

6 7 8 **On the relationships among work** 9 **characteristics and learning-related** 10 **behavior: Does age matter?** 11

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25 26 27 **Summary**

28 This 3-wave longitudinal study examined (a) the causal direction of the relationships among
29 psychosocial work characteristics (e.g., job demands, job control, and supervisor support) and
30 indicators of learning-related behavior (e.g., motivation to learn and active problem solving),
31 and (b) whether these relationships differed across age, by comparing the results for young
32 (≤ 30), middle-aged (31–44) and older (≥ 45) workers. The results for the total sample revealed
33 significant reciprocal causal relationships among job demands, job control, and learning-
34 related behavior. Furthermore, significant age differences were found in the level of the work
35 characteristics and learning-related behavior, as well as in the cross-lagged relationships
36 among the variables. Compared to earlier—predominantly cross-sectional—results, the
37 present study underlines the importance of taking a dynamic as well as a life-span view
38 on the relationships between work and learning-related behavior. Copyright © 2009 John
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40 41 42 **Introduction**

43 Due to the challenges posed by the dynamic labor market, global competition and technological
44 innovation, lifelong learning ranks high among the topics on the management as well as research
45 agenda (Nijhof, 2005; Ouweneel, Taris, Van Zolingen, & Schreurs, 2009). Past research has revealed
46 that contemporary careers can be viewed as a series of learning cycles across a person's life (Hall, Zhu,
47 & Yan, 2002), and that learning must be examined in relation to the context in which it occurs,
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51
52 *Received 14 February 2008*

53 *Revised 3 April 2009*

54 *Accepted 16 June 2009*

2 including the characteristics of one's job (Poel, Van Dam, & Van den Berg, 2004; Taris, Kompier, De
3 Lange, Schaufeli, & Schreurs, 2003).

4 Although the work environment (especially job characteristics such as job autonomy) is often
5 regarded as a major determinant of learning, studies examining the links between work and learning in
6 a longitudinal perspective are still scarce (e.g., Holman & Wall, 2002; Taris & Kompier, 2004).
7 Moreover, current research on the learning-related effects of the job environment neglects age
8 differences and changes in informal learning at work across time (Poel et al., 2004). This is remarkable,
9 as forecasts suggest that the number of older workers in the Western world will substantially increase,
10 while the number of young workers will decrease (European Commission, 2005; Kanfer & Ackerman,
11 2004). Further, as the safety net of funded (early) retirement is currently being withdrawn worldwide, it
12 appears likely that many workers will not retire before the age of 65. Consequently, in the not-so-distant
13 future companies will increasingly rely on the work of older employees. Although this group of
14 workers has attracted considerable research interest, as yet their career development, well-being and
15 learning-related behavior have not been studied extensively (De Lange, Taris, Jansen, Smulders,
16 Houtman, & Kompier, 2006; Warr, 2007, 2008). Drawing on data from 1237 Dutch workers, the
17 present study was designed to fill this gap by examining the longitudinal relationships among work
18 characteristics and learning-related behavior in the context of age.
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22 *Learning and the psychosocial work environment*

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24 It is often proposed that the *psychosocial* work environment, referring to psychological and social job
25 conditions, affects worker well-being. One influential example of such a model is Karasek and
26 Theorell's (1990) Demand–Control–Support (DCS) model. According to the *activation hypothesis* of
27 this model, people working in jobs characterized by high job demands, high control, and high social
28 supervisor support (i.e., *active* jobs), will develop high intrinsic motivation for learning and personal
29 growth. In active jobs workers are not only continuously exposed to challenging job demands but also
30 have the autonomy and social support to explore different ways of dealing with the job demands. The
31 exposure to this challenging, but resourceful work environment will promote learning (Bandura, 1997).
32 Karasek and Theorell (1990) define learning-related behavior as “. . . an environmentally facilitated,
33 active approach toward learning new behavior patterns” (p. 170). Taris and Kompier (2004) argue that
34 workers under time pressure and quantitative overload have little opportunity for setting new goals and
35 developing new action plans, and tend to revert to prior automatized skills, which results in lower levels
36 of learning-related behavior. However, in active jobs supervisors can provide a learning climate that
37 encourages workers to learn new behavior, to show more personal initiative, and to develop new action
38 plans (Frese, Garst, & Fay, 2007; Warr, Allan, & Birdi, 1999).

39 Conversely, people working in jobs with low job demands, low control, and low social support
40 (*passive* jobs) will display low levels of activation and learning-related behavior, as the individual
41 experiences few learning opportunities. Further, people working in *low-strain* jobs (with low job
42 demands, high control, and social support) and *high-strain* jobs (characterized by high job demands,
43 low job control, and social support) will experience moderate levels of intrinsic motivation, as the
44 individual possesses insufficient resources to respond optimally to situational demands (Holman &
45 Wall, 2002; Karasek & Theorell, 1990; Taris et al., 2003).

46 In line with De Lange, Taris, Kompier, Houtman, and Bongers (2003), in this study we consider the
47 activation hypothesis supported when: (i) High job demands are related to more learning-related
48 behavior (Hypothesis 1a), (ii) high job control is related to more learning-related behavior (Hypothesis
49 1b), and (iii) high supervisor support is related to more learning-related behavior across time
50 (Hypothesis 1c) (cf. the paths A in Figure 1). Furthermore, as we want to examine the effects of
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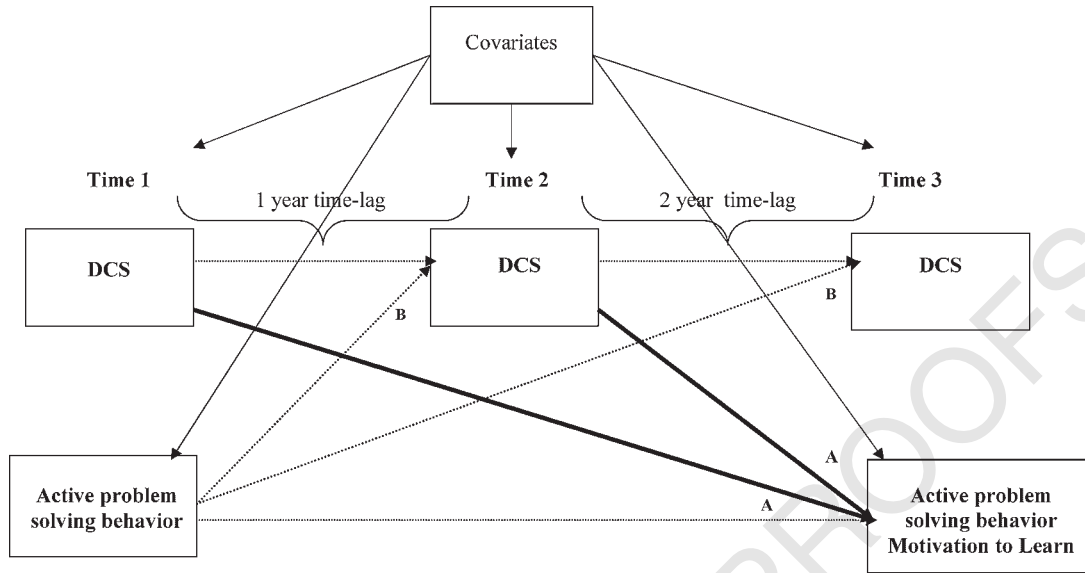


Figure 1. Research model (M₀) for the relation between DCS dimensions and learning-related behavior
 Note: DCS refers to demands, control and supervisor support; A refers to normal cross-lagged paths from DCS dimensions to learning-related behavior, and B refers to the control for reversed cross-lagged paths from active problem solving to the DCS dimensions

continuous exposure to these psychosocial work characteristics, we will control for the stability of these measures in our analyses.

The active shaper hypothesis

Besides the aforementioned “normal” causal effects of psychosocial work characteristics on learning-related behavior across time, we want to provide the first longitudinal test for possible “reversed” effects of active problem solving (cf. Figure 1, paths B; De Lange, Taris, Kompier, Houtman, & Bongers, 2005). In line with life-span developmental theory (Taris, Bok, & Caljé, 1998), we argue that employees are active shapers of their work environment, not just passive receivers of environmental influences. According to Wrzesniewski and Dutton (2001), employees react to their perceptions of the social or work context, and have autonomy to define and enact on the job. Frese et al. (2007) refer in this context to the concept of *reciprocal determinism* (cf. Bandura, 1997), stating that people can be the producer as well as the product of their social systems. Consistent with this reasoning, we expect that workers who engage in active problem solving will be more effective in creating or using job resources like job control and/or social support than workers who display less problem solving behavior (de Lange, De Witte, & Notelaers, 2008). Through widening their thought and action repertoire, active problem solvers will be better at crafting their jobs by selecting different job resources or promotion opportunities; resulting in improved emotion regulation (Fredrickson, 2001; Gross, 1998; Hobfoll, 2001; Salanova, Bakker, & Llorens, 2006). Thus, learning may also lead to changes in the job environment of workers.

The direction of a possible reversed effect of active problem solving on job demands is less clear. For example, active problem solvers may be more effective in reducing job demands, suggesting that active problem solvers will experience lower job demands in time. However, they may also attempt to make

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3 their job more interesting and challenging, which could lead to *higher*, rather than lower demands (De
4 Lange et al., 2008). Thus, it is difficult to hypothesize about the direction of the effects of active
5 problem solving on job demands.

6 Previous longitudinal research has provided some evidence for reciprocal relationships among
7 psychosocial work characteristics on the one hand, and mental health indicators (De Lange, Taris,
8 Kompier, Houtman, & Bongers, 2004; Taris, Kompier, Geurts, Houtman, & Van den Heuvel, in press;
9 Ter Doest & De Jonge, 2006) and personal initiative on the other (Frese et al., 2007). However, this
10 dynamic longitudinal perspective has not been taken in the context of learning-related behavior.
11 Consistent with previous research on the relationships between work characteristics and mental health,
12 we will therefore examine whether we can find evidence for reciprocal relations between psychosocial
13 work characteristics and learning-related behavior (Hypothesis 2; Figure 1, paths B).

14 *Age differences in the evaluation of work*

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17 Many researchers examining the DCS model routinely control for age in their studies. De Lange, Taris,
18 Kompier, Houtman, and Bongers (2003) showed that of the 45 longitudinal studies included in their
19 review on the Demand–Control–(Support) model, 91 per cent controlled for demographic variables,
20 among which age. However, none of these studies provided arguments *why* or *how* age would affect the
21 relationship between psychosocial work characteristics and well-being. Age has often been studied as a
22 covariate or confounder in occupational health research, but relatively few studies have taken a life
23 span perspective on vocational interests, values or the importance of various job dimensions such as
24 task complexity, autonomy, and variety (Griffiths, 1997; Kanfer & Ackerman, 2004; Warr, 2008). In
25 this study we therefore examine the prevalence of age differences in the level of psychosocial work
26 characteristics and learning-related behavior. Note that age can be studied as both *intra-individual*
27 (within-person) change and *inter-individual* (between-person) change (Baltes & Nesselrode, 1979, p.
28 3). The examination of potential intra-individual change as a function of age is necessary to enhance
29 our understanding of the across-time relationships among work and learning-related behavior. We start
30 with discussing potential age group differences, highlighting relevant life span developmental theories
31 to hypothesize further on how age may play a role in work and learning.

32 *Age group*

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34
35 The distinction between younger and older employees is often based on the respondent's chronological
36 or calendar age. The meaning of the term "older worker" may vary to include workers from age 40 to
37 75, depending on the purpose of the organization as well as the needs of the worker (Collins, 2003).
38 Although the cut-off point between young and older workers is not fixed, throughout this paper we use
39 the often employed threshold of 45 years to refer to older employees versus younger or middle-aged
40 workers (cf. Stroh & Greller, 1995; Warr, 2000). Specifically, we examine whether older workers (≥ 45
41 years) differ significantly from young (≤ 30 years) and middle-aged workers (31–44 years) regarding
42 the level of reported psychosocial work characteristics as well as learning-related outcomes.

43 *Life span developmental theory and learning: Hold on to what you got?*

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45
46 According to Baltes' (1987) life span theory, the motivational process of striving toward maximization
47 of gains and minimization of losses becomes more salient as people age, because of the loss of
48 biological, mental as well as social reserves across the life span (Bajor & Baltes, 2003; Higgins, 1997;
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3 Hobfoll & Shirom, 2001). According to the Selection Optimization with Compensation (SOC) model
4 of Baltes, Staudinger, and Lindenberger (1999), the allocation of resources for so-called “growth or
5 promotion” goals decreases with age, whereas maintenance and regulation of “loss or prevention”
6 goals increases with age. Similarly, Carstensen’s socio-emotional selectivity life span theory
7 (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000) proposes that individuals will select goals in
8 accordance with their perceptions of the future as being limited or open-ended (Lang & Carstensen,
9 2002). Younger generations would perceive time as being open-ended (holding a “time since birth”
10 perspective) and will be especially motivated by growth or *knowledge-related* goals (acquiring new
11 information or social interactions) that can be useful in the more distant future. In contrast, older
12 generations would perceive time as constraint (holding a “time till death” perspective), and will be
13 more motivated by achieving short-term emotion-related goals, such as deepening one’s existing
14 relations. As for older workers retirement will arrive sooner than for young or middle-aged workers,
15 work-related future perspectives also decrease faster for older workers (Carstensen, Isaacowitz, &
16 Charles, 1999). As a consequence, older workers may look for more emotion instead of learning-
17 related aspects in their work environment. In sum, these approaches suggest that older workers
18 experience a relatively lower need to learn new skills than their younger colleagues.

19 In line with these life span theories, earlier research has shown that as people age their openness to
20 new experiences and change decreases (Terracciano, McCrae, Brant, & Costa, 2005). Kanfer and
21 Ackerman (2004) suggest that aging workers face a loss of fluid intellectual abilities, which may
22 negatively affect their learning outcomes. For example, a decline in memory may lead to cognitive
23 slowing, reductions in processing resources, and deficits in reflective processes (Hess, 2005). However,
24 research has also shown that older workers have better emotion regulation skills compared to their
25 younger colleagues, and tend to use more passive, intrapersonal emotion-focused forms of coping skills
26 instead of active problem-focused behavior (Charles, Reynolds, & Gatz, 2001; Folkman, Lazarus,
27 Pimley, & Novacek, 1987). Applying these findings to learning-related behavior, the relatively high
28 level of expertise and knowledge of older workers may result in a lower need to learn new behavior
29 compared to younger workers. We therefore expect older workers to report lower levels of learning
30 motivation and active problem solving than others (Hypothesis 3).

31 *Life span developmental theory and psychosocial work characteristics: Old and* 32 *wise versus old and out?*

33
34 Warr (2007) reviewed the research on age-related preferences in job features, finding that age was
35 positively associated with increased preferences for physical security, salary, and opportunities for skill
36 utilization, and negatively associated with the importance of high job demands, job variety, and
37 provision of external goal assignments. He argues that older workers are likely to have different job
38 concerns than younger ones, due to life span changes such as changed family position, experience, and
39 perceptions of themselves at different stages in the life course. Furthermore, career developmental
40 theories focus on the idea that one’s self-concept becomes more clearly defined with age and that career
41 choice is a process of matching one’s self-concept with images of the occupational world (Watkins &
42 Subich, 1995), suggesting that older workers will have obtained careers that better *fit* their self-concept.
43 Similarly, Wright and Hamilton’s (1978) job change hypothesis assumes that due to experience,
44 seniority, and skills, the group of active older workers will have obtained a relatively better person–
45 environment fit, and higher level occupations with more job control than their younger colleagues
46 (Edwards, Cable, Williamson, Lambert, & Shipp, 2006).

47
48 Relevant for knowledge acquisition is also the feedback and social support of supervisors (Karasek,
49 1979). Because of their “time till death” perspective, older workers tend to be more selective in
50 investing time and effort in emotionally close interaction partners, and to reduce the effort invested in
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2
3 acquiring new social contacts (Carstensen, 1998). Moreover, supervisors may hold negative
4 stereotypes about older workers. As a result, they may provide older workers with less stimulating
5 feedback or support than others (Van der Heijden, 2006; Van der Heijden, De Lange, Demerouti, & Van
6 de Heijde, 2009). We therefore expect older workers to report a significantly higher level of job control,
7 and a lower level of supervisor support than other workers (Hypothesis 4). As there is no relevant age-
8 related research on job demands, we will not specify hypotheses for job demands.

9 10 *Intra-individual age effects?*

11
12 Besides age differences with respect to the scores on the DCS dimensions and learning-related
13 behavior, it is also important to address potential intra-individual, cross-lagged changes in the
14 relationships between psychosocial work characteristics and learning-related behavior. Earlier research
15 (Bal, De Lange, Jansen, & Van der Velde, 2008; Rousseau, 2001) revealed that older workers may
16 experience dampening of emotional responsiveness and possess stable mental models about their
17 employment situations, and they may therefore react less strongly to the same job demands than
18 younger workers. This could lead to weaker cross-lagged effects for older as compared to young and
19 middle-aged workers. Moreover, as older workers will on average have held their jobs for a relatively
20 long time, they may experience fewer learning stimuli from their psychosocial work environment than
21 workers who have just entered the labor market (Park, 1994). Considering the scarce research on these
22 issues, we do not specify specific hypotheses here. Instead, we exploratory test whether the relationships
23 between psychosocial work characteristics and learning-related behavior differ as a function of age.
24

25 26 **Organizational Context**

27 28 29 *Sample*

30
31 This study was initiated in 1993 by the Dutch TNO Work & Employment in order to identify work-
32 related risk factors for musculoskeletal complaints (Ariëns, Bongers, Miedema, Van der Wal,
33 Bouter, & Van Mechelen, 2001; Hoogendoorn et al., 2000). In cooperation with Dutch occupational
34 health services, a representative group of 2064 workers from 34 companies of various industrial and
35 service sectors, located throughout the Netherlands, were selected to participate in the study on
36 musculoskeletal disorders, absenteeism, stress and health (SMASH). Both blue-collar (65.2 per
37 cent) and white-collar (26.3 per cent) jobs were included. In order to be included, companies should
38 not be involved in major reorganizations during the 3 years of examination and the pre-study annual
39 turnover rate of their workforce should be lower than 15 per cent. Further, in order to realize enough
40 exposure to the current psychosocial work characteristics, we selected only respondents who had
41 been working for at least 1 year and held a permanent contract for at least 20 hours per week.
42

43 44 *Labor market perspective*

45
46 During the time period in which this study was carried out, the situation on the Dutch labor market
47 was relatively stable. Many social funds were available such as good pension programs.
48 Consequently, there were few financial incentives for older workers to remain active on the labor
49 market, resulting in high percentages of workers who voluntarily retired before the age of 60. In
50 comparison to Dutch trend data of the early 1990s as well as more recent trend data (Houtman et al.,
51

2004), our sample reported a comparable job autonomy, and relatively higher work pressure scores. For example, of the Dutch work population, 65 per cent in 1994 to 73 per cent in 2002 reported to have decision latitude. In our panel 59 per cent of the participants reported to have decision latitude. For work pressure, percentages of 38 per cent in 1994 to 41 per cent in 2002 were found for the Dutch work population, as compared to 59.8 per cent for our sample.

Method

Subjects

Of the invited workers, 1742 (84 per cent) participated at baseline in this study. At each wave (i.e., Time 1, 1994; Time 2, 1995; and Time 3, 1997) the respondents completed a self-report questionnaire, tapping concepts such as general working conditions, changes in the workplace, psychosocial work characteristics, psychosocial and physical health, and background factors. The learning-related outcomes were measured on Time 1 (active problem solving) and Time 3 (active problem solving and motivation to learn). The response rates were relatively high and varied from 84 per cent ($N = 1742$) at baseline to 85 per cent ($N = 1473$) at the third follow-up measurement, as compared to the previous wave. Non-response analysis revealed that drop-outs tended to be younger, and reported a lower level of education, more strain, and less control across time, a quite common phenomenon in longitudinal research (Taris, 2000). Furthermore, we examined the means for demands, control, and supervisor support for the blue collar versus white collar jobs, and found only significant differences in job control on Time 1 ($F(1, 1730) = 130.6$), Time 2 ($F(1, 1405) = 76.7$), and Time 3 ($F(1, 1390) = 61.2$). Further, blue collar workers reported lower job control scores than white collar workers. After listwise deletion of missing values the sample included 1237 respondents.

Measures

Job demands

Job demands were measured using a five-item Dutch version of Karasek's (1985) Job Content Questionnaire (e.g., "My job requires working very fast," "my job requires working very hard," 1 = "strongly disagree," 4 = "strongly agree"). The reliability (Cronbach's α) of this scale varied from .65 to .72 across waves (median $\alpha = .71$).

Job control

Consistent with Karasek (1979), job control was measured as the mean of two scales. *Skill discretion* was measured using a five-item scale (e.g., "my job requires creativity" and "my job requires learning new things"), and *decision authority* was measured using a three-item scale (e.g., "My job allows me to take many decisions on my own," "I have many opportunities to participate in decision making about my job," 1 = "strongly disagree," 4 = "strongly agree"). The reliabilities of the job control scale ranged from .81 to .83 (median $\alpha = .83$).

Supervisor support

Supervisor support was measured using a four-item Dutch version of Karasek's (1985) Job Content Questionnaire (e.g., "My supervisor pays attention to what I say," 1 = "strongly disagree,"

2
3 4 = “strongly agree”). The reliability (Cronbach’s α) of this scale varied from .82 to .88 across
4 occasions (median $\alpha = .86$).

5 *Learning-related behavior* was measured by the scales Motivation to learn and Active problem
6 solving. *Motivation to learn* refers to the degree to which workers report that their job motivates
7 them to learn new behavior patterns and skills on their job, or that they have to solve problems at
8 their job (Taris & Kompier, 2004). This approach is consistent with the definition of Karasek and
9 Theorell (1990), who defined active learning in terms of an active approach toward learning new
10 behavior and solving new problems. The concept was measured with a validated seven-item Dutch
11 scale developed by Van Mierlo, Rutte, Kompier, and Seinen (2001). Typical items are: In my work:
12 “I feel challenged by new problems,” “I look for solutions for problems of colleagues,” “I continue
13 to work on a problem until it is resolved” 1 = “never,” 4 = “often”). The reliability (Cronbach’s α)
14 of this scale, only measured on Time 3, was .83. *Active problem solving* was measured by four items
15 of the Dutch active coping scale (Schreurs, Van der Willige, Tellegen, & Brosschot, 1988), including
16 items such as “I perceive problems as challenges;” “I compare different solutions in solving a
17 problem;” “I work goal-oriented in solving problems,” 1 = “never,” 4 = “always”). The reliability
18 (Cronbach’s α) of this scale varied from .75 to .77 on Time 1 and Time 3. As expected, exploratory
19 factor analysis revealed that the psychosocial work characteristics and learning-related behavior
20 items measured different underlying factors.

21 **Covariates**

22
23 Gender, educational level, and job tenure were used as covariates in the analysis, because these
24 variables may be significantly related to the outcome variables in this study. Failing to control for these
25 variables may bias the effects of other variables.

26 **Statistical analysis**

27
28 Structural equation modeling (SEM; Jöreskog & Sörbom, 1993) was used to test and compare various
29 competing models for the relationships among demands, control and supervisor support, and learning
30 related behavior across time. SEM provides global measures of fit. In the present research we
31 performed a comparative analysis in which the fit of several competing models was assessed to
32 determine which model fitted the data best. Considering the problems caused by estimating all
33 observed items and latent variables (low statistical power and model under-identification, Bentler &
34 Chou, 1987), we assumed the scale and latent variables to be identical. However, following the two-
35 step approach proposed by James, Mulaik, and Brett (1982) we first tested the measurement models for
36 each of the variables before fitting the structural models (these results can be obtained from the first
37 author). These analyses showed that the factor structures of the research variables were consistent
38 across time. Finally, we report the standardized results, based upon an analysis of the covariances
39 among the variables.

40 To examine the causal relationships between the DCS dimensions and learning-related behavior
41 (Hypotheses 1 and 2) we tested a baseline model versus several competing nested models. We tested the
42 following models:

- 43
44 (M0) Baseline model: Includes temporal stabilities and synchronous effects (e.g., DCS measures were
45 allowed to correlate with one another within the same time wave) of variables over time and
46 controls for the influence of the covariates age, gender, level of education, and job tenure. This
47 model is used as the reference model.
- 48 (M1) Normal causation model: M₀ extended with cross-lagged structural paths from the Time 1, Time
49 2, and Time 3 DCS dimensions to Time 3 learning-related behavior (active problem solving and
50 motivation to learn; cf. Figure 1).

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2
3 (M2) Reversed causation model: M_0 extended with cross-lagged structural paths from Time 1
4 learning-related behavior to the Time 2 and Time 3 DCS dimensions.
5 (M3) Reciprocal causation model (M_3): M_0 extended with reciprocal cross-lagged structural paths
6 (i.e., the regular paths included in model M_1 as well as the reversed paths included in model M_2).
7 (M4) Reciprocal causation model with equal cross-lagged normal and reversed effects of the DCS
8 dimensions and learning-related behavior: To determine the causal predominance of the normal
9 and reversed cross-lagged effects, the normal and reversed effects between the DCS dimensions
10 and learning-related behavior are constrained to be equal.
11
12

13 Age effects

14 Analysis of variance (ANOVA) was used to test Hypotheses 3 and 4 regarding mean differences among the
15 age groups. To test whether the postulated reciprocal causal model differed as a function of age, we applied
16 multiple-group analysis using SEM (Jöreskog & Sörbom, 1993). The advantage of this method is that all
17 cross-lagged effects in Figure 1 could be tested simultaneously for all three age groups. In line with Byrne's
18 (1998) suggestions, we first tested the proposed standardized cross-lagged effects for each subgroup
19 separately (forming a baseline model). Then we tested for invariance across the age groups. All model tests
20 were based on the covariance matrix and using maximum likelihood estimation. In judging the fit of
21 models we considered both the χ^2 -value and other fit indexes, including the goodness-of-fit index (GFI),
22 the non-normed fit index (NNFI), and the root-mean square error of approximation (RMSEA). Levels of
23 .90 or better for GFI and NNFI and levels of .05 or lower for RMSEA signify acceptable fit (Byrne, 1998).
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26 Results

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28
29 Prior to the multi-group SEM analyses, preliminary analyses were carried out to gain insight into the
30 data, and to examine meaningful differences among the age groups (cf. Kooij, De Lange, Jansen, &
31 Dijkers, 2008). Table 1 shows that the age groups differed significantly regarding job tenure, gender,
32 leadership position, family situation, and number of care-needing persons at home. Not surprisingly,
33 older workers had significantly higher job tenure, occupied more often a supervisory position than
34 younger workers, whereas the middle-aged workers experienced significantly more care-giving tasks
35 than other workers. No significant differences emerged for educational level, socio-economic status,
36 career possibilities, experienced recognition, rewards and job security among the age groups.
37

38 Tables 2a and 2b present the correlations among the variables under study for the total group of
39 respondents and the three age groups separately. As regards the across-time stability of the variables, the
40 Time 1–Time 2 test–retest correlations ranged from .47 (for Supervisor support), and .50 (for Demands) to
41 .67 (for Control, all p 's < .001); the Time 2–Time 3 test–retest correlations ranged from .56 (for Supervisor
42 support), and .52 (for Demands) to .68 (for Control; all p 's < .001), and the Time 1–Time 3 test–retest
43 correlations ranged from .43 (for Demands), .49 (Supervisor support), .55 (active problem solving) to .71
44 (Control; all p 's < .001). Thus, the stability and reliability of the measures was satisfactory.
45

46 *Hypotheses 1 and 2:* Are there reciprocal cross-lagged relationships between job demands, control,
47 supervisor support, and indicators of learning-related behavior?
48

49 In order to examine Hypotheses 1 and 2, the fit of the four competing structural models M_0 – M_3 (see
50 Method) was compared (Table 3). The fit of all models was satisfactory (NNFI, GFI \geq .90 and
51 RMSEA \leq .05).
52

Table 1. Demographic characteristics and information on type of work and home situation across age groups (means and standard deviation scores are presented between brackets)

Variables	≤30 (N = 407)	31–44 (N = 601)	≥45 (N = 229)	Univariate <i>F</i>
Age*	26.2 (2.50)	37.2 (3.97)	48.5 (2.79)	<i>F</i> (2, 642) = 1733.89
Job tenure*	4.52 (2.48)	10.86 (7.06)	17.86 (9.73)	<i>F</i> (2, 642) = 161.69
% Men*	57%	78.7%	72.8%	<i>F</i> (2, 642) = 24.86
% Level of education				
1: Primary or lower	5.0%	10.6%	23.2%	<i>F</i> (2, 642) = 1.85
2: Lower vocational	44.7%	39.8%	37.0%	
3: Secondary or middle vocational	33.7%	26.6%	21.4%	
4: Higher vocational	7.8%	10.3%	9.5%	
5: College/University	7.7%	11.7%	7.3%	
% Socio-economic status				
1: Blue collar jobs	74.2%	69%	71.6%	<i>F</i> (2, 642) = 2.59
2: White collar job	25.7%	31%	28.4%	
% Sufficient career possibilities (yes)	54.7%	53.0%	46.5%	<i>F</i> (2, 642) = .30
% Sufficient recognition (yes)	67.7%	68.7%	69.1%	<i>F</i> (2, 642) = .91
% Sufficient rewards (yes)	60.2%	59.3%	63.0%	<i>F</i> (2, 642) = .57
% Leadership position*	7.5%	15.2%	20.2%	<i>F</i> (2, 642) = 11.50
% Job change in past 12 months (no)	84.7%	84.4%	84.4%	<i>F</i> (2, 642) = .80
% Job security (agree)	89.2%	88.1%	87.5%	<i>F</i> (2, 642) = .00
% Family situation*				
1: Unmarried, not living together,	17.2%	11.2%	7.0%	<i>F</i> (2, 642) = 9.74
2: Married or living together,	63.0%	80.1%	81.0%	
3: Divorced, not living together,	1.3%	2.8%	4.0%	
4: Widowed, not living together	0.0%	0.0%	.9%	
5: Living with parents	14.0%	1.2%	2.4%	
% Children or other care-needing persons at home (yes)?*	10%	30.3%	20.5%	<i>F</i> (2, 642) = 59.44

Note: All variables are measured on Time 1, Multivariate $F(112, 4375) = 8.93$.

*Significant differences between groups ($p < .001$).

Further, we compared the nested structural models M_1 – M_3 to the baseline model M_0 using the χ^2 -difference test, in order to see whether the nested models show a better fit than the baseline model without these relationships. Table 3 shows that models M_1 – M_3 fitted the data significantly better than the baseline model M_0 . Thus, the DCS dimensions and learning-related behavior were indeed related. The results also show that the reciprocal model (M_3) accounted better for the data than the normal causation model (M_1 versus M_3 : $\Delta\chi^2(12, N = 1237) = 43.76, p < .05$), and the reversed causation model (M_2 versus M_3 : $\Delta\chi^2(6, N = 1237) = 45.21, p < .05$). Figure 2 presents the significant cross-lagged effects of the best fitting reciprocal causal model (M_3). Specifically, for Time 3 motivation to learn significant positive cross-lagged effects were found of Time 1 job control ($\beta = .12$), Time 2 job demands ($\beta = .07$), and positive cross-sectional effects of Time 3 job demands ($\beta = .07$) and job control ($\beta = .39$). For Time 3 active problem solving significant cross-lagged effects were found of Time 1 job control ($\beta = .07$), and significant cross-sectional effects of Time 3 job demands ($\beta = .06$), and job control ($\beta = .12$). These results provide evidence for positive effects of job demands as well as job control in predicting learning-related behavior across time. No significant effects were found for supervisor support (Hypotheses 1a and 1b supported; 1c not supported).

Table 2a. Correlations among the research variables for all workers in the upper diagonal ($N = 1237$), and for the young workers (≤ 30 years, $N = 407$) in the lower diagonal; listwise deletion of missing values

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1 Age	—	-.17	-.08	.59	.03	.11	.04	.07	.03	.11	.00	.04	.04	-.03	.01	.03
2 Gender ^a	-.23	—	.16	-.22	.03	-.17	.03	-.13	.01	-.14	.04	-.01	-.17	.05	-.11	-.13
3 Education ^b	.11	.25	—	-.19	-.02	.22	-.01	.28	-.02	.21	.01	.04	.23	.05	.31	.34
4 Job tenure	.42	-.06	-.19	—	.03	.09	-.02	.00	-.01	.07	-.04	.01	.04	-.03	-.03	.06
Time 1																
5 Demands	.10	.04	.02	.10	—	-.02	-.17	.04	.55	-.01	-.11	.47	-.03	-.11	.04	.02
6 Control	.17	-.05	.21	-.02	-.03	—	.26	.31	-.02	.64	.14	.03	.59	.18	.31	.47
7 Supervisor support	-.01	.04	.09	-.10	-.21	.27	—	.00	-.10	.15	.47	-.12	.18	.37	.00	.05
8 Active problem solving	.21	-.11	.22	.02	.07	.30	.04	—	-.02	.27	-.01	.09	.31	.06	.59	.45
Time 2																
9 Demands	.06	-.01	.04	.04	.56	-.03	-.07	-.02	—	-.06	-.21	.54	-.07	-.18	.01	.05
10 Control	.13	-.06	.17	-.05	.00	.61	.14	.24	-.07	—	.33	.02	.62	.20	.27	.45
11 Supervisor support	.05	.05	.05	-.12	-.12	.18	.40	.06	-.21	.33	—	-.15	.22	.47	.04	.07
Time 3																
12 Demands	.08	-.01	.05	.05	.43	.06	-.11	.10	.55	.08	-.14	—	.00	-.23	.11	.14
13 Control	.12	-.11	.20	-.02	-.07	.53	.22	.25	-.04	.57	.26	.04	—	.36	.34	.57
14 Supervisor support	.07	.03	.06	-.04	-.15	.22	.40	.11	-.15	.20	.47	-.15	.41	—	.08	.11
15 Active problem solving	.16	-.05	.23	-.02	-.01	.27	.04	.55	-.02	.24	.08	.09	.28	.11	—	.48
16 Motivation to learn	.11	-.05	.27	.00	.04	.43	.09	.44	.13	.36	.09	.18	.55	.15	.49	—

Note: Overall sample, $N = 1237$; correlations of .06 and higher significant at $p < .05$. Sample of young workers, $N = 407$; correlations of .10 and higher significant at $p < .05$.

^aGender: 1 = male and 2 = female.

^bEducation: 1 = primary or lower, 2 = lower vocational, 3 = secondary or middle vocational, 4 = higher vocational, 5 = College/University degree.

Figure 2 also shows significant reversed effects of Time 1 active problem solving on reported DCS dimensions across time. Specifically, Time 1 active problem solving was significantly related to Time 2 job demands ($\beta = -.05$; this is presumably a suppressor effect, as the underlying correlation was positive), Job control ($\beta = .06$), Time 3 job demands ($\beta = .08$), job control ($\beta = .10$), and supervisor support ($\beta = .06$). Overall, the results show that Time 1 active problem solving was related to more job demands, job control as well as supervisor support across time.

The question remains whether the normal versus reversed pattern is causally predominant. We therefore tested the equality of the normal and reversed β coefficients (model M_4 ; see Method). Table 3 shows that the χ^2 -difference between the models with and without equality constraints was not significant (M_3 versus M_4 : $\Delta\chi^2(3, N = 1237) = 6.86, p > .05$). Consequently, the normal and the reversed cross-lagged effects between the DCS dimensions and learning-related are comparable (supporting Hypotheses 1a, b, c and 2).

Hypotheses 3 and 4: Do older workers report significantly lower levels of motivation to learn, active problem solving, supervisor support, and more job control than their younger colleagues?

To examine Hypotheses 3 and 4, a 3 (Age; young workers versus middle-aged workers versus older workers) \times 2 or 3 (Time: Time 1, Time 2, and Time 3) ANOVA with Time as a within-participants factor and Group as a between-participants factor was carried out. Main effects of Age were found for Time 1 job control, $F(2, 1225) = 11.24$; Time 2 job control, $F(2, 1225) = 5.80$; Time 3 job control, $F(2, 1225) = 8.90$; Time 1 active problem solving, $F(2, 1225) = 5.64$; Time 3 active problem solving, $F(2, 1225) = 7.67$; and for Time 3 motivation to learn, $F(2, 1225) = 3.79$ (all p 's $< .05$). Table 4 also shows

Table 2b. Correlations between research variables for middle aged workers in upper diagonal (31–44 years; $N=601$), and for old workers in lower diagonal (≥ 45 years; $N=229$); listwise deletion of missing values

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1 Age	—	-.02	-.05	.34	-.01	.08	.06	.02	.00	.10	.06	.00	.03	.05	.00	.02
2 Gender ^a	-.01	—	.09	-.09	.02	-.17	.03	-.13	.01	-.13	.02	-.01	-.17	.04	-.14	-.15
3 Education ^b	-.08	.18	—	-.15	-.07	.24	-.03	.28	-.05	.26	-.02	.05	.27	.00	.31	.39
4 Job tenure	.16	-.41	-.26	—	.02	.02	-.03	-.06	-.08	.02	.02	-.04	.01	.02	-.07	.06
Time 1																
5 Demands	-.01	.02	.04	.02	—	-.04	-.17	-.01	.55	-.02	-.13	.48	-.02	-.10	.02	.03
6 Control	-.00	-.30	.20	.19	.02	—	.29	.33	-.05	.64	.12	.03	.60	.17	.33	.45
7 Supervisor support	.04	.01	-.09	-.04	-.10	.15	—	.04	-.09	.18	.49	-.12	.19	.41	.00	.05
8 Active problem solving	-.06	-.08	.37	-.01	.13	.23	-.13	—	-.06	.30	-.04	.03	.35	.03	.57	.39
Time 2																
9 Demands	.01	.01	-.04	.01	.50	.04	-.18	.08	—	-.09	-.22	.52	-.10	-.17	-.04	.01
10 Control	.00	-.20	.18	.10	-.01	.64	.13	.23	-.01	—	.32	.00	.63	.19	.29	.45
11 Supervisor support	-.01	.08	-.02	-.09	-.05	.11	.55	-.05	-.17	.32	—	-.18	.19	.50	.03	.06
Time 3																
12 Demands	.01	.01	.02	.03	.50	-.03	-.16	.19	.56	-.03	-.08	—	-.02	-.27	.06	.12
13 Control	.01	-.22	.15	.11	.02	.65	.12	.25	-.04	.65	.17	-.04	—	.32	.36	.54
14 Supervisor support	.00	.11	.12	-.02	-.05	.14	.24	.08	-.22	.23	.36	-.25	.35	—	.05	.08
15 Active problem solving	-.01	-.09	.38	.04	.16	.29	-.04	.68	.15	.29	.00	.22	.37	.10	—	.45
16 Motivation to learn	-.00	-.20	.31	.13	-.05	.56	.04	.52	.07	.48	.05	.15	.59	.09	.57	—

Note: Middle-aged sample, $N=601$; correlations of .08 and higher significant at $p < .05$. Sample of older workers, $N=229$; correlations of .13 and higher significant at $p < .05$.

^aGender: 1 = male and 2 = female.

^bEducation: 1 = primary or lower, 2 = lower vocational, 3 = secondary or middle vocational, 4 = higher vocational, 5 = College/University degree.

significant Time effects for Time 1–3 Job control, Time 1–3 active problem solving, and Time 3 motivation to learn. *Post hoc* Least square difference tests and regression analyses revealed significant inverted u-curve relationships between age, job control, motivation to learn, and active problem solving. Most significant effects were found when comparing the middle-aged workers compared to young as well as older workers. The middle-aged group of workers reported significantly higher levels of job control, active problem solving, and motivation to learn compared to the younger and older groups of workers. Moreover, the significant Time \times Age group effect for active problem solving revealed that all workers showed a significant decrease in active problem solving across time, of which the older workers showed the greatest decline in active problem solving. All in all, the older workers

Table 3. Fit indices for different nested models ($N=1237$)

Model	χ^2 ^a	df	NNFI	GFI	RMSEA
M_0 : Baseline model (stability effects only)	129.59	36	.95	.99	.046
M_1 : Normal causality ^b	84.38	24	.95	.99	.045
M_2 : Reversed causality ^b	85.83	30	.96	.99	.039
M_3 : Reciprocal causality ^{b,c}	40.62	18	.98	1.00	.032
M_4 : Reciprocal causality ^b (equal normal and reversed effects DCS-learning-related behavior)	47.48	21	.98	1.00	.032

^aAll χ^2 -values are significant at $p < .001$.

^bThis χ^2 -value is significantly lower ($p < .001$) than that of Model M_0 .

^cThis χ^2 -value is significantly lower ($p < .001$) than that of Models M_1 and M_2 .

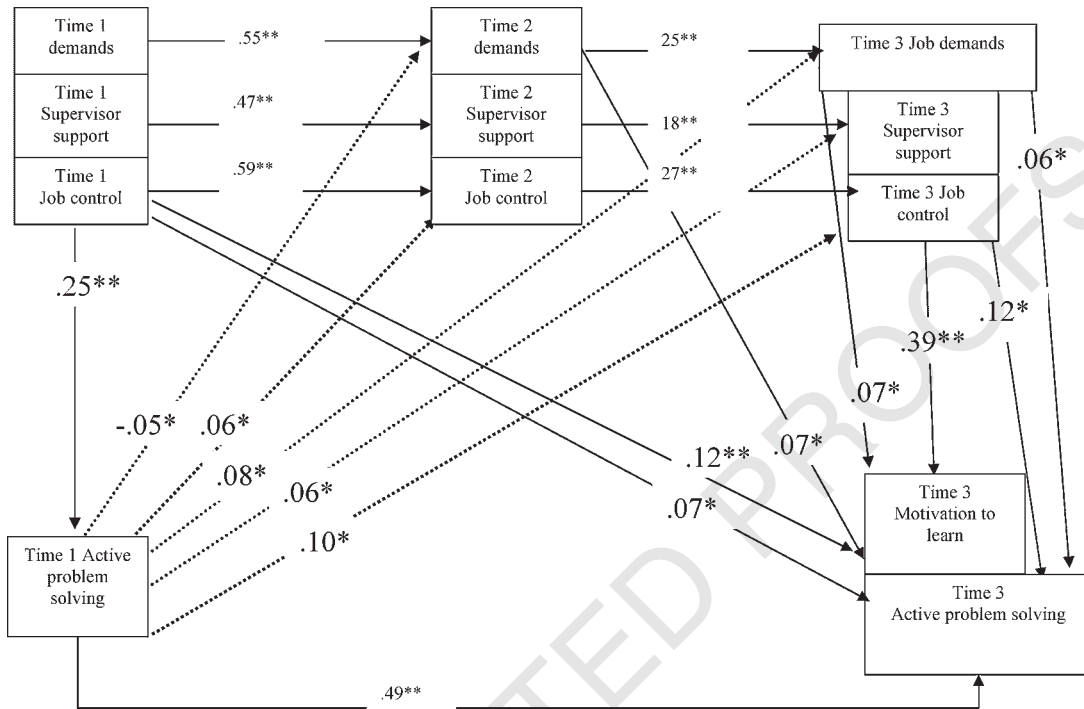


Figure 2. Standardized results for all workers (N = 1237)
 Note: *p < .05; **p < .01.

indeed reported lower motivation to learn and active problem solving than middle-aged workers, but not compared to the youngest group of workers (Hypothesis 3 partially supported). Furthermore, the results do not confirm Hypothesis 4, as we found no consistent evidence that the older workers reported significantly higher levels of job control or lower levels of supervisor support than the other age groups.

Age differences in cross-lagged effects of DCS dimensions and active problem solving behavior?

In the aforementioned structural equation analyses for the whole sample, M₄ (with the normal and reversed cross-lagged effects constrained as equal) fitted the data significantly better than M₃ (reciprocal causal model). However, the χ^2 -difference test comparing M₃–M₄ among the middle-aged workers revealed that the normal and the reversed cross-lagged effects between the DCS dimensions and learning-related behavior were not comparable (M₃ versus M₄: $\Delta\chi^2(3, N = 601) = 9.43, p < .05$; cf. the footnote to Table 5). Consequently, to examine potential age differences in the cross-lagged relationships between the DCS dimensions and active problem solving behavior, we conducted several multiple-group analyses using the fit indices of the reciprocal causal model (M₃; revealing a satisfactory fit for all age groups), and compared five nested models by means of the χ^2 -difference test. These nested models were: M₅ (variant reciprocal model): The hypothesized cross-lagged relationships in Figure 1 are allowed to vary across the age groups; M₆ (Beta invariant reciprocal

Table 4. Comparison of mean scores across the age groups (standard deviations in brackets)

Variables	Age groups				MANOVA <i>F</i> -values		
	≤30 (<i>N</i> = 407)	31–44 (<i>N</i> = 601)	≥45 (<i>N</i> = 229)	Total (<i>N</i> = 1237)	<i>F</i> (Age) ^a	<i>F</i> (Time) ^b	<i>F</i> (Age × Time) ^b
T1 Demands	2.60 (.45)	2.58 (.47)	2.63 (.46)	2.59 (.45)	.51		
T2 Demands	2.53 (.49)	2.52 (.47)	2.58 (.52)	2.65 (.47)	.90		
T3 Demands	2.57 (.46)	2.60 (.46)	2.63 (.48)	2.59 (.47)	1.18	9.44**	.82
T1 Job control	2.78 (.47)	2.92 (.46)	2.85 (.51)	2.86 (.48)	11.24*** ^c		
T2 Job control	2.81 (.46)	2.94 (.46)	2.88 (.54)	2.88 (.47)	5.80*** ^c		
T3 Job control	2.82 (.48)	2.92 (.46)	2.81 (.53)	2.87 (.48)	8.90*** ^c	2.48	.28
T1 Supervisors support	2.74 (.53)	2.73 (.53)	2.72 (.57)	2.74 (.54)	.76		
T2 Supervisors support	2.67 (.59)	2.70 (.54)	2.63 (.69)	2.65 (.57)	2.00		
T3 Supervisors support	2.66 (.59)	2.65 (.58)	2.56 (.62)	2.64 (.59)	3.73	23.74*	.225
T1 Active problem solving	2.52 (.52)	2.63 (.55)	2.59 (.60)	2.58 (.56)	5.64*** ^c		
T3 Active problem solving	2.41 (.50)	2.49 (.53)	2.42 (.57)	2.44 (.53)	7.67*** ^c	88.33**	3.2*
T3 Motivation to learn	2.06 (.50)	2.18 (.52)	2.07 (.54)	2.11 (.52)	3.79*** ^c		
Covariates							
T1 Age	26.2 (2.50)	37.2 (3.97)	48.5 (2.79)	35.76 (8.5)			
T1 Gender	1.43 (.50)	1.22 (.41)	1.25 (.44)	1.29 (.46)			
T1 Education	2.71 (.98)	2.82 (1.17)	2.45 (1.20)	2.71 (1.12)			
T1 Job tenure	4.52 (2.48)	10.86 (7.06)	17.86 (9.73)	9.62 (7.58)			

Note: Age groups are based on Time 1 Calendar age. Multivariate $F(24, 2430) = 2.27^{**}$; the results remained significant after controlling for level of education, gender and job tenure.

^aAll *F*-values have (2,1225) degrees of freedom.

^bAll *F*-values have (2,2536) degrees of freedom, except T3 Active problem solving, where $df = (1,1360)$.

^cRegression analyses revealed significant inverted u-shaped relationships ($p < .01$) between age and T1 job control: $F(2, 1268) = 20.04$, T2 job control: $F(2, 1268) = 18.76$, T3 job control: $F(2, 1268) = 11.10$, T3 Motivation to learn: $F(2, 1268) = 10.73$, T1 active problem solving: $F(2, 1268) = 15.05$, T3 active problem solving: $F(2, 1268) = 6.33$.

* $p < .05$; ** $p < .01$.

model): In which the cross-lagged effects are presumed to be invariant across the three age groups; and M_7 – M_9 , in which the β 's of certain age groups are presumed to be equal (for example, in M_7 the β 's of young and older workers are constrained to be equal).

Table 5 presents the fit indices and χ^2 -difference tests of these models, revealing that the variant model fits the data better than the invariant model (M_5 versus M_6 : $\Delta\chi^2(40) = 63.48$, $p < .05$). When comparing the variant model M_5 with Models M_7 – M_9 (see Appendix 1 with syntax of M_9), M_9 did not account better for the data than M_5 . Further, Figure 3 shows that most significant differences were found between the middle-aged and older workers.

To further examine the effects of the covariates (Cohen, Cohen, West, & Aiken, 2003), we performed a *Post hoc* χ^2 -difference test of the variant model 5 with a new invariant model 10 (with the covariate effects constrained invariant across the age groups). The results revealed a non-significant χ^2 -difference test (M_5 versus M_{10} : $\Delta\chi^2(136, N = 1237) = 151.82$, $p > .05$). Considering that parsimonious models (i.e., models with relatively few parameters) should be preferred to more complex models with the same fit (Kelloway, 1998), the results show that the covariate effects can be constrained equal across

Table 5. Fit indices and χ^2 -difference tests of different nested models using multi-group analyses ($N = 1237$)

Model		χ^2	df	NNFI	GFI	RMSEA	Comparison	$\Delta\chi^2$	Δdf
M ₅	M ₃ ^a , Variant reciprocal model	78.41*	54	.97	.99	.032			
M ₆	M ₃ , Be invariant across age groups	141.89*	94	.97	.97	.034	M ₅ vs. M ₆	63.48*	40
M ₇	M ₃ , Be invariant for group 1 and 3	106.39	74	.98	.97	.031	M ₅ vs. M ₇	27.98	20
M ₈	M ₃ , Be invariant for group 1 and 2	103.74	74	.99	.97	.030	M ₅ vs. M ₈	24.59	20
M ₉	M ₃ , Be invariant for group 2 and 3	121.21	74	.96	.97	.038	M ₅ vs. M ₉	42.80**	20

* $p < .05$; ** $p < .01$.^aFit indices reciprocal causation model (M₃ and M₄) for each age group:

Age groups	χ^2	df	NNFI	GFI	RMSEA	$\Delta\chi^2$	Δdf
M ₃ Young workers (≤ 30 years, $N=407$)	31.31*	18	.95	.99	.043	2.45	3
M ₄ Young workers (≤ 30 years, $N=407$)	33.76*	21	.96	.99	.039		
M ₃ Middle-aged workers (31–44 years, $N=601$)	21.28	18	.99	1.00	.017	9.43*	3
M ₄ Middle-aged workers (31–44 years, $N=601$)	30.71	21	.99	.99	.028		
M ₃ Older workers (≥ 45 years, $N=229$)	25.83	18	.95	.99	.040	1.57	3
M ₄ Older workers (≥ 45 years, $N=229$)	27.40	21	.97	.99	.033		

* $p < .05$; ** $-p < .01$.

the age groups. The results showed significant effects of all covariates in predicting Time 1 job control (β 's ranging from .05 for age ($p < .05$) to .28 for education ($p < .01$)), but no significant effects were found for Time 2 job control, and small effects were found for Time 3 job control (β 's ranging from .06 for education ($p < .05$) to $-.07$ for gender, $p < .05$). For Time 1 problem solving significant effects were found of gender ($\beta = -.14$, $p < .01$) and level of education ($\beta = .22$, $p < .01$), whereas for Time 3 problem solving only significant effects of level of education were found ($\beta = .12$, $p < .01$). Finally, a significant effect of education was also found for Time 3 Motivation to learn ($\beta = .16$, $p < .01$).

Considering the across-time effects between the DCS dimensions and learning-related behavior, Figure 3 shows that positive effects were found of job demands and control in relation to active problem solving behavior, and positive reversed effects were found of active problem solving on reported job demands or job control. The middle-aged workers reported negative effects of Time 1 supervisor support ($\beta = -.09$) and positive effects of Time 1 job control ($\beta = .11$) on Time 3 active problem solving. The middle-aged workers also reported significant reversed effects of active problem solving on Time 2 and 3 job control (β 's were .07/.12; $p < .05$), whereas the young and older workers reported only positive effects of active problem solving on Time 3 job demands (β 's were .09/.14; $p < .05$). In sum, we found significant age group differences in the effects of the DCS dimensions and active problem solving behavior, with the effects for the middle-aged workers being the strongest.

Discussion

The aims of this 3-wave study were to test whether: (a) Exposure to job demands and job control as well as social support predict later reported learning-related behavior, (b) whether there is evidence

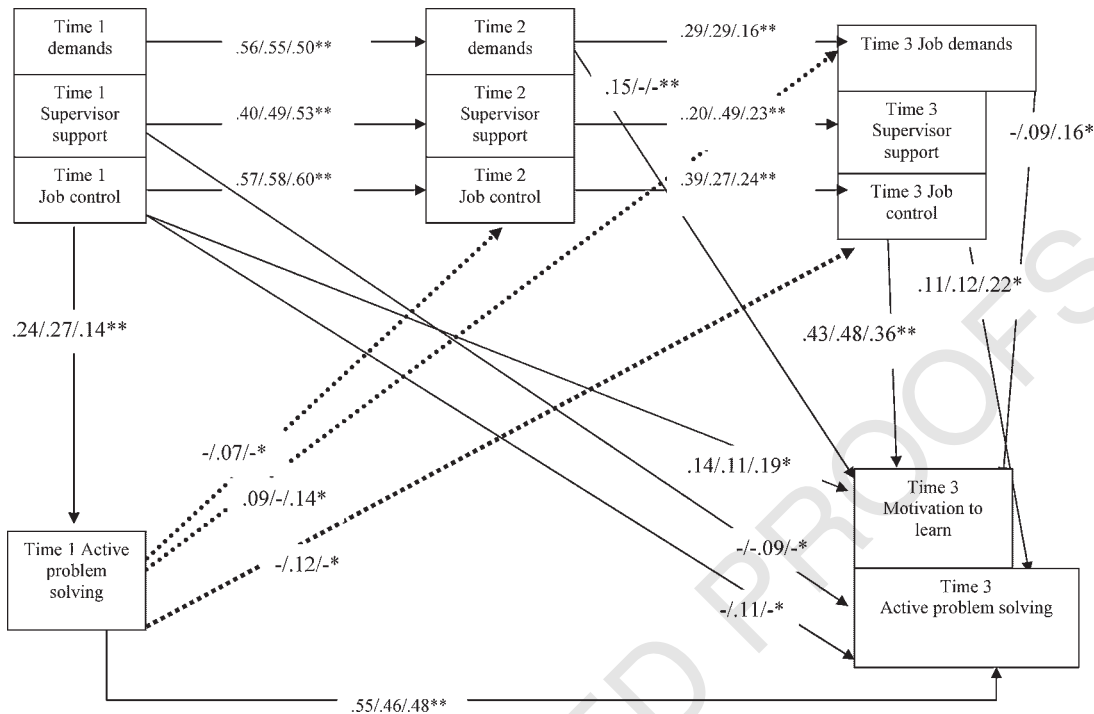


Figure 3. Standardized results for age groups.
 Note: .55/.46/.48** refer to significant autocorrelations for respectively young/middle-aged/older; -: Refers to not significant effect; * $p < .05$; ** $p < .01$.

for reversed effects of learning-related behavior on job demands, job control or social support, and (c) whether there are meaningful age differences in the aforementioned relations. The results of the “causal direction” analyses confirmed the hypothesized bidirectional or reciprocal nature of the relationships under study. Besides the positive cross-lagged effects of job demands and job control on learning-related behavior across time (supporting Hypotheses 1a and b), this study was the first to find reversed effects of active problem solving behavior on reported job demands, control as well as supervisor support across time (supporting Hypothesis 2).

These results are not only in line with the activation hypothesis of the Demand–Control–Support model (Karasek & Theorell, 1990) but also provide evidence for the “active shaper” reversed causation hypothesis. Specifically, the results suggest that the one-directional view on the relationship between work and learning-related behavior postulated in the DCS model does not capture the full picture. In line with earlier life-span developmental theory, the notion of reciprocal determinism (Bandura, 1997; Taris et al., 1998) and Hobfoll’s (2001) conservation of resources theory, our results show that workers are active shapers who try to increase their job resources, rather than just being passive receivers of environmental influences.

Furthermore, the results show that age effects matter in the relationships between work and learning-related behavior. Our multigroup analyses revealed significant inverted u-curve relationships between age, job control, and learning-related behavior, such that the middle-aged workers reported significantly more job control and learning-related behavior than the young and older workers (partially supporting Hypothesis 3, and rejecting Hypothesis 4). Further, age differences were found in the cross-lagged relationships between job demands, control, and learning-related behavior. Especially the older and middle-aged workers differed significantly in terms of the cross-lagged effect sizes obtained for

1
2
3 these groups. The middle-aged workers reported more significant effects of the DCS dimensions in
4 predicting learning-related behavior, and different reversed effects of active problem solving (on job
5 control) than the other workers (who reported only reversed effects on job demands). Thus, middle-
6 aged workers stand out regarding their high levels of job control and learning-related behavior.

7 Possible explanations for these effects may be that middle-aged workers have transferred to the jobs
8 with higher levels of job control that fit their self-concept (job change hypothesis of Wright &
9 Hamilton, 1978), but still see changes for job transfer to other interesting positions, whereas older
10 workers have reached the highest position possible in the company, and do not have options for further
11 (internal or external) job transfer (Hedge, Borman, & Lammlein, 2006). Another explanation is that job
12 control has a time-limited effect, showing stronger effects among younger workers (Bradley, 2007).
13 Furthermore, older workers (who see retirement approaching quicker than middle-aged workers) may
14 take a reduced time perspective, resulting in motivational consequences like a lower motivation to learn
15 (Carstensen & Charles, 1998). Similarly, Hansson, DeKoekkoek, Neece, and Patterson (1997) showed
16 that the accomplishment of one's late career goals can result in detachment from the career and in
17 pursuing new learning activities that are less career-related. A final explanation is the differential
18 treatment in the work environment of middle-aged versus younger and older workers. Earlier research
19 has revealed that supervisors hold negative stereotypes, provide less organizational developmental or
20 training activities to and treat older workers less fairly than middle-aged or younger workers (Simpson,
21 Greller, & Stroh, 2002; Van der Heijden et al., 2009). This suggests that the position of the middle-
22 aged workers in the organization is much more favorable than that of both younger and older
23 workers.

24 *Study limitations*

25
26
27 The most important limitations of our study are the following. First, the findings reported in this study
28 were based on self-reports and may therefore be subject to bias, e.g., due to personality traits such as
29 negative affectivity (Frese & Zapf, 1988). However, Spector (2006) argued that the problem of common
30 method variance is overstated and may even be outdated, as it is more a question of measurement bias
31 than bias of the method itself. Our scales showed good reliability scores as well as a good fit of the
32 measurement models across time, and we therefore expect that the measurement bias in this study is
33 relatively small. Furthermore, the 3-wave longitudinal design allowed us to control for earlier levels of
34 most of the variables, and as a result potential common method variance (Zapf, Dormann, & Frese, 1996),
35 but there may always be unknown third variables that could not be controlled for.

36 A second limitation follows from the longitudinal design of this study. Although longitudinal data
37 are potentially much better suited for studying causal direction of relationships than cross-sectional
38 data (Taris, 2000), whether this benefit is fully realized depends on the degree to which the time lag
39 between waves suits the process and etiology of the relationship between the research variables under
40 study (De Lange et al., 2004). We have employed a time lag of 1 and 2 (and a total of 3) years, and found
41 relatively the strongest normal causal effects across 3 years, and reversed effects across 1 year.
42 Nonetheless, the chosen time lags may be too long or too short in revealing the true dynamics between
43 work and learning-related behavior, and age. For example, smaller time lags (such as 3 months) may
44 reveal larger effects of the psychosocial work characteristics in predicting learning-related behavior,
45 whereas longer lags may be needed to fully examine effects of intra-individual age effects across time
46 (De Lange et al., 2004). Furthermore, we were unable to examine a complete longitudinal design as the
47 learning-related behavior variables were not measured on all occasions; we were therefore unable to
48 control for all synchronous effects and auto-correlations (Zapf et al., 1996).

49 We found relatively small effect sizes for the relationships between the DCS dimensions and
50 learning-related behavior. According to Semmer, Zapf, and Greif (1996), small standardized effects are

3 to be expected as they argue that there is an upper limit of 15–20 per cent variance in strain that can
4 be explained by job stressors. Moreover, it is important to note that the cross-lagged effects of,
5 for instance, job demands on active problem solving refer to predicting *changes* in active problem
6 solving from Time 1 to Time 3 (i.e., after controlling for Time 1–Time3 stability effects). By definition
7 these effects will be small, as many phenomena will be relatively stable across time. Thus, the small
8 effects found in this study may also be regarded as common in longitudinal research (and not a major
9 limitation).

10 Furthermore, it is difficult to disentangle the age differences found in this study from so-called
11 ‘cohort’ effects; the result of common experiences peculiar to a particular historical period in which
12 workers were born (Kanfer & Ackerman, 2004). We cannot exclude that historical differences in the
13 experiences of the different cohorts account for the differences among age groups (Folkman et al.,
14 1987). For example, the positive results obtained for the middle-aged workers may also be explained by
15 the fact that they have found themselves in a work context optimized with the (then) current and
16 accepted methods, practices and technologies so that a cohort explanation might be equally valid as an
17 aging explanation. Moreover, we must also point to the particular context of this study. As the Dutch
18 funded pension programs (in the late 1990s), and protected retirement programs may have contributed
19 to lower levels of motivation to learn in the older workers of this study, we cannot directly generalize
20 the findings to other national contexts and current situations with less favorable pension programs.
21 For example, in countries like the United State, retirement-aged workers face increasing
22 uncertainty about the future of their social security benefits and the age requirement to receive a
23 full social security pension continues to increase. Thus, in such countries the incentives for keeping
24 one’s skills and knowledge up-to-date may be much stronger than in countries having liberal pension
25 programs.

26 27 28 *Study implications*

29
30 In spite of these limitations, we feel that our findings have implications for both practice and future
31 research. From a practical point of view, the normal causal effects found in this study indicate that
32 interventions directed at increasing job control may be useful in improving the motivation to learn of all
33 age groups (even after 3 years), but that increasing job demands or supervisor support may have
34 different effects across the age groups. Further, an implication of the evidence found for reciprocal
35 relationships is that workplace interventions should also address the long-term effects in employees.
36 Middle-aged workers may benefit from learning new skills in crafting their jobs with more job control
37 across time, whereas younger and older workers report more reversed effects on their job demands. Our
38 subgroup analyses also revealed that younger and older workers may need more positive attention to
39 increase their learning-related behavior.

40 41 42 **Research agenda**

43 This longitudinal study is the first to investigate the causal direction as well as effects of aging
44 in relationships between psychosocial work characteristics and learning-related behavior across
45 time. Further research should investigate why and how these effects develop across time, and can
46 specify more dynamic theories and hypotheses regarding these effects. We feel the results found call
47 for:

- 48
49 (1) *Meta-analyses*: As it is too early to draw strong conclusions regarding the relationships between
50 work, learning-related behavior, and aging based on one study, we call for meta-analyses

examining results of earlier longitudinal studies. Meta-analyses on the longitudinal dynamics between job demands, job control, and supervisor support versus learning-related behavior, and on the effects of aging are needed to determine actual effect sizes.

- (2) *Direct measures of underlying concepts*: Reviews of the relationships between age and organizationally relevant outcomes (e.g., Kooij et al., 2008; Sterns & Miklos, 1995; Warr, 2001) have suggested that chronological or calendar age serves as a proxy measure for many age-related processes (Kanfer & Ackerman, 2004). In line with Sterns and Doverspike (1989) and De Lange et al. (2006), it is important to examine other operationalisations of the factor age like: (a) Performance-based or functional (e.g., work ability or health measures); (b) psychosocial or subjective (e.g., how old the person desires to be or age norms applied to an individual with respect to an occupation, company, or society; cf. Kaliterna, Larsen, and Brkljacic (2002)); (c) organizational (e.g., job tenure, career stage); and (d) life-span approaches (e.g., family status or life stage measures). In our analyses, controlling for the organizational age measure job tenure, and the life span age measures family status and care-needing people (cf. Table 1) did not alter our results found. However, future studies could include more age measures like age norms or health. By measuring and examining these underlying age-related processes, we may better explain the effects of age. For example, Hwalek et al. (1982) have argued that the social pressure resulting from age norms is the strongest factor in the aging process and the decision to retire (see also McCann & Giles, 2002), and therefore these psychosocial variables should be included in future studies on the relationships between work and learning-related behavior.
- (3) *Theory-based longitudinal and experimental studies*: We hope that our results will inspire researchers to develop innovative, theory-based, longitudinal, or experimental (as opposed to cross-sectional and correlational) studies on the causal relations between work and learning-related behavior. These studies should further examine the explanatory mechanisms for the reversed effects of learning-related behavior on work. In line with De Lange et al. (2005), one should distinguish between *environmental* change and *perceptual* change mechanisms for such reversed effects. Environmental change mechanisms for possible reversed effects of learning-related behavior include: (a) Internal job changes: The worker's newly-learned skills could result in self-determined or supervisor-directed changes in the current job (a worker may seek new challenges, or the worker's supervisor could provide new tasks), or (b) external job changes: Newly learnt skills could make a worker more attractive to other companies (De Lange et al., 2008). In these reversed environmental effects, the learning process and newly learnt skills facilitate promotion to new and more challenging work environments (Frese et al., 2007; Wrzesniewski & Dutton, 2001). On the other hand, perceptual reversed mechanisms reflect within-person perceptual (and not actual) changes in the work environment. For example, due to higher feelings of mastery due to learning, the same job demands could be perceived as being less demanding (cf. Taris et al., in press). We need more controlled experimental designs to further disentangle environmental from perceptual change mechanisms for reversed effects.

For the effects of aging at work, it is important to include insights of life span theories into occupational health models like the DCS model. For example, insights of Selection, Optimization, and Compensation (SOC) theory (Baltes et al., 1999), Socio-emotional selectivity theory (Carstensen, 1998), and Regulatory focus theory (Higgins, 1997) can be integrated into job design models. These life span theories highlight important regulatory processes and underlying variables such as time perspective that may explain the motives of older workers to continue learning at work (Carstensen, 1998; Higgins, 1997).

2 3 Acknowledgements

4
5
6 This study was partly financially supported by the Dutch Ministry of Social Affairs and Employment;
7 The Dutch Ministry of Public Health, Welfare, and Sports; and the Dutch National Institute for Social
8 Security.

9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56

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30
31 **Appendix 1:**

32 Model 9 reciprocal causation multigroup analysis (with beta’s of groups 2 and 3 invariant)
33 Group 1=young workers
34 da NG=3 ni=16 no=407 ma=cm
35 km sy
36 See Table 2a
37 sd
38 2.66 .50 .97 2.60 .45 .47 .54 .54 .49 .47 .56 .47 .48 .59 .50 .50
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Group 2= Middle-aged workers

Da NO=601

km sy

See Table 2a

sd

4.08 .41 1.15 6.92 .46 .49 .53 .57 .46 .47 .55 .46 .46 .58 .54 .51

Group 3=Older workers

Da NO=229

km sy

See Table 2b

sd

3.33 .45 1.16 9.70 .46 .52 .58 .62 .52 .54 .69 .47 .51 .61 .59 .54

la

age gend educ jobtenu dem1 con1 ssp1 t1prob t2dem t2contr t2ssup t3dem t3cont t3ssup t3prob t3mol/

mo ny=16 ne=16 ly=id te=ze be=fu,fi ps=sy,fi

le

age gend educ jobtenu dem1 con1 ssp1 t1prob t2dem t2contr t2ssup t3dem t3cont t3ssup t3prob t3mol/

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