COMPARING AND COMBINING THE DEMAND-CONTROL-SUPPORT MODEL AND THE EFFORT REWARD IMBALANCE MODEL TO PREDICT LONG-TERM MENTAL STRAIN

Abstract:

A purpose of this prospective study was to compare the predictive power of baseline measures of the Effort-Reward Imbalance (ERI) model and the Demand-Control-Support (DCS) model in regard to long-term mental strain. The study further aimed to investigate whether combining the models would improve the predictive power in regard to long-term mental strain for two occupational groups, managers/professionals (n=660) and manual workers (n=385). Both models explained small albeit significant proportions of variance in mental strain for both occupational groups, the slightly higher explanatory power found for ERI model compared to the DCS model may in part have been due to the lower consistency in the measurements of the latter model. As expected both models explained larger proportions of variance in mental strain for manual workers than for the professional group. When introduced after DCS model in the regression equation the ERI model explained additional variance in mental strain whereas the DCS model failed to add explanatory power to mental strain when introduced last in the equation. A conclusion from the study is that combining the two models may increase the explanatory power to predict work-related mental strain.

Work-related stress has been firmly associated with a broad spectrum of negative health outcomes and with impeded wellbeing. In order to reduce the complexity of the relationships between psychosocial work environment and the health reactions of the individual, several generic models have been developed in order to identify crucial elements in the pathway between the psychosocial working conditions and health outcomes (Van Vegchel, de Jonge, Bosma & Schaufeli, 2005). In relation to health Sigriest & Marmot (2004) define the psychosocial environment in terms of the opportunities available to support the individual's need of positive self-experience. Self-efficacy, the individual's belief in his/her ability to accomplish tasks, and self-esteem, the continued positive experience of a person's self-worth, are according to Siegrist & Marmot (2004) two aspects of self-experience that are of crucial importance to health and wellbeing. Two models that have received special attention in the recent past, the Demand-Control/(Support) (DC/S) model and the Effort-Reward Imbalance (ERI) model, analyse the relationship between the psychosocial opportunity structure provided by work and health outcomes, by the pathway of work-related self-experience, according to Siegrist and Marmot (2004).

The Demand-Control-Support Model. The DCS model comprises three dimensions of psychosocial working conditions (Karasek and Theorell, 1990; Karasek, Brisson, Kawakami, Houtman, Bongers, and Amick, 1998). Psychosocial work demand relates to how hard and intense the job holder has to work and includes for example time pressure and quantitative workload. Control or decision latitude comprises two distinct but closely related components. Task authority reflects the scope of the job holder's authority to make decisions at work, while skill discretion relates to the level and variety of the skill required for the work tasks and the long-term possibilities to acquire new skills in the work role. The third dimension, later added to the model,

work-related social support, mainly refers to emotional and instrumental support from colleagues and immediate superiors (Karasek and Theorell, 1990).

In psychological terms the model is characterised by a stimuli approach, where the external environment is assumed to determine the emotional reactions and behaviour of the individual, while psychological traits or subjective factors are not taken into consideration (Karasek et al., 1998, Karasek and Theorell, 1990). The Strain Hypothesis derived by the model claims that adverse long-term psychosocial working conditions, high psychosocial demands in combination with low control opportunities, will reduce the job holder's self-efficacy and create high psycho-physiological strain, which in turn will exert a negative impact on health, possibly mediated through neuropsychological pathways (Frankenhaeuser and Johansson, 1986; Karasek and colleagues, 1979; 1990; 1998). High-strain job, characterized by high demands and low control, are mainly to be found in machine paced work and in low-status service work (Karasek and Theorell, 1990).

By exclusively reviewing longitudinal studies based on the DC(S) model, with a large range of outcome health and well-being measures, de Lange, Taris, Kompier, Houtman & Bongers (2003) concluded that there was good evidence for longitudinal causal main effects between psychosocial working conditions included in the DC/S model and health and well-being outcomes, especially self-reported outcomes. On the other hand, this review provided only limited support for the high strain assumption of the model.

The Effort-Reward Imbalance Model. The Effort-Reward Imbalance (ERI) model has its origin in medical sociology and represents a more recent approach to the relation between work and health (Siegrist, 1996; Marmot, Siegrist, Theorell, & Feeney, 1999). The ERI model takes not only the work content into account, but also the work

role in a social perspective, as well as the job holder's individual coping pattern and need for control (Calnan, Wainwright, & Almond, 2000; Siegrist, 1996).

The ERI model conceptualizes work in a social exchange perspective and the work role is seen as a link between the social opportunity structure and self-regulatory need of the person (Siegrist, 1996; 2000). The ERI model shifts the attention from control in work, to the social and economical rewards from work. For most people the work role provides the main reciprocal exchange link between the individual's self-regulatory system (e.g. self-esteem) and the social reward system (Siegrist, 1996). The reward dimension of the ERI model embraces three so called transmitter systems by which rewards are distributed - status control, economical rewards and esteem (Siegrist 1996; 2000). The concept of status control has a central role in the theory behind the model, and refers to the degree of strength and security the work role provides to support the self-regulatory system of the individual (Siegrist, 1996). A loss of status control is thought of as being strongly associated with negative feelings, Siegrist (1996) suggests that low status control is a more threatening and therefore potentially more stressful condition than low task control.

The effort dimension of the ERI model distinguishes between extrinsic and intrinsic efforts (Siegrist, 1996). The extrinsic component concerns job demands and obligations while the intrinsic component refer to over-commitment, defined as "*a set of attitudes, behaviours and emotions reflecting excessive striving in combination with a strong desire of being approved and esteemed*" (Siegriest, 2004, p. 2). High efforts are thus thought of as occurring either from high extrinsic job demand and/or from the coping pattern of the individual worker.

The ERI model predicts that the working conditions most likely to elicit emotional and physiological strain reactions are those with a lack of reciprocity

between the (extrinsic and/or intrinsic) efforts invested in work – and the rewards gained from work (Siegrist, 1996; 2002). An important prerequisite for the model is that the social rewards are unevenly distributed within the labor market, and that the really exhausting jobs often are the worst rewarded. Therefore an effort-reward imbalance is most likely to occur in occupations with low status control, e.g. manual jobs (Siegrist, 1996). Two recent reviews (Tsutsumi & Kawakami, 2004; van Vegchel et al., 2005), concludes that the imbalance hypothesis between high extrinsic efforts and low rewards has gained considerable support for a wide range of health outcomes. The findings were more contradictory on the moderating role of over-commitment in the relation between ERI and health (van Vegchel et al., 2005).

A conceptual comparison between the DCS model and the ERI model. In a wider sense both models integrate sociological and psychological theories to conceptualise and analyse the relationship between the psychosocial working conditions and health outcomes and there are overlapping features between them. The Demand dimension of the DCS model and the Extrinsic Effort dimension of the ERI model both mainly refer to time pressure and quantitative workload. Although the Reward dimension of the ERI model is attending towards more general social and economical opportunities and outcomes of the work, the esteem dimension has an obvious overlap with social support dimension of the DCS model, conceptual as well as in operational terms.

The intrinsic effort component of the ERI model refers to the individual work-related coping pattern of over-commitment and inability to withdraw from work (de Jonge, Bosma, Peter & Siegriest, 2000; Siegrist, 1996; van Vegchel et al., 2005). By inclusion of individual characteristics in the ERI model, the subjective meaning of work experience is taken into consideration in the work stress process (Calnan et al., 2000). Furthermore, the ERI model takes labor market factors and the work role in a

macro-social perspective into account (Calnan et al, 2000; Marmot et al., 1999; Peter et al., 2002; Siegrist, 1996). While the DCS model is focused on the immediate work content and implies that work task control is critical to counter job strain, the ERI model is mainly focused on the broader concept of fairness and reciprocity in the social exchange process (Marmot et al., 1999; Siegrist 1996). By providing information of different but related aspects of the relationship between the psychosocial work environment and health, the two models may complement each other (Siegrist & Marmot, 2004). These authors claims that the DCS model, with it's focus on the content of the work tasks links the psychosocial working conditions and self-efficacy, whereas the focus of ERI model on the reward structure *"defines a link between the opportunity structure at work and the working persons' experience of self-esteem*" (p. 1466).

Due to the complimentary features of the DC(S) and ERI models and the comprehensive and firm empirical support for the two models, there have been calls in the literature for further prospective studies to evaluate the predictive power on work-related ill-health by combining the two models to capture a broader range of potential job stressors (de Jonge et al., 2000; Marmot et al., 1999; Peter et al., 2002; Siegrist & Marmot, 2004). A number of previous studies have reported improved predictive power on combining the models (Bosma, Peter, Siegrist, & Marmot, 1998; de Jonge et al., 2000; Ostry, Kelly, Demers, Mustard, & Hertzman, 2004). On the other hand, in a recent cross-sectional study the ERI model was consistently found to be more strongly related to self-reported measures on wellbeing compared to the DCS Model (Calnan et al., 2004).

Different types of working conditions may be of importance for the emergence of work-related stress in different occupations (Marmot et al., 1999, Sparks and

Cooper, 1999). It has been suggested that the two models may be associated with distinct contributions in explaining work stress in different occupations (Marmot et al., 1999). Both models do although predict the most adverse working conditions to be found in low-status manual service or blue-collar occupations (Karsek and Theorell, 1990; Siegrist, 1996; Theorell and Karasek, 1996). The DCS model was focused on job strain among industrial workers and the model has shown its strongest power in predicting adverse health outcomes for manual workers (Karasek & Theorell, 1990). Also in regard to the ERI model, Siegrist (1996; 2000) implies that low status control and therefore low rewards are most commonly associated among persons in low-qualified occupations, mainly for manual workers. Van Vegchel et al., (2005) claims that the ERI model mainly has been applied in the human service sector and calls for further studies with other occupational groups to generalize the applicability of the findings.

The first purpose of the present study was to compare the predictive power of the DCS model and the ERI model in regard to long-term predictive power on mental strain. A second purpose of the study was to examine whether combining the DCS model and the ERI model will improve longitudinal predictive power on mental strain. Although previously reported findings on combining the models are somewhat contradictory, the two models do to some extent refer to different sources of work stress. It may therefore be reason to expect a somewhat improved predictive power by combining the models. A third purpose of the study was to compare the predictive power of the combined model for two different occupational groups: managers/ professionals and manual workers. Based on the conceptual content of both models we presume that they, separate or combined, will predict long-term mental strain better for manual workers than for the professional group. This study may add to

existing knowledge by providing comparative data of the long-term influence on mental health by the components of the two recently most attended models of work-related stress, for two occupational groups with heterogeneous working conditions and therefore potentially distinct sources of work-related stress.

Method

Respondents. The respondents were all participating in a large longitudinal study on work stress and work-related musculoskeletal and mental disorders (Devereux, Rydstedt, Kelly, Weston, & Buckle, 2004). The study involved in all twenty British companies and public organizations - with a large variety in size and location, within a large variety of industrial sectors. The companies were selected strategically to include the largest possible variety of professions and working conditions into the study (the authors do although not claim the sample to be statistically representative for the British workforce). The selection procedure of participants varied between the companies. In some of the (mainly) smaller companies the entire workforce was drawn to the sample, whereas in other cases the participants were randomly selected by the researchers from the staff lists.

About 8000 participants were included in the initial sample, and the response rate was about 40%. Manual workers were over-represented in the non-respondent group. For the comparison a short questionnaire with some core questions on musculoskeletal complaints and perceived job stress were distributed to a sub-sample of non-respondents, whom, compared to the participants, reported higher job stress (21% of the non-respondents compared to 12% of the participants found their jobs “very” or “extremely” stressful). The second and third wave of data collection included only those respondents that participated in the baseline study. After attrition (mainly due to turnover and downsizing in some of the companies) the sample for the

final wave of data collection consisted of 2640 persons. About 86% of the participants at Time 1, or 2270 persons, completed the questionnaire at follow-up. The attrition did not affect the age and gender distribution in the sample.

Based on the job title reported in the questionnaire the participant's sub-major occupational groups were classified according to the Standard Occupational Classification 2000 (SOC2000). For this study two major occupational categories was compared in the analyses, managers/professionals (major occupational groups 1-2, SOC2000) and manual workers (major occupational groups 8-9, SOC2000). Only participants with complete data for all the actual variables were selected.

The professional group consisted of 660 persons, whereof 30% were females and 70% males, with an average age 41.5 years (Sd 9.8). Three out of ten (30%) of the participants in the professional group were "managers and senior officials", while 38% were classified as "science and technology professionals", 15% as "business and public service professionals", 17% as "teaching and research officials" and 1% as "health professionals". The group of manual workers consisted of 385 persons, whereof 15% females and 85% males, with an average age of 42.1 years (Sd 9.7). The largest sub-major groups were "transport and mobile machine drivers" (42%) and "process, plant and machine operatives" (35%). Moreover 16% of the manual workers were in "elementary trades, plant and storage related occupations" and 7% held "elementary administrative and service occupations".

Independent variables. The Demand-Control-Support model was assessed by the Job Content Questionnaire (JCQ) modified for the Whitehall II study (Stansfeld, Head & Marmot, 2000). Demands were measured by four items with α coefficient of 0.66. Work-related control was measured by 16 items with α coefficient of 0.87, ten

aimed at decision authority in the work situation and six items aimed at skill variety. Work-related social support was measured by seven items with α coefficient of 0.79.

The ER questionnaire (Siegrist, 2004; Siegrist, Starke, Chandola, *et a*l., 2004) was used for assessing the ERI model. Subjects rated extrinsic efforts and rewards on a five point scale. Efforts were measured by 5 items (excluding the item of physical demands) with the α coefficient 0.78. Rewards were measured by 11 items, with the α coefficient of 0.86. Intrinsic efforts (over-commitment) were measured by six items with an α coefficient of 0.86.

Outcome variable The short version of the General Health Questionnaire (12) was used as an indicator of mental strain (Goldberg and Williams, 1998), with the α coefficient 0.86.

Statistical analyses. To control for the baseline value of the outcome variable hierarchic multiple regression analysis was used, where the baseline value of mental strain (GHQ) was introduced in the first step of the equation. For the first equation the components of the DCS model were introduced in the second step, while the ERI model was introduced in the third step, to examine whether additional predictive power could be gained by combining the models. For the second equation the models were introduced in the reversed order that is the ERI model was introduced before the DCS model. Separate analyses were made for the professional group and the manual workers. Since the interaction effects in the DCS model did not add significantly to the explained variance, they have been excluded from the equations.

Results

Table 1 presents the inter-correlations between the dimensions of the two models, the baseline and outcome measures of mental strain (GHQ), separately for the professional group and manual workers.

INSERT TABLE 1 ABOUT HERE

Table 1 show that the professionals reported significantly higher job demands ($t=8.1$, $p<.01$) but also higher control ($t=30.2$, $p<.01$) and work-related social support ($t=6.3$, $p<.01$) than the manual workers. The professionals also reported higher Intrinsic Efforts ($t=5.2$, $p<.01$) but also more satisfying Rewards from work (($t=6.9$, $p<.01$) than the manual workers. The professionals reported higher mental strain at baseline as well as in the follow-up ($t= 2.5/2.3$, $p<.05$).

As further revealed in Table 1, there was a correlation between Demands in the DCS model and Extrinsic Efforts ($r=.64$ for the professional group and .49 for manual workers) as well as between Demands and Intrinsic Efforts in the ERI model ($r=.48$ for the professional group and .33 for manual workers respectively), thus, indicating a certain degree of overlap between the models. The correlation between control and rewards was .38 for the professional group and .35 for manual workers, while the correlation between support and rewards was 0.56 for the professional group and .53 for the manual workers. This indicates a slightly higher overlap between the dimensions of the models in this study compared to what was reported by Siegrist (2004). The correlation between baseline and outcome mental strain was considerably weaker for the professional group (.29) than for the manual workers (.48).

Initial introduction of the DCS model to predict long-term mental strain. Step II in Table 2 shows the relation between the components of the DCS model at baseline and perceived mental strain in the follow-up. After controlling for baseline mental strain the DCS model accounted for 1.4% of the variance in outcome mental strain for the professionals, and 4.4% for the manual workers. The beta weights reveals that Job Demands related significantly to the outcome measure of mental strain for the professionals whereas for the manual workers Social Support significantly predicted

the outcome. Thereafter, when introduced in the third step the ERI Model also accounted for a significant proportion of the variance in mental strain for the professional group (δR^2 =.021) as well as for the manual workers (δR^2 =.027).

INSERT TABLE 2 ABOUT HERE

In regard to the separate components of the ERI model, Rewards predicted variance in mental strain for both occupational groups, as shown by the beta-weights in Table 2. Intrinsic effort was related to mental strain only in the professional group.

Initial introduction of the ERI model to predict long-term mental strain. Step II in Table 3 shows the relation between the components of the ERI model at baseline and perceived mental strain in the follow-up, after control for the baseline measure of GHQ. The ERI model accounted for significant proportions of the variance in mental strain for the two occupational groups, 3.6% for the professionals and 6.1% for the manual workers. When introducing the DCS model in the third step, it did not significantly contribute to predicting the variance in outcome mental strain for any of the occupational groups.

INSERT TABLE 3 ABOUT HERE

In regard to the separate components of the ERI model Rewards related significantly to mental strain for both groups whereas Intrinsic Efforts related significantly to mental strain among only in the professional group.

Discussion

When initially introduced both the DCS model and the ERI model related significantly to long-term mental strain for both occupational groups. When the DCS model was introduced in the final step of the equation, after the ERI model, it did not explain any additional variance in mental strain. On the other hand, when the ERI model was introduced in the final step of the equation it contributed significantly to

the explained long-term variance in mental strain for both occupational groups. For the manual workers the latter analytical strategy gave the highest total proportion of explained variance in mental strain - 7.0%. For the professional group the combined model did not predict mental strain better than the ERI model alone. At least for manual workers the present results suggested that combining the two models may improve long-term prediction of mental strain by psychosocial work characteristics.

In terms of explained variance the ERI model emerged as the more powerful predictor of mental strain, alone or in combination with the DCS model. This is in line with recently reported findings (Calnan et al., 2004; Ostry et al., 2004). Due to some remaining concerns about the fairness of the present comparison no far reaching conclusions about their relative strength in predictive power of the models should although be drawn from this study. For fair tests of comparative effects between models Cooper & Richardson (1986) claims that the models should have been measured with equivalent strength. This includes distributional equivalence or the range of values the measurements of the models takes in the population. The measures covered about the full range of possible values for the different components of both models and the standard deviations of the measurements were relatively comparable, which thus indicates acceptable distributional equivalence in the study. Equivalent strength also concerns procedural equivalence, that "*the competing theories, factors or variables are operationalized, manipulated or measured with equal care and fidelity*" (Cooper & Richardson, 1986, p. 179). Even though both models were measured by well established scales the alpha coefficient for the subscale of the demand component in the DCS scale was markedly weaker (0.66) than in the subscale of the ERI model measuring the extrinsic effort component (0.78). Even though this consistency measure from the present study was in level with what was reported by

Stansfield et al. (2000) on the same measure (0.67), the relatively low reliability of this subscale may have caused a disadvantage for the DCS model and therefore rendered the comparison between the models with some degree of unfairness.

The long-term predictive power of the combined models never went beyond a small effect size (Cohen, 1988). From the point of view of content and methodological limitations small longitudinal stressor-strain relationships, even in case of multiple correlations such as in this study, are although to be expected (Zapf, Dormann & Frese 1996). The multi-causal antecedents to mental strain and unavoidable measurement bias are among the most prominent reasons for the limited effect sizes of these relations (Zapf et al., 1996). Controlling for the initial level of the outcome variables may also have led to an underestimation of the magnitude of the long-term relationships. Most of the participants have been exposed to the same type of potentially adverse psychosocial working conditions for a prolonged period of time. It therefore seems reasonable to assume that also the initial level of mental strain was related to the psychosocial working conditions in the actual job. The effect sizes may also have been reduced by sample attrition, since the attrition analysis a slightly higher level of job strain among the non-respondents compared to the participants.

Both models accounted for higher proportion of variance in mental strain for manual workers than for professionals and managers. This is consistent with previously reported findings as well as with the conceptual content of both the models – primarily intended to assess work stress in manual low status occupations (Marmot et al, 1999; Karasek & Theorell, 1990; Siegrist, 1996). In particular the Reward component of the ERI model, referring to low returns from work in terms of money, esteem and status control were shown to be related to long-term mental wellbeing for the manual workers. Siegist and Marmot (2004) suggests that lower socioeconomic

status may increase the negative health effects of adverse psychosocial working condition due to more frequent exposure and/or due to increased vulnerability.

The main reason to develop general work stress models has been to identify core elements in the complex stressor-strain relationship (van Vegschel et al., 2005), which is of central importance for the theoretical development of this field of research. On the other hand Sparks and Cooper (1999) argues that the use of generic models embracing a limited range of potential stressors possibly have led to the attention away from other work characteristics of importance for well-being and therefore argues for job-specific models. The present results indicate that what psychosocial factors predict mental strain seems to some extent to be dependent on the occupations and organisations being investigated. Even though general models best identifies core sources of work-related strain more job-specific models are also needed to explain the different sources of strain in different occupations.

While the ERI encompasses individual traits of the job holder, the DCS model adopts a stimuli approach, where psychological traits or subjective factors are not taken into consideration in the perception of the psychosocial work environment. Nevertheless Siegrist & Marmot (2004) suggests that both the models offer complementary information on the pathways between the psychosocial work conditions and health by the mediation through individual psychological processes, self-efficacy for the DCS model and self-esteem for the ERI model. To further understand the role of psychosocial working conditions for health outcomes it will of importance to further illuminate and analyze the so far still hypothetical mediating link of psychological processes in the long-term work-related stressor-strain relationship.

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Table 1.

Inter-Correlations between Baseline Working Conditions and Mental Strain at Follow-Up. Manual Workers (n=385) Above the Diagonal; Managers/ Professionals (n=660) Below the Diagonal.

			1	2	3	4	5!!	6	7	8
Manual	M		2.65	2.37	2.86	2.06	406	2.08	1.82	1.95
workers	Sd		0.58	0.48	0.59	0.66	0.72	0.58	0.31	0.44
	Professionals									
	M	Sd.								
1	2.93	0.52	-	13	-16	.49	-26	.33	.19	.18
2	3.18	0.37	.0!	-	.41	-08!	.35	-05!	-13	-15
3	3.08	0.51	-22	.35	-	-23	.53	-17	-17	-28
4	2.14	0.67	.63	-09	-31	-	-57	.57	.37	.34
5!!	4.36	0.63	-17	.38	.56	-35	-	-28	-32	-37
6	2.27	0.54	.48	-00!	-24	.51	-13	-	.46	.34
7	1.88	0.35	.22	-16	-32	.33	-27	.37	-	.48
8	2.02	0.47	.17	-07!	-16	.22	-19	.24	.29	-

! p> .05

!! Higher value indicates higher rewards

1. Demands (DCS)
2. Control (DCS)
3. Support (DCS)
4. Extrinsic efforts (ERI)
5. Rewards (ERI)
6. Intrinsic efforts (ERI)
7. Mental strain at baseline
8. Mental strain at follow-up

Table 2.

Hierarchic Multiple Linear Regression Analysis. Control for Baseline Mental Strain. The DCS Model Followed by the ERI Model - in Relation to Mental Strain for (1) the Professional Group (N=660 and (2) Manual Workers (N=385).

	1	2
I. Baseline DV		
R^2	.083**	.234**
II. DCS model		
R^2	.097**	.278**
δR^2	.014**	.044**
β weights:		
Demands	.10*	.07
Control	-01	-01
Support	-06	-19**
III. ERI model		
R^2	.118**	.305
δR^2	.021**	.026**
β weights:		
Extrinsic efforts	.05	.04
Rewards	-11*	-14*
Intrinsic efforts	.12**	.10

*p<0.05 **p<0.01

Table 3

Hierarchic Multiple Linear Regression Analysis. Control for Baseline Mental Strain, The ERI Model Followed by the DCS Model - in Relation to Mental Strain for (1) the Professional Group (N=660) and (2) Manual Workers (N=385).

	1	2
I. Baseline DV		
R^2	.083**	.234**
II. ERI model		
R^2	.118	.295**
δR^2	.036**	.061**
β weights:		
Extrinsic efforts	.06	.03
Rewards	-10*	-21**
Intrinsic efforts	.13**	.11
III. DCS model		
R^2	.119	.305**
δR^2	.000	.010
β weights:		
Demands	.01	.01
Control	.01	-00
Support	.01	-12*

*p<0.05 **p<0.01