ratio of positive affect to negative affect can be taken as an indicator of well-being (Fredrickson & Losada, 2005). Therefore, it can be argued that, overall, the active learning hypothesis of the DCSM was supported.

The analyses indicated that when the affective expression scales were omitted from the analyses, there were some direct associations between the problem-solving scales and anxious affect. None of these associations was found in both samples. For each association, the corresponding affective expression scale was significant when included in the analyses (e.g., when included in the analyses in Sample 1, changing aspects of work activities to express affect was associated with anxious affect assessed the same time, when omitted from the analyses

changing aspects of work activities to solve problems was associated with anxious affect assessed the same time). Therefore, shared variance between the problem-solving variables and the affective expression variables provides one explanation for the discrepancies between analyses with affective expression variables included and excluded. However, this may not preclude the possibility that there are situations when changing aspects of work activities to solve problems or discussing problems to solve problems can be associated with anxious affect.

Notwithstanding that the support for Hypotheses 1 and 2 was specific to activated pleasant affect, the results are relevant to research that has found positive associations between aspects of well-being or performance and certain kinds of demands, such as problem-solving demands (Morgeson & Humphrey, 2006; N. P. Podsakoff, LePine, & LePine, 2007). It may be that such positive associations are underpinned by a process of deploying job control or social support to resolve issues and learn from experiences at work. Moreover, by linking problem-solving to aspects of well-being, the findings reinforce research concerning the importance of proactivity in the workplace (Griffin et al., 2007; Parker et al., 2006; Parker, 2007).

The proactivity literature also provides some clues on likely predictors of changing aspects of work activities or discussing problems with others to solve problems. Table 2 shows that there were no associations between job control and social support on the one hand and whether people change aspects of their work activities or discuss problems to solve problems on the other. The availability of job control or social support may only be distal influences on changing aspects of work activities to solve problems and discussing problems to solve problems. Attitudes towards problem-solving efficacy or the perceived breadth of roles may be more proximal influences that may mediate the availability of job control or social support (Parker et al., 2006). There is also the possibility that the availability of job control and social

support interact with individual differences to predict changing aspects of work activities to solve problems and discussing problems with others to solve problems. Some studies have found that job control and social support can buffer the detrimental effects of job demands on well-being when coupled with individual differences that are plausible predispositions to problem-solving (e.g., internal locus of control, Daniels & Guppy, 1994; self-efficacy, Parker & Sprigg, 1999; Schaubroeck, Jones, & Xie, 2001; self-determination, Fernet, Guay, & Senécal, 2004).

Strengths and Limitations

One strength of the study was the use of electronic ESM to examine dynamic cognitive and affective processes related to the DCSM. The advantages of electronic ESM allowed better measurement accuracy and internal validity than many other methods used in field research (Bolger et al., 2003; Tennen et al., 2006). Another strength of the study was the use of two samples of relatively large sizes for ESM studies. This enhances the potential generalizability of the findings and ensures that the analyses are conducted with relatively high statistical power for both between- and within-person comparisons. Many studies that have examined the DCSM have assessed levels of demands, control, and support. These studies involve the assumption that any significant relationships reflect the cognitive and affective processes outlined by Karasek and Theorell (1990). Therefore, another strength of this study was to directly assess processes related to how job control and social support were used in relation to a specific type of demand.

There were a number of limitations. First, the study was conducted over a relatively short period (one week). Even so, with participants sampled up to four times per day, the period of data collection was long enough to be consistent with Hypotheses 1 and 2, which map onto dynamic phenomena. Nevertheless, collecting data over longer time periods may allow researchers to test trajectories in learning or well-being that evolve over longer time frames

(Raudenbush, 2002). Second, only self-report measures were used in this study, raising issues concerning common method variance. The greater accuracy of measurement afforded by electronic ESM, variation in response formats, and inclusion of a range of control variables mitigated against common method bias (P.M. Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Self-report methods were also appropriate for this study because the study centered on cognitive and affective activity, including the incidence of cognitive, problem-solving demands. Third, in spite of statistical controls for lagged dependent and other variables, the significant hypothesized relationships involved variables assessed at the same point in time. Insofar that affect was measured as felt at the moment of assessment, but levels of learning and problem-solving were assessed over the previous hour, there was an element of causal priority in relation to the measures of affect used to examine the Hypotheses 1 and 2. However, causal inferences are not warranted from this study. A field experiment, in which groups of participants are trained how to use control and support to solve problems, is an example of a method that might enable stronger causal inferences concerning the processes outlined in the DCSM's active learning hypothesis. Nevertheless, the evidence from this study does indicate that conducting such field experiments might be a fruitful line of enquiry.

Finally, we used items that mapped the processes of using job control and support for problem-solving in relation to problem-solving demands. Using complex items allowed us to examine processes underpinning the DCSM. We also used complex items to assess major control variables of changing aspects of work activities and talking to others to express affect. We did not directly assess affective reactivity to problem-solving demands. However, by controlling for state affect in the time period before our assessment of demands and especially trait affect, we were able to control for major sources of intraindividual and interindividual differences in

affective reactivity to problem-solving demands (Suls, 2001; Williams, Watts, MacLeod, & Mathews, 1996). However, future research with both the problem-solving and affective expression scales could use a range of dependent variables upon which the impact is thought to be delayed rather than concurrent. Not only would this strengthen causal inference by providing temporal precedence, but such a strategy could control for affect during exposure to demands. It should also be noted that control and support could also be enacted for other strategies to cope with a wider range of job demands. An example of using job control to avoid quantitative demands might be rescheduling work tasks to be away from one's work station during a particularly busy period.

Practical Implications

Consistent findings across two samples provide a basis for suggesting practical implications for that might enhance on-the-job learning and activated pleasant affect. The first practical implication is that the mere provision of job control or social support may be insufficient to increase learning or activated pleasant affect. Indeed, not all job redesign interventions show uniform benefits (Briner & Reynolds, 1999). The present study indicates that job redesign interventions to increase job control and support might be enhanced by problem-solving skills training, networking skills training to solicit good advice in problem-solving, and establishment of communities of practice to enhance the ability of workers to obtain support in solving problems at work (cf. Brown & Duguid, 1991). Moreover, such networks may also be a source of knowledge on how to change aspects of work activities to solve problems. A relatively simple means of improving such networks may entail holding regular cross-departmental meetings to discuss problems, possible solutions, and approaches to generating solutions. Managerial training on how to support workers' problem-solving may be especially beneficial,

as this might increase discussing problems with others to solve problems and may also accentuate benefits from job control (Logan & Ganster, 2005; Janssen, 2005).

Conclusion

Karasek and Theorell's DCSM is one of the most influential theories of job design. By examining how people use control and support to respond to problem-solving demands, this study used a methodology consonant with the DCSM's focus on worker activity as a means of producing personal and organizational benefits. As such, this study has been able to supply a fine-grained analysis of critical aspects of this important and popular model. The findings indicated that how individuals use control and support to respond to problem-solving demands is associated with important organizational and individual phenomena (learning and affective well-being).

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Footnotes

¹ Daniels et al. used the following terms in their paper: ‘problem-focused coping enacted by control’ for changing aspects of work activities to solve problems; ‘problem-focused coping enacted through support’ for discussing problems with others to solve problems; ‘emotional approach enacted by control’ for changing aspects of work activities to express affect; and ‘emotional approach enacted through support’ for talking to others to express affect. We have changed Daniels et al.’s terminology because the new phrasing conveys the content of the scales, especially the affective expression scales, more precisely.

² The items used to assess changing aspects of work activities to solve problems, discussing problems with others to solve problems, changing aspects of work activities to express affect, and talking to others to express affect are complex items that assess whether a job characteristic (e.g., control) was executed for a specific purpose (e.g., problem-solving). To illustrate the meaning of the items, consider the item “In the past hour, did you discuss the issues to help you solve them?”. If a participant rated an item as *not at all*, this would indicate only that the participant had not discussed the issues to solve the issues. It does leave open the possibility that the participant had used other means to solve the issues (e.g., through changing aspects of work activities) or had discussed the issues for other purposes (e.g., to express affect). If another participant rated this same item as *to a large extent*, this would mean the participant had engaged in extensive discussion to solve the issues. It provides no information on whether the participant had also used other means to solve problems (e.g., through changing work processes). This rating also provides no information on whether the participant had discussed the issues for other reasons (e.g., to express affect). Such complex items link the enactment of control and support to specific purposes, rather than having to infer such processes through assessments of levels of demands, control, and support. These items also preclude

inferring that control and support are enacted for problem-solving or expressing affect from correlations between control and support on the one hand, and problem-solving and expressing affect on the other.

Table 1

Means, Standard Deviations, and Internal Consistencies, and Correlations for Sample 1

Scale	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10	11
1. Hourly learning	1.50	0.70	(.87)	.29	.09	.40	.36	.38	.24	.26			
2. Momentary activated pleasant affect	3.09	0.96	.28*	(.92)	-.16	.13	.15	.04	.03	.04			
3. Momentary anxious affect	1.71	0.84	.21	-.15	(.86)	.28	.16	.17	.32	.31			
4. Demands	.96	1.20	.47**	.11	.38**	(--)	.58	.62	.34	.34			
5. Changing aspects of work activities to solve problems	1.83	1.30	.46**	.26*	.13	.62**	(.85)	.56	.28	.29			
6. Discussing problems to solve problems	2.28	1.73	.52**	.06	.25*	.70**	.55**	(.95)	.26	.41			
7. Changing aspects of work activities to express affect	1.15	0.54	.46**	.08	.40**	.52**	.36**	.50**	(.79)	.63			
8. Talking to others to express affect	1.26	0.73	.49**	.09	.49**	.49**	.34**	.51**	.85**	(.83)			
9. Typical learning	3.21	0.74	.54**	.32**	.00	.27*	.47**	.39**	.30**	.37**	(.86)		
10. Trait activated pleasant affect	4.34	0.75	.27**	.62**	-.18	.24*	.27*	.19	.00	.02	.42**	(.75)	
11. Trait anxious affect	3.05	0.84	-.13	-.25*	.48**	.19	-.08	.10	.19	.13	-.25*	-.36**	(.89)

Note. $N = 78$, no. of observations = 935, alpha coefficients of reliability shown in parentheses on main diagonal, correlations aggregated at the person level shown below primary diagonal, correlations for ESM data above the main diagonal.

* $p < .05$, ** $p < .01$. Significance tests not shown for ESM data because of non-independence of observations.

Table 2

Means, Standard Deviations, and Internal Consistencies, and Correlations for Sample 2

Scale	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Hourly learning	1.51	0.72	(.87)	.13	.05	.27	.32	.35	.19	.20					
2. Momentary activated pleasant affect	3.18	1.08	.17*	(.92)	-.20	-.02	-.05	-.01	-.12	-.12					
3. Momentary anxious affect	1.67	0.92	.03	-.16	(.85)	.26	.30	.27	.32	.33					
4. Demands	.90	1.30	.44**	-.02	.31**	(--)	.60	.59	.32	.35					
5. Changing aspects of work activities to solve problems	1.78	1.31	.53**	-.06	.38**	.66**	(.85)	.71	.42	.47					
6. Discussing problems to solve problems	1.89	1.46	.54**	.02	.38**	.62**	.81**	(.93)	.40	.51					
7. Changing aspects of work activities to express affect	1.20	0.59	.37**	-.22*	.34**	.40**	.53**	.54**	(.77)	.68					
8. Talking to others to express affect	1.25	0.70	.30**	-.15	.36**	.35**	.53**	.58**	.88**	(.86)					
9. Typical learning	3.52	0.65	.43**	.10	-.06	.13	.10	.11	.03	.06	(.79)				
10. Trait activated pleasant affect	4.74	0.67	.11	.52**	-.11	.12	.05	.06	-.12	-.09	.30**	(.75)			
11. Trait anxious affect	2.85	0.81	-.05	.07	.45**	.16	.20**	.30**	.00	.08	-.21*	-.23*	(.81)		
12. Job control	3.91	0.58	.07	.37**	-.19	-.03	-.10	-.10	-.19*	-.13	.40**	.47**	-.17	(.80)	
13. Social support	4.01	0.67	.05	.10	-.04	.04	-.03	.04	-.02	.00	.43**	.23*	-.17	.25*	(.80)

Note. $N = 106$, no. of observations = 1439, alpha coefficients of reliability shown in parentheses on main diagonal, correlations

aggregated at the person level shown below primary diagonal, correlations for ESM data above the main diagonal.

* $p < .05$, ** $p < .01$. Significance tests not shown for ESM data because of non-independence of observations.

Table 3

Multilevel Regressions on Hourly Learning, Activated Pleasant Affect, and Anxious Affect

	Learning		Activated Pleasant Affect		Anxious Affect	
Sample	1	2	1	2	1	2
Independent variables	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)
Organizational variables						
Research organization	0.05 (0.04)		-0.12 (-0.06)		0.17 (0.11)	
Construction firm	-0.03 (-0.02)		-0.06 (-0.03)		-0.06 (-0.03)	
Organizational size		0.00 (0.00)		0.00 (0.00)		0.00 (0.00)
Service vs product		-0.04 (-0.03)		0.08 (0.04)		-0.01 (-0.01)
Technological level		0.10 (0.07)		0.17 (0.08)		0.02 (0.01)
Person level variables						
Typical learning	0.12 (0.14)	0.20 (0.18)**	-0.02 (-0.02)	-0.18 (-0.11)*	-0.05 (-0.05)	0.04 (0.03)
Trait activated pleasant affect	0.05 (0.06)	0.01 (0.01)	0.31 (0.24)**	0.36 (0.22)**	-0.01 (-0.01)	-0.06 (-0.04)

Table continues

Table 3 (continued)

Sample	Learning		Activated Pleasant Affect		Anxious Affect	
	1	2	1	2	1	2
Independent variables	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)
Person level variables						
Trait anxious affect	-0.02 (-0.03)	-0.03 (-0.03)	0.00 (0.00)	-0.14 (-0.10)*	0.25 (0.27)**	0.19 (0.17)**
Job control		0.01 (0.01)		0.16 (0.09)		0.01 (0.01)
Social support		-0.05 (-0.05)		0.13 (0.08)		-0.04 (-0.03)
Compliance rate	0.00 (0.00)	-0.11 (-0.03)	0.14 (0.03)	-0.05 (-0.01)	0.06 (0.01)	-0.25 (-0.05)
ESM variables						
Monday	0.08 (0.05)	0.12 (0.07)	-0.15 (-0.07)	-0.03 (-0.01)	0.01 (0.01)	-0.11 (-0.05)
Tuesday	0.13 (0.08)	0.11 (0.06)	-0.07 (-0.03)	0.04 (0.02)	0.06 (0.03)	-0.10 (-0.05)
Wednesday	0.07 (0.05)	0.05 (0.03)	-0.09 (-0.04)	0.09 (0.03)	-0.02 (-0.01)	-0.04 (-0.02)
Thursday	0.03 (0.02)	0.07 (0.04)	-0.05 (-0.02)	0.10 (0.04)	-0.03 (-0.01)	-0.07 (-0.03)
12.30 p.m.	-0.02 (-0.01)	-0.16 (-0.11)**	0.03 (0.01)	-0.06 (-0.03)	-0.01 (-0.01)	0.01 (0.01)

Table continues

Table 3 (continued)

Sample	Learning		Activated Pleasant Affect		Anxious Affect	
	1	2	1	2	1	2
Independent variables	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)
ESM variables						
2.30 p.m.	-0.07 (-0.05)	-0.05 (-0.05)	-0.14 (-0.07)	-0.14 (-0.06)*	-0.07 (-0.04)	0.01 (0.01)
Lagged activated pleasant affect	-0.02 (-0.03)	0.05 (0.08)	0.38 (0.37)**	0.41 (0.40)**	0.02 (0.02)	0.04 (0.05)
Lagged anxious affect	-0.03 (-0.04)	-0.02 (-0.03)	0.06 (0.05)	0.01 (0.01)	0.25 (0.26)**	0.36 (0.37)**
Demands						
Averaged	0.15 (0.23)	0.05 (0.05)	-0.17 (-0.17)	0.04 (0.03)	0.08 (0.10)	0.13 (0.11)
Average squared	-0.07 (-0.16)	-0.07 (-0.13)	0.10 (0.15)	0.01 (0.01)	-0.01 (-0.02)	-0.13 (-0.19)
Lagged	0.03 (0.05)	-0.07 (-0.10)	0.02 (0.02)	-0.03 (-0.03)	0.01 (0.01)	0.06 (0.07)
Lagged squared	-0.02 (-0.06)	0.01 (0.03)	-0.05 (-0.10)	-0.02 (-0.04)	-0.04 (-0.10)*	-0.01 (-0.02)
Concurrent	0.02 (0.03)	0.02 (0.03)	0.03 (0.03)	-0.04 (-0.04)	0.05 (0.06)	0.07 (0.08)
Concurrent squared	0.01 (0.03)	0.01 (0.01)	0.02 (0.04)	-0.02 (-0.04)	-0.01 (-0.03)	0.01 (0.02)

Table continues

Table 3 (continued)

Sample	Learning		Activated Pleasant Affect		Anxious Affect	
	1	2	1	2	1	2
Independent variables	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)
ESM variables						
Changing aspects of						
work activities to						
express affect						
Averaged	0.52 (0.23)	0.75 (0.37)**	-0.21 (-0.06)	-0.56 (-0.18)*	-0.33 (-0.12)	0.70 (0.27)**
Lagged	0.01 (0.02)	-0.01 (-0.01)	0.08 (0.05)	0.01 (0.01)	0.01 (0.01)	-0.17 (-0.11)**
Concurrent	0.06 (0.05)	-0.02 (-0.02)	-0.03 (-0.02)	0.05 (0.03)	0.28 (0.18)*	0.11 (0.07)
Talking to others						
to express affect						
Averaged	0.16 (0.10)	-0.54 (-0.30)**	0.26 (0.10)	0.45 (0.16)	0.67 (0.33)**	-0.66 (-0.29)**
Lagged	-0.06 (-0.07)	0.01 (0.01)	-0.02 (-0.01)	0.03 (0.02)	-0.02 (-0.02)	0.00 (0.00)
Concurrent	-0.07 (-0.08)	0.06 (0.06)	-0.13 (-0.10)**	-0.25 (-0.14)**	-0.01 (-0.01)	0.23 (0.16)**

Table continues

Table 3 (continued)

	Learning		Activated Pleasant Affect		Anxious Affect	
Sample	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>2</u>
Independent variables	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)
ESM variables						
Changing aspects of						
work activities to solve						
problems						
Averaged	-0.06 (-0.06)	0.00 (0.00)	0.05 (0.03)	-0.13 (-0.08)	-0.08 (-0.07)	0.09 (0.07)
Lagged	0.01 (0.02)	-0.03 (-0.06)	-0.02 (-0.03)	0.02 (0.02)	0.02 (0.03)	-0.06 (-0.09)
Concurrent	0.05 (0.10)*	0.06 (0.11)*	0.04 (0.05)	-0.03 (-0.03)	0.05 (0.08)	0.04 (0.06)
Discussing problems to						
solve problems						
Averaged	-0.02 (-0.02)	0.12 (0.12)	-0.01 (-0.01)	-0.05 (-0.03)	0.01 (0.01)	0.02 (0.02)
Lagged	-0.03 (-0.08)	0.04 (0.08)	0.00 (0.00)	-0.01 (-0.01)	-0.02 (-0.04)	0.00 (0.00)
Concurrent	0.05 (0.13)**	0.06 (0.12)**	-0.03 (-0.05)	0.04 (0.05)	0.00 (0.00)	0.01 (0.02)

Table continues

Table 3 (continued)

Sample	Learning		Activated Pleasant Affect		Anxious Affect	
	1	2	1	2	1	2
Independent variables	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)	<i>B</i> (Beta)
ESM variables						
Hourly learning						
Averaged	--	--	-0.03 (-0.01)	0.46 (0.18)**	-0.09 (-0.05)	-0.10 (-0.05)
Lagged	0.07 (0.08)	0.13 (0.13)**	0.05 (0.04)	-0.01 (-0.01)	-0.03 (-0.03)	-0.07 (-0.06)
Concurrent	--	--	0.24 (0.16)**	0.16 (0.10)**	-0.02 (-0.02)	0.02 (0.02)
Variance components for regression on learning				Sample 1	Sample 2	Sample 2
					organization	person
Intercept				0.05**	0.00	0.05**
Problem-solving demands – concurrent				0.04**		0.04**
Changing aspects of work activities to express affect – concurrent						0.06**

Table continues

Table 3 (continued)

Variance components for regression on activated pleasant affect	Sample 1	Sample 2 organization	Sample 2 person
Intercept	0.11**	0.00	0.09**
Talking to others to express affect – concurrent			0.09**
Hourly learning – concurrent	0.20**		
Variance components for regression on anxious affect	Sample 1	Sample 2 organization	Sample 2 person
Intercept	0.09**	0.02**	0.05**
Problem-solving demands – concurrent			0.03*
Changing aspects of work activities to express affect – concurrent	0.19**		0.10**
Hourly learning – concurrent		0.01*	0.01*

Note. Sample 1 $N = 78$ participants, no. of observations = 533; Sample 2 $N = 106$ participants, no. of observations = 847. Averaged values are between-person variables. Standardized regression coefficients (betas) shown in parentheses. Fixed parameters not shown in variance components section.

* $p < .05$, ** $p < .01$.

Table 4

Summary of Mediated Effects Through Hourly Learning on Activated Pleasant Affect

	<u>Sample 1</u>	<u>Sample 2</u>
Mediated effects	<i>B</i> (Beta)	<i>B</i> (Beta)
Hypothesis 1:		
Changing aspects of work activities to solve problems → learning → activated pleasant affect	0.01 (0.02)**	0.01 (0.01)**
Hypothesis 2:		
Discussing problems to solve problems → learning → activated pleasant affect	0.01 (0.02)**	0.01 (0.01)**

Note. Standardized mediated effects (betas) shown in parentheses.

* $p < .05$, ** $p < .01$.

Figure Caption

Figure 1. Operational definitions and hypothesized relationships.

Appendix A

Items in the hourly learning scale

Have you learnt anything in the past hour that would help your work performance?

Have you learnt anything in the past hour that would help you deal with difficult issues more efficiently?

Have you learnt anything in the past hour that would help you solve work problems more quickly?

Items in the problem-solving and affective expression scales

Changing aspects of work activities to solve problems

In the past hour, did you change your work objectives for the hour to solve the issues?

In the past hour, did you change the order in which you normally do work tasks to solve the issues?

Discussing problems to solve problems

In the past hour, did you discuss the issues to help you solve them?

In the past hour, did you ask for other people's views to help solve the issues?

Changing aspects of work activities to express affect

In the past hour, did you change your work objectives for the hour to get your emotions off your chest?

In the past hour, did you change the order in which you normally do work tasks to get your emotions off your chest?

Talking to others to express affect

In the past hour, did you talk to people at work about the issues to get your emotions off your chest?

In the past hour, did you confide in other people about the issues to get your emotions off your chest?

Items in the typical levels of learning scale

How often do you learn things that help your work performance?

How often do you learn things that help you deal with difficult issues more efficiently?

How often do you learn things that help you solve work problems more quickly?

Appendix B

To check for significant variation in regression slopes between individuals or organizations, an incremental, stepwise approach was taken to analyze the data (Snijders & Bosker, 1999). Variables were entered in sequential steps: (a) person-level and organizational-level (Sample 2 only) control variables; (b) day of the week; (c) time of day; (d) lagged dependent variables; (e) average levels of demands and average levels of demands squared; (f) average levels of problem-solving and affective expression; (g) lagged levels of demands and lagged levels of demands squared; (h) lagged levels of problem-solving and affective expression; (i) concurrent levels of demands and concurrent levels of demands squared; (j) concurrent levels of problem-solving and affective expression; (k) for anxious and activated pleasant affect only, weekly average levels of learning; (l) for anxious and activated pleasant affect only, concurrent levels of learning.

In each step, data were first entered with all slopes allowed to vary across individuals (Samples 1 and 2) and across organizations (Sample 2). Slopes were fixed to be invariant across individuals or organizations if they had non-significant variance components ($p > .10$) or low reliabilities ($< .05$, Raudenbush & Bryk, 2002, p.125). The step was then run again to examine for further invariance in slopes and so on. When only varying slopes remained, model building moved to the next step and the process of examining slopes for variables in the new block repeated.

Although our theoretical processes indicated grand mean centering is appropriate, grand mean centering can underestimate slope variability (Enders & Tofighi, 2007; Raudenbush & Bryk, 2002, pp. 143-148). Therefore, variables were centered at individual or organizational means in our initial models to provide accurate estimates of group variability (Enders & Tofighi,

2007; Raudenbush & Bryk, 2002, p.143). This is sometimes known as centering within cluster (Enders & Tofighi, 2007). If the data indicated a variable's slope should be fixed, the variable was then centered at its grand mean or, for the temporal dummy variables, entered in their raw metric. At the final step in model building, to provide accurate estimates, variance components of varying slopes were estimated centered within cluster. The regression slopes were then estimated after centering variables at their grand mean or entering them into the model in their raw metric as appropriate, while still allowing slopes to vary if they had significant variance components when centered within cluster (cf. Enders & Tofighi, 2007).

We examined the robust standard errors as a check that violations of the assumption of normality had not affected the results (Maas & Hox, 2004; Raudenbush & Bryk, 2002). HLM6 was unable to estimate robust standard errors in Sample 2 for a three-level model because of the model's complexity. Therefore, to obtain robust standard errors, the model was re-estimated as a two-level model. In this two-level model, organizational level control variables were not used and slopes allowed to vary between organizations in the three-level model were allowed to vary between individuals instead.

When using robust standard errors, all of the mediated effects, total effects, and all but one of the significant relationships in the multilevel regression equations remained significant ($p < .05$). The exception was changing aspects of work activities to solve problems on learning in Sample 1. This effect was marginally significant with robust statistics ($p < .09$). The difference in non-robust and robust standard errors was less than 0.01. We decided to accept the relationship as significant because of the small difference in standard errors, the marginal significance under robust estimation, and non-robust and robust estimation indicated significant relationships in the other sample.