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Linking the Demands-Control-Support Model to Innovation: The Moderating Role of  
Personal Initiative on the Generation and Implementation of Ideas

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## Abstract

The demands-control-support model (R.A.Karasek & T.Theorell, 1990) indicates that workers can use job control and social support for problem-solving. We examined whether personal initiative moderated relationships between, on the one hand, job control used for problem-solving and social support used for problem-solving and, on the other hand, ideas generation and ideas implementation. We operationalised job control used for problem-solving as “changing aspects of work activities to solve problems”. We operationalised social support used for problem-solving as “discussing problems to solve problems”. Using an experience sampling methodology, participants provided data for up to four times a day for up to five working days ( $n = 89$ ). The extent to which people “changed aspects of their work activities to solve problems” was associated with higher levels of ideas generation for people with high personal initiative. The extent to which people “discussed problems to solve problems” was associated with higher levels of ideas implementation for people with high personal initiative.

## Linking the Demands-Control-Support Model to Innovation: The Moderating Role of Personal Initiative on the Generation and Implementation of Ideas

The Demands-Control-Support-Model (DCSM, Karasek & Theorell, 1990) has been extensively researched in relation to well-being (de Lange, Taris, Kompier, Houtman & Bongers, 2003). The DCSM is also a model of job design and work performance. Karasek and Theorell indicate that job control and social support enable workers to engage in problem-solving that enhances performance. Research has given little attention to the explanatory power of the DCSM in relation to innovation. This is surprising: problem-solving is an important influence on innovation (e.g., Scott & Bruce, 1994).

Our first contribution is to examine whether the principles underpinning the DCSM can be extended to key aspects of the innovation process; the generation and implementation of ideas (George, 2007). We focus on the instrumental purposes for which job characteristics such as control and support may be enacted. Therefore, our second contribution is to examine whether the principles from the literature on job crafting and enacted job characteristics (Clegg & Spencer, 2007; Daniels, 2006; Wrzesniewski & Dutton, 2001) are relevant to innovation. A third contribution is to examine whether proactivity is an important moderator of the links between problem-solving and ideas generation and implementation. We examined personal initiative (Frese & Fay, 2001), which is an overarching concept underpinning a range of proactive behaviours (Parker & Collins, in press).

We begin by examining the literature on links between job characteristics and ideas generation and implementation. We then position the DCSM as a suitable model for explaining how job control and support can be enacted to solve problems, and hence generate and implement ideas. We then consider personal initiative as an important moderator of the

link between problem-solving and ideas generation and implementation, before testing the hypotheses.

### Demands, Control, Support and Innovation

Key components of the DCSM (Karasek & Theorell, 1990) are conceptualised as follows: Demands (e.g., difficult work and time pressures) require psychological effort; Job control relates to authority to make decisions concerning the job, such as decisions concerning when and how to execute tasks (e.g., Breugh, 1985); Support is defined in the DCSM as helpful interactions with others at work. In this section, we detail how these components of the DCSM have been linked to creativity and innovation. Creativity is the generation of new and useful ideas, and is seen as the precursor of innovation, which is the implementation of those ideas (e.g., George, 2007).

Associations with ideas generation, and hence implementation, are usually explained by the motivating potential of some job characteristics (e.g., Shalley, Zhou & Oldham, 2004). This explanation is applied to work demands, job control and social support amongst other job characteristics (Amabile, Conti, Coon, Lazenby & Herron, 1996; Oldham & Cummings, 1996). However, relationships between job characteristics and ideas generation and implementation may not just reflect motivational processes. Some job characteristics may also serve instrumental purposes. Specifically, job control may also allow individuals to apply a wider array of knowledge, actions and search strategies to generate ideas (Frese & Zapf, 1994). Social support may also serve instrumental purposes, as support can involve instrumental aid and information (House, 1981).

Most studies of job design and innovation rely on measures of job characteristics that assess typical levels of job demands, typical levels of the availability of control and typical levels of the availability of support. Such methods are not able to separate out the

motivational effects of job characteristics from their instrumental purposes. Theoretically, the DCSM is able to explain how job control and support can be directly instrumental in generating and implementing ideas. Operationalising the theoretical processes embedded in the DCSM allows for a separation of the instrumental from motivational aspects of job control and social support.

### *The DCSM and Problem-solving*

Most research on the DCSM has also assessed workers' typical levels of demands, control and support, or imputed them from occupational classifications (de Lange et al., 2003). Such measurement practices are based on the assumption that job characteristics are relatively stable (Daniels, 2006). Job crafting is an alternative line of theorising on job characteristics. Job crafting relates to how individuals shape the characteristics of their jobs and portrays job characteristics as dynamic phenomena (Clegg & Spencer, 2007; Wrzesniewski & Dutton, 2001). In this line of reasoning, jobs characteristics can be used for specific purposes (Wrzesniewski & Dutton, 2001).

The idea that job characteristics are enacted for specific purposes is also embedded in the DCSM. Karasek and Theorell (1990) describe dynamic processes that underpin the DCSM. In one of these processes, labelled the active learning hypothesis, workers are portrayed as active problem-solvers that use control and support to solve problems caused by high work demands. For Karasek and Theorell, job control allows workers to apply their own knowledge to problems, to choose how best to cope with problems, to test alternative courses of action in response to these problems and learn from what is effective and ineffective to anticipate solutions to future problems. For Karasek and Theorell, support can also be used for problem-solving and allows collective discussion of problems. Therefore, in the DCSM, because workers are conceptualised as actively using control and support to solve problems, the focus of the DCSM is on the instrumental effects of the job characteristics of job control

and social support. Consequently, the use of control and support to solve problems is theoretically more important than typical levels of job demands, job control and social support.

Typical levels of job characteristics are different phenomena from enacted job characteristics (Daniels, 2006). Typical levels of job characteristics are general across time and purposes, whereas enacted job characteristics are used for specific purposes at a specific time. The decision to enact a specific job characteristic for a specific purpose may be dependent on factors other than the levels of that job characteristic available, such as the relative perceived benefit of enacting a job characteristic weighted against its perceived cost (Daniels, Harris & Briner, 2004). The differentiation between typical levels and enacted job characteristics is important, since enacting job characteristics for problem-solving relates directly to the instrumental processes outlined in the DCSM. Therefore, our focus is on problem-solving demands, how job control and social support are used for problem-solving, and how these processes translate in ideas generation and implementation.

We operationalised job control used to solve problems as the extent to which workers “change aspects of their work activities to solve problems”. This relates to control over schedules and objectives as elements of job control (Breugh, 1985). For example, a worker might change work schedules to devote more time to solving a problem. We operationalised social support used for solving problems as the extent to which workers “discuss problems with others to solve those problems”, reflecting instrumental and informational aspects of support oriented to problem-solving (House, 1981). In both instances, the use of control and support are operationalised as a response to problem-solving demands and specific to problem-solving demands. In support of operationalising processes underpinning the DCSM in this way, studies have found relationships between a range of indicators of well-being and performance on the one hand, and both “changing aspects of work activities to solve

problems” and “discussing problems to solve problems” on the other (Daniels, Beesley, Cheyne & Wimalasiri, 2008; Daniels, Boocock, Glover, Hartley & Holland, 2009; Daniels & Harris, 2005).

We do not expect main effects to characterise relationships between ideas generation or implementation and problem-solving demands, “changing aspects of work activities to solve problems” or “discussing problems to solve problems”, because unadapted, pre-existing ideas and solutions may be applied to problems. Indeed, although problem-solving is central to the DCSM, problem-solving demands have no specific requirement to generate novel and useful solutions (cf. Unsworth, Wall & Carter, 2005). Therefore, we expect that personal initiative is important for problem-solving to generate and implement novel and useful ideas.

#### Personal Initiative

Personal initiative is a set of co-occurring behaviours, and people high in personal initiative can be characterised as self-starting, persistent in implementing goals and having a long-term orientation (Frese & Fay, 2001). ‘Self-starting’ relates to behaviour motivated by goals that the individual sets, rather than goals assigned, for example through job descriptions, role requirements or supervisor instructions. ‘Persistence’ relates to overcoming barriers and setbacks to implementing changes and ideas in order to reach goals. ‘Long-term orientation’ implies anticipation of future circumstances and anticipation of chances to prepare for such circumstances. Personal initiative is also conceptualised as having long-term benefits for individuals and organisations (Frese & Fay, 2001). By definition then, we would expect people high in personal initiative to generate and implement new and useful ideas in response to problems.

Because the DCSM indicates job control can be used for problem-solving, we expect people high in personal initiative to be more likely to use job control to solve problems in



such a way to generate new and useful ideas (cf., Searle, 2008). People with high personal initiative are future oriented, and personal initiative may also predispose individuals to notice the potential for new ideas that resolve ambiguous problem situations (Seibert, Kraimer & Crant, 2001, see Fiske & Taylor, 1991) and so develop ideas that are more creative (Binnewies, Ohly & Sonnentag, 2007). We expect individuals with high personal initiative to use job control to solve problems in such a way that they apply their knowledge in different ways, try new things out, try alternative courses of action if initial plans fail, and reschedule tasks to persist in the search for new ideas. Therefore:

*Hypothesis 1:* Personal initiative will moderate the relationship between “changing aspects of work activities to solve problems” on ideas generation, so that people high in personal initiative will be more likely to generate ideas when “changing aspects of their work activities to solve problems”.

We do not expect people with high personal initiative to use support more effectively to generate new ideas, because the presence of others can disrupt cognitive processes related to generating ideas from unique information (Paulus, Larey & Dzindolet, 2001; Shalley, 1995). However, implementing ideas has a social element, in which individuals need to gather feedback on their ideas, involve others in selecting the best ideas, transform their ideas and gain support for their ideas (e.g., De Dreu, 2002, 2006; De Dreu & West, 2001; Van der Vegt & Janssen, 2003; West, 2002). Because people high in initiative are persistent in implementing ideas (Frese & Fay, 2001), we expect that when people high in personal initiative engage in these social processes, they are motivated to engage in such a way as to discuss problems with others to improve and implement new ideas for solving the problems (Frese & Fay, 2001). We also expect that individuals high in personal initiative will be motivated to acquire the political and social knowledge (Siebert et al., 2001) to help them develop plans (Frese & Fay, 2001) and overcome the social barriers inherent in implementing

ideas in organisational settings (West, 2002), again making the discussion of problems effective for implementing ideas for solutions. Therefore, we expect that people high in personal initiative will be more effective in using support to implement new ideas for solving problems.

*Hypothesis 2:* Personal initiative will moderate the relationship between “discussing problems to solve problems” on ideas implementation, so that people high in personal initiative will be more likely to implement ideas when “discussing problems to solve problems”.

Figure 1 summarises the relationships we investigate, and embeds the relationships in the processes of problem-solving outlined in the DCSM.

#### *The Present Study*

We used an electronic experience sampling methodology (ESM) to collect data four times per day over one working week. For ideas implementation, ideas generation assessed at the same time was controlled since ideas generation precedes implementation (George, 2007). We controlled for typical levels of the dependent variables to control for differences between people in the extent to which they typically generate and implement ideas. We also controlled for typical levels of job control and typical levels of social support. We controlled for linear and curvilinear effects of problem-solving demands, given potential curvilinear relationships between problem-solving demands and ideas generation and implementation (e.g., George, 2007).

Problem-solving demands might elicit various affective regulation processes (cf., Daniels et al., 2009). One such process is affective expression, which allows adverse cognitive and physiological reactions to a stressor to diminish through catharsis and may also help individuals to understand their situation and their goals (Austenfeld & Stanton, 2004; John & Gross, 2004; Lepore, Ragan & Jones, 2000). Affective expression might be particularly

pertinent for ideas generation and implementation. For example, Bond and Bunce (2000) found training in affect regulation was associated with subsequent improvements in innovation, and Daniels et al. (2008, 2009) have found affective expression to be related to indicators of cognitive performance.

Job control and social support could be used for affective expression as well as or instead of problem-solving (Daniels & Harris, 2005; Daniels et al., 2008, 2009). Therefore, we also controlled for “changing work activities to express affect” and “talking to others to express affect”. “Changing work activities to express affect” relates to using job control for affective expression. “Talking to others to express affect” relates to using social support for affective expression.

## Method

### *Sample and Procedure*

Participants came from five UK organisations ( $n = 89$ ). The average age was 39.30 years ( $SD = 9.12$ ), the average tenure in current role was 4.02 years ( $SD = 4.82$ ) and the average tenure in their organisation was 11.56 years ( $SD = 9.40$ ). Most of the sample was male (80.9%). Participants were recruited by requesting volunteers from each organisation. A maximum of between 10 and 40 participants were requested from each organisation, depending on its size. Some 116 people were approached in all (overall response rate = 76.7%). The five organisations comprised of managerial staff from the sales department of a utility company ( $n = 28$ ), engineers from an automotive engineering consultancy ( $n = 22$ ), managers and designers from a subsidiary company of an automotive manufacturer ( $n = 21$ ), consultants from a small management consultancy ( $n = 13$ ) and researchers from a university engineering department ( $n = 5$ ).

Data were collected using personal digital assistants (PDAs). The PDAs administered questionnaires four times daily over one working week (Monday to Friday). Participants

completed questionnaires at 10.00 a.m., 12.00 p.m., 2.00 p.m. and 4.00 p.m. Participants provided data on 1,005 out of a possible 1,535 occasions (after taking into account scheduled leave, absence etc), giving an overall compliance rate of 65.5%. The average number of responses was 11.29 (range 3 to 18). To adjust for differences in compliance rates, each individual's compliance rate was included in the analyses. To adjust for possible differences in patterns of responses across time, we controlled for day of week and time of the day.

Before the ESM period, all participants completed a questionnaire. This questionnaire assessed personal initiative, demographics and other control variables.

#### *PDA measures*

*Hourly ideas generation and ideas implementation.* Because creativity and innovation relate to new and useful ideas, we assessed ideas generation and implementation in relation to ideas to improve work performance and problem-solving. Three-item scales assessed ideas generation ( $\alpha = .84$ ) and ideas implementation ( $\alpha = .86$ ) over the previous hour. An example of the ideas generation scale is "In the past hour, have you had any ideas that could improve your work performance?". An example of the ideas implementation scale is "In the past hour, have you implemented new ideas that could help you deal with difficult issues more efficiently?". Participants rated each item on 5-point full anchored scale (1 = no, 2 = yes, one idea, 3 = yes, two ideas, 4 = yes, three ideas, 5 = yes, four or more ideas). Scores were calculated by summing item scores and dividing by three. Multilevel confirmatory factor analysis (CFA) supported the separation of ideas generation from implementation (two-factor solution: Normed Fit Index, NFI = .99, Comparative Fit Index, CFI = .99; one-factor solution, NFI = .95, CFI = .96).

*Problem-solving demands.* Problem-solving demands were assessed with a single item ("In the past hour, how many issues without an obvious answer or solution have you had to deal with?", Daniels et al., 2008) rated on a 6-point scale (0, 1, 2, 3, 4, 5 or more).

*Problem-solving and affective expression.* Participants rated how they responded in the past hour to the level of problem-solving demands they had experienced. Each scale consisted of two items and ratings were made on a 6-point fully anchored scale (1 = *not at all*, 6 = *to a large extent*). 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” ( $\alpha = .87$ ), “discussing problems to solve problems” ( $\alpha = .94$ ), “changing aspects of work activities to express affect” ( $\alpha = .76$ ) and “talking to others to express affect” ( $\alpha = .82$ ). In previous studies using these items, CFA indicated that the proposed four-factor model exceeded conventional goodness of fit criteria and had a better fit than several alternative factor structures (Daniels et al., 2008, 2009). Multilevel CFA with this sample also indicated acceptable fit for the hypothesised four-factor solution (NFI = .99, CFI = 1.00). 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 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”.

### *Questionnaire Measures*

*Personal initiative.* Personal initiative was assessed by six items from a seven-item measure developed in Germany (Frese, Fay, Hilburger, Leng & Tag, 1997). To make the scale more appropriate for a British sample, two items were modified slightly and one item dropped. An example item is “I use opportunities quickly in order to attain my own goals”.

Items were rated on a 5-point scale (1 = *strongly disagree*, 5 = *strongly agree*), summed and divided by six to derive scores ( $\alpha = .73$ ).

*Typical levels of ideas generation and implementation.* We assessed typical levels of ideas generation and implementation with two three-item scales with similar wording to the hourly measures assessed during the ESM period. An example of the ideas generation scale is “How often do you have ideas that could improve your work performance?”. An example of the ideas implementation scale is “How often do you implement new ideas that could help you solve work problems more quickly?”. Items were rated on a 5-point scale (1 = *never*, 5 = *very often*), summed and divided by three to derive scores ( $\alpha = .85$  for ideas generation,  $\alpha = .87$  for ideas implementation). CFA indicated a two-factor solution provided a better fit to the data than a one-factor solution (two-factor solution: NFI = .95, CFI = .98; one-factor solution, NFI = .90, CFI = .93).

*Typical levels of job control and social support.* Typical levels of job control were assessed by six items adapted from Breugh’s (1985) measure (e.g., “Can you decide when to do particular work activities?”). Support was assessed by four items adapted from Daniels’ (2000) measure (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 ( $\alpha = .83$  for job control,  $\alpha = .72$  for support).

### *Analyses*

Three-level multilevel regressions were fitted to the data, ascending from hourly responses, embedded in 89 participants, embedded in the five organisations. The hypotheses predict cross-level interactions between personal initiative and two problem-solving variables (“changing aspects of work activities to solve problem” and “discussing problems to solve problems”). To test cross-level interactions, the variable assessed at the person level (personal initiative) is used to predict each participant’s regression slope for the relationship between

the independent (problem-solving) and dependent (ideas generation or implementation) variables (Raudenbush & Bryk, 2002).

In the DCSM, the focus of analysis is absolute differences in levels of “changing aspects of work activities to solve problems” and “discussing problems to solve problems”. Therefore, we centred these variables at their grand mean in the multilevel regressions, so that we were able to compare different levels of these variables. However, grand mean centring does not remove stable between-person variance but the analysis of ESM data requires this to be controlled. Participants’ average levels of variables across an ESM period represent between-person variation. Therefore, we controlled for each participant’s average levels of “changing aspects of work activities to solve problems”, “discussing problems to solve problems” and most other ESM variables (all grand mean centred). This is a recognised technique for removing between person variance (e.g., Raudenbush & Bryk, 2002). Personal initiative was also centred at the grand mean for the sample, as were all control variables assessed at the level of the person. Between-person variance in the cross-level interactions was controlled by including the cross-product of personal initiative and each participant’s average values of the problem-solving variables. To control for curvilinear relationships between the dependent variables and problem-solving demands, values of demands were centred at the grand mean and then squared. To take into account between-person variation in demands, participants’ average values of demands were centred at the grand mean and then squared.

Other variables for the analyses were time of day and day of week. Time of day was represented by three dummy codes (representing 10 a.m., 12.00 p.m. and 2.00 p.m.). Day of week was represented by four dummy codes (Monday through Thursday). Dummy variables were left in their raw metric.

As the hypotheses are directional, they were evaluated with asymmetric two-tailed tests. Unlike one-tailed tests, asymmetric two-tailed tests allow a possibility of detecting a relationship in the opposite direction to that expected. For an overall of type I error of  $\alpha = .05$ , we set the probability of type I error for the hypothesised direction to  $\alpha = .045$  and that for the unexpected direction to  $\alpha = .005$  (Nosanchuk, 1978). Otherwise, we used symmetric two-tailed tests.

## Results

Table 1 shows the means, standard deviations, internal consistencies (Cronbach's alpha) and correlations. There was a strong correlation between ideas generation and implementation assessed at the hourly level ( $r = .78$ , significance tests inappropriate because of non-independence of observations). This correlation was weaker than the correlation between participants' weekly average levels of hourly ideas generation and implementation ( $r = .90, p < .01$ ). We retained hourly ideas generation and implementation as separate variables based on the multilevel CFA, the distinction in the literature between ideas generation and implementation, and our focus on hourly levels, where there is the lower correlation of  $r = .78$ .

Participants' typical levels of ideas generation correlated at marginal levels of significance with both weekly average levels of hourly ideas generation ( $r = .20, p < .10$ ) and implementation ( $r = .19, p < .10$ ). Typical levels of ideas implementation were not correlated with either weekly average levels of hourly ideas generation ( $r = -.03, ns$ ) or implementation ( $r = -.10, ns$ ). Average levels of hourly ideas generation and implementation did not correlate with personal initiative, typical levels of ideas implementation or typical levels of social support (range of  $rs$ .00 to .14,  $ns$ ). Typical levels of job control had an inverse association with hourly ideas generation ( $r = -.21, p < .05$ ) and hourly ideas implementation ( $r = -.30, p < .05$ ). Typical levels of ideas generation and implementation had positive associations with personal initiative, typical



levels of job control and typical levels of social support (range of  $r$ s .25 to .55,  $p < .05$ ). Typical levels of job control were not associated with average levels of “changing work activities to solve problems” ( $r = -.17$ ,  $ns$ ) and typical levels of social support were not associated with average levels of “discussing problems to solve problems” ( $r = .08$ ,  $ns$ ).

Table 2 shows the multilevel regressions on hourly ideas generation and implementation.<sup>1</sup> There was a significant cross-level interaction between personal initiative and “changing work activities to solve problems” on hourly ideas generation ( $B = 0.06$ ,  $p < .05$ ). The positive sign of the coefficient indicates that “changing aspects of work activities to solve problems” was more strongly associated with hourly ideas generation for people high in personal initiative. This result supports Hypothesis 1. Using formulae from Raudenbush and Bryk (2002), we estimated that the combined effect of the cross-level interaction, the two problem-solving variables and personal initiative accounted for an additional 4% of the variance between occasions and an additional 5% of variance between people above all the other variables. The cross-level interaction itself accounted for all 4% of the additional variance between occasions and 2% of the additional variance between people. The two problem-solving variables accounted for 2% of the additional variance between people and personal initiative an additional 1%.

For hourly ideas implementation, there was a significant cross-level interaction between personal initiative and “discussing problems to solve problems” ( $B = 0.04$ ,  $p < .05$ ), in which “discussing problems to solve problems” was more strongly associated with hourly ideas implementation for people higher in initiative. This result supports Hypothesis 2. We estimated that the combined effect of the cross-level interaction, the two problem-solving variables and personal initiative accounted for an additional 2% of the variance between occasions and an additional 0.7% of variance between people above all the other variables. The cross-level interaction itself accounted for all 2% of the additional variance between occasions, but none of

the additional variance between people. The two problem-solving variables accounted for 0.35% of the additional variance between people and personal initiative an additional 0.35%.

Some additional findings warrant comment. Both “changing work activities to express affect” and “talking to others to express affect” were related to ideas generation ( $B = 0.05, p < .01$ ; and  $B = 0.06, p < .05$ , respectively). Affective expression variables accounted for an estimated additional 1% of the within-person variance and 7% of the between person-variance above all the other variables in the ideas generation model. However, the between-person variable of weekly averaged levels of “changing work activities to express affect” was inversely related to ideas implementation ( $B = -0.09, p < .05$ ). We estimated that the affective expression scales accounted for an additional 2% of the variance in ideas implementation above all the other variables.

## Discussion

We found that for people with higher levels of personal initiative, “changing aspects of work activities to solve problems” was more closely related to ideas generation and “discussing problems to solve problems” was more closely related to ideas implementation. One contribution of this study is to show that the principles of the DCSM can be extended to explain the relationships between problem-solving demands on the one hand, and ideas generation and implementation on the other. This adds to research on job characteristics and the innovation process, as our findings indicate that creativity and innovation are linked to whether job control and support are enacted to solve problems.

This study adds an important qualification: In relation to processes underpinning innovation, the results indicate that personal initiative may be an important moderator of the processes embedded in the DCSM. As personal initiative is an overarching concept underpinning a range of proactive behaviours (Parker & Collins, in press), our research adds

to studies that have indicated direct relationships between parts of the innovation process and personal initiative (Binneweis et al., 2007) or proactive personality (Siebert et al., 2001) by indicating contingencies in how personal initiative may be linked to ideas generation and implementation.

*Comparisons with other studies of innovation and creativity*

Many studies have linked typical levels of demands, control and support to creativity and innovation, and intrinsic motivation has been posited as the link between typical levels of job characteristics and creativity, and hence innovation (George, 2007; Shalley et al., 2004). In this study, we focused on the instrumental purposes of the enactment of control and support for problem-solving. These are different constructs to typical levels of job characteristics, and reflect dynamic processes described in the DCSM. Therefore, our results are framed within perspectives that portray job characteristics as dynamic phenomena that are enacted for specific purposes (Clegg & Spencer, 2007; Daniels, 2006; Wrzesniewski & Dutton, 2001).

Our results indicate that the role of job characteristics in the innovation process can be viewed in different ways. For example, when examining typical levels of job characteristics, it may be that primarily motivational factors are responsible for creativity and innovation. In contrast, when examining job control and support in particular, it may be that using job control and support to solve problems is linked to the generation and implementation of ideas respectively for people high in personal initiative. Job control used for problem-solving may be linked to ideas generation because a wider array of knowledge, actions and search strategies might be used to solve problems (Frese & Zapf, 1994), whereas support used for problem-solving may allow for the transformation and implementation of ideas through collaborative problem-solving (De Dreu, 2006). Moreover, because our analyses controlled for levels of problem-solving demands and included incidences of no problem-solving

demands, the results indicate it is not merely the presence of problem-solving demands that is linked to ideas generation and implementation, rather it is whether people use job control and social support to solve those problems that is important.

The moderating role of personal initiative indicates “changing aspects of work activities to solve problem” and “discussing problems to solve problems” lead to ideas generation and implementation only for people with a tendency to look for longer-term solutions to problems, develop action plans for implementing those solutions and who have the competences needed to generate and implement ideas (cf., Frese & Fay, 2001; Searle, 2008). Therefore, our research indicates that people high in initiative enact job control and support to solve problems in such a way as to generate and implement novel solutions, rather than simply engaging in more problem-solving activity.

The combined effects of personal initiative, “changing aspects of work activities to solve problems” and their cross-level interaction account for a reasonable amount of variation in ideas generation between people (up to 5%) and also variation within the same people over time (up to 4%). Given that ideas generation precedes ideas implementation, these effects can be assumed to be transmitted. For people high in initiative, the specific relationships of “changing work activities to solve problems” to ideas generation, but “discussing problems to solve problems” to implementation indicates people high in initiative may not air ideas until they are in a form suitable to consider for implementation. In support of this, Siebert and colleagues (2001) found that proactive personality was related to innovation but not voice, which involves drawing others’ attention to problems but not necessarily offering solutions. For people high in initiative then, the early stages of problem recognition and generating tentative solutions may be a solitary activity. However, the combined effects of personal initiative, “discussing problems to solve problems” and their cross-level interaction account for a more modest amount of variation only within the same people over time (up to 2%). The

specificity of the cross-level interaction to within-person variance may indicate that people high in initiative may implement ideas better when they elicit support for problem-solving above their usual levels.

Both “changing work activities to express affect” and “talking to others to express affect” were related to hourly ideas generation. One possible explanation for such findings is that “changing work practices to express affect” or “talking to others to express affect” may involve workers switching to less cognitively demanding activities to regulate their affect. Performing less cognitively demanding tasks may replenish or make available cognitive resources to devote to problem-solving (Elsbach & Hargadon, 2006) or allow time for unconscious cognitive processes to work on solving problems (so called incubation effects, Sio & Ormerod, 2009). However, the results also indicate that people who generally “change work activities to express affect” more often than others are less likely to implement ideas, perhaps reflecting habitual disengagement from work tasks.

#### *Methodological Considerations*

The sample size was large enough to generate enough observations to have high statistical power for detecting cross-level interactions and was larger than is typically found in ESM studies in organisations. However, the sample consisted of workers in knowledge intensive jobs with, it is assumed, a relatively high frequency of problem-solving demands and requirements to solve those problems. Moreover, as our measure of problem-solving demands indexed problems without obvious answers or solutions, it might be claimed that our measure reflected open problems more than closed problems (Unsworth, 2001). As personal initiative moderated the impact of “changing work activities to solve problems” and “discussing problems to solve problems” on ideas generation and implementation respectively, it might also be claimed that there is a level of voluntariness involved in the generation and implementation of ideas assessed in this study. In this respect, our findings

may be limited to open-ended problems for which generating and implementing creative solutions is a voluntary activity. This circumstance resembles Unsworth's (2001) category of 'proactive creativity'. However, as 81% of workers in the developed and transition economies of Western and Eastern Europe report solving unforeseen problems at work (Parent-Thirion, Fernández Macías, Hurley & Vermeulen, 2007), the results may generalise to ideas generation and implementation in many jobs in more advanced industrial economies.

It might be argued that measures assessing the extent to which work practices were changed are confounded with measures reflecting the innovation process because innovation can entail changing work processes. Similarly, it might be argued that "discussing problems to solve problems" is confounded with our dependent variables. We do not think this is viable explanation of our results for two reasons. First, our dependent measures are specific to generating and implementing ideas that are useful for work performance and problem-solving, rather than new ideas in general. "Changing work activities to solve problems" or "discussing problems to solve problems" need not be related to ideas for improving work performance or solving problems more effectively in the future. Second, when controlling for other factors, there is no main effect between either "changing aspects of work activities" or "discussing problems to solve problems" on the one hand and ideas generation or implementation on the other. The relationships are entirely dependent on personal initiative. Moreover, the moderated relationships are specific: "Changing work activities to solve problems" had a moderated relationship with ideas generation only; "discussing problems to solve problems" had a moderated relationship with ideas implementation only. This empirical evidence is counter to an argument that the measures are confounded, because main effects on both variables, not specific moderated relationships, would be expected from simple confounding.

The finding that personal initiative moderates specific relationships involving “changing work activities to solve problems” and “discussing problems to solve problems” also counters an argument that the results reflect demand characteristics and presentational biases, in which participants may provide inflated reports of problem-solving activity, ideas generation and ideas implementation. Examining the means for relevant variables also counters this argument (table 1). In each case, the mean score was close to its theoretical minimum (i.e., 1), indicating participants were not motivated to over-report ideas or problem-solving activity.<sup>2</sup>

Moreover, evidence suggests that data captured over limited time frames is more accurate than more generalised retrospective reports (Tennen, Affleck, Larsen, Coyne, & DeLongis, 2006) and that generalised self-reports that rely on recall over longer periods may overestimate the incidence of phenomena (Todd, Tennen, Carney, Armeli & Affleck, 2004). Potential inaccuracy and inflation of self-reports gathered by the background questionnaire may explain the pattern of within-method and between-methods correlations for variables assessed by the background questionnaire (table 2). For example, the positive association between typical levels of job control and trait levels of ideas generation might be explained, at least partially, by bias inherent in assessing both by questionnaire. On the other hand, non-significant and negative correlations between PDA data and questionnaire data might reflect attenuation of relationships because of potential biases in questionnaire data that are likely to be absent in data collected by PDA (Siemsen, Roth & Oliveira, in press) and/or that the hourly processes of problem-solving, ideas generation and implementation are not related to more stable aspects of the person or the work environment in a straightforward way, but single or multiple moderators could be present.

## Conclusion

This study adds to the literature on Karasek and Theorell's popular model of job design, the DCSM. It does so by extending the scope of the DCSM to the innovation process, with the qualification that the explanatory power of the DCSM as an account of innovation might be usefully expanded to include the concept of personal initiative. The study also adds to the literature on personal initiative by indicating it is how people with high initiative solve problems, not necessarily the level of problem-solving activity, that is linked to generating and implementing ideas. Finally, the study adds to the literature on job characteristics and creativity and innovation by indicating that, rather than just the motivating potential of typical levels of job characteristics, enacting job control and social support to solve problems can be important.



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## Footnotes

<sup>1</sup> To check the robustness of the results, we examined each hypothesis in seven additional models, including models which included the lagged dependent variables, robust standard errors and models in which between-person effects for demands, problem-solving and affective expression scales were controlled by centring ESM variables at the person's mean. In all but two cases, both hypotheses were supported ( $p < .05$ ). The exceptions were both for Hypothesis 2. In each case, Hypothesis 2 was supported at marginal levels of significance ( $p < .07$ ). Given the support for Hypothesis 2 at conventional levels of significance in all other models, it was decided to accept Hypothesis 2.

<sup>2</sup> Although these means indicate the data were skewed, the results were replicated in analyses that require no distributional assumptions (i.e., using robust standard errors, see footnote 1).

Table 1

*Means, Standard Deviations, Internal Consistencies and Correlations*

Scale	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10	11	12
1. Hourly ideas generation	1.37	0.60	(.84)	.78	.41	.33	.15	.37	.30					
2. Hourly ideas implementation	1.28	0.53	.90**	(.86)	.34	.29	.15	.25	.23					
3. Demands	1.06	1.24	.67**	.63**	--	.60	.41	.54	.37					
4. Changing aspects of work activities to solve problems	2.07	1.39	.57**	.50**	.68**	(.87)	.52	.51	.40					
5. Discussing problems to solve problems	1.71	1.33	.18†	.17	.36**	.53**	(.94)	.15	.54					
6. Changing aspects of work activities to express affect	2.03	1.53	.54**	.33**	.53**	.52**	-.09	(.76)	.48					
7. Talking to others to express affect	1.41	0.89	.46**	.35**	.37**	.38**	.52**	.38**	(.82)					
8. Personal initiative	4.03	0.49	.03	.00	.14	.04	.01	.25*	.13	(.73)				
9. Typical ideas generation	3.47	0.72	.20†	.19†	.19†	.04	-.01	.09	.04	.51**	(.85)			
10. Typical ideas implementation	3.26	0.77	-.03	-.10	.01	-.08	-.03	.05	.02	.47**	.75**	(.87)		
11. Typical levels of job control	3.90	0.63	-.21*	-.30*	-.08	-.17	-.07	.13	-.08	.41**	.39**	.55**	(.83)	
12. Typical levels of social support	3.99	0.62	.06	-.12	-.12	-.11	.08	-.01	-.05	.12	.25*	.29*	.43**	(.72)

*Note.*  $N = 89$ , no. of observations = 1005, 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.

†  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ . Significance tests not shown for ESM data because of non-independence of observations.

Table 2

*Multilevel Regressions on Hourly Ideas Generation and Hourly Ideas Implementation*

Independent variables	<u>Ideas Generation</u>			<u>Ideas Implementation</u>		
	<i>B</i>	<i>se</i>	<i>t</i>	<i>B</i>	<i>se</i>	<i>t</i>
Person level variables						
Compliance rate	-0.12	0.15	-0.78	0.11	0.09	1.27
Personal initiative	-0.05	0.07	-0.80	0.04	0.04	1.20
Typical ideas generation	0.04	0.06	0.63	0.00	0.04	1.12
Typical ideas implementation	0.04	0.06	0.65	-0.01	0.04	-0.20
Typical levels of job control	-0.04	0.06	-0.74	-0.01	0.03	-0.15
Typical levels of social support	0.01	0.05	0.31	-0.01	0.03	-0.56
ESM variables						
Monday	0.07	0.05	1.29	0.00	0.03	0.13
Tuesday	0.06	0.05	1.13	0.02	0.03	0.63
Wednesday	0.07	0.05	1.30	0.09	0.03	2.61*
Thursday	0.05	0.05	0.92	0.05	0.03	1.38

*Table continues*



Table 2 (continued)

Independent variables	<u>Ideas Generation</u>			<u>Ideas Implementation</u>		
	<i>B</i>	<i>se</i>	<i>t</i>	<i>B</i>	<i>se</i>	<i>t</i>
ESM variables						
10.00 a.m.	-0.02	0.04	-0.37	-0.04	0.03	-1.35
12.30 p.m.	-0.01	0.04	-0.20	-0.03	0.03	-0.96
2.30 p.m.	-0.05	0.04	-1.225	-0.03	0.03	-1.26
Hourly ideas generation						
Average for each participant				0.27	0.06	4.42**
ESM assessment				0.58	0.02	27.70**
Demands						
Average for each participant	-0.03	0.07	-0.42	-0.07	0.04	-0.17
Average for each participant squared	0.07	0.03	2.472*	0.05	0.02	2.78**
ESM assessment	0.06	0.03	2.03*	-0.02	0.02	-0.97
ESM assessment squared	0.01	0.01	1.30	0.01	0.01	1.25

Table continues

Table 2 (continued)

Independent variables	<u>Ideas Generation</u>			<u>Ideas Implementation</u>		
	<i>B</i>	<i>se</i>	<i>t</i>	<i>B</i>	<i>se</i>	<i>t</i>
ESM variables						
Changing aspects of work activities to express affect						
Average for each participant	0.02	0.06	0.34	-0.09	0.03	-2.54*
ESM assessment	0.05	0.02	3.19**	0.00	0.01	-0.08
Talking to others to express affect						
Average for each participant	0.15	0.09	1.72	-0.01	0.05	-0.17
ESM assessment	0.06	0.03	2.20*	-0.02	0.02	-1.26
Changing aspects of work activities to solve problems						
Average for each participant	0.11	0.06	1.73	0.02	0.04	0.53
ESM assessment	0.02	0.02	1.21	0.01	0.01	1.22
Discussing problems to solve problems						
Average for each participant	-0.01	0.06	-0.20	0.02	0.01	1.45
ESM assessment	-0.02	0.02	-1.18	0.01	0.01	1.22

Table continues

Table 2 (continued)

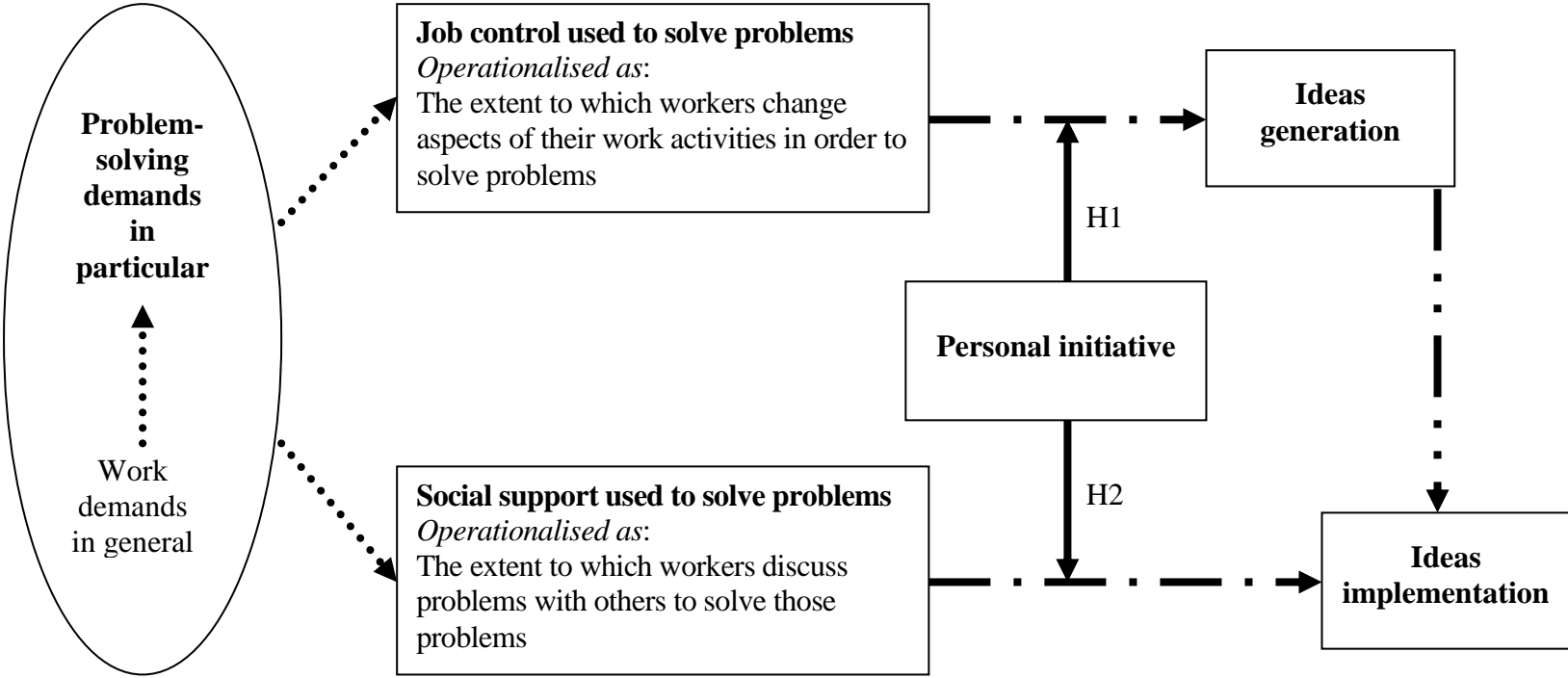
Independent variables	<u>Ideas Generation</u>			<u>Ideas Implementation</u>		
	<i>B</i>	<i>se</i>	<i>t</i>	<i>B</i>	<i>se</i>	<i>t</i>
<hr/>						
Personal initiative interactions						
<hr/>						
Changing aspects of work activities to solve problems						
Between persons interaction with participant's average	-0.02	0.09	-0.28			
Cross-level interaction with ESM assessment	0.06	0.03	1.73*			
<hr/>						
Discussing problems to solve problems						
Between persons interaction with participant's average				-0.07	0.05	-1.52
Cross-level interaction with ESM assessment				0.04	0.03	1.74*
<hr/>						
Variance components	<u>Ideas Generation</u>			<u>Ideas Implementation</u>		
Individual intercept	0.04**			0.01**		
Organisational intercept	0.00			0.00		
Changing aspects of work activities to solve problems	0.01**					
Discussing problems to solve problems				0.01**		

*Note.*  $N = 89$  participants, no observations = 1005. Averaged values are between-person variables.

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

Figure Captions

*Figure 1.* Hypothesized relationships embedded in the processes of the DCSM, ideas generation and ideas implementation.



- ..... Relationship described in DCSM but not tested
- Hypothesis examined
- - - - Examined relationship underpinning hypotheses