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Endocrinological and psychological responses to job stressors: An experimental test of the Job Demand—Control Model

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Summary The buffer hypothesis of the Job Demand—Control Model predicts that high levels of job control compensate for the negative effects of high job demands on well-being and health. Several studies have tested this hypothesis, but the results are far from consistent. The objective of this study was to test the buffer hypothesis with respect to psychological (subjective well-being) and physiological (salivary cortisol) indicators of job strain, using an experimental study design. Seventy-seven men and women worked at a simulated computer workplace for more than two hours. Job demands and job control were manipulated in a 2 (job demands: high vs. low) × 2 (job control: high vs. low) × 7 (time of measurement) study design. Demands were operationalized in terms of workload, and pacing control (self-paced vs. machine-paced) was used as a job control manipulation. As dependent variables, subjective well-being and salivary cortisol were measured at seven time points during the experiment (T1—T7). In line with the buffer hypothesis, high control eliminated the impact of high demands on salivary cortisol responses. The hypothesis was supported by a predicted significant three-way interaction of demands, control and time of measurement ($p < .001$), qualified by the absence of significant effects of the independent variables at T1 and T2 due to lagged cortisol reactions, and significant two-way interactions of demands and control, as predicted by the model, at the five remaining times of measurement (T3—T7): high demands led to increased cortisol reactions only in the low control condition. In contrast, no main or interaction effects of the independent variables were found for subjective well-being. This discrepancy between physiological and psychological stress reactions might be due to the lack of specificity inherent in measures of subjective well-being, due to lagged psychological reactions, or due to self-report biases in the subjective measures. In sum, this study provides the first clear-cut experimental evidence for the idea that the negative impact of high job demands on endocrinological responses can be buffered by high levels of job control.

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1. Introduction

In 1979, Karasek introduced the Job Demand–Control (JDC) model that became outstandingly popular in the following years, and remains one of the most examined models in occupational health psychology and epidemiology today. According to the JDC model, the negative impact of high job demands on subjective well-being and health can be buffered by high levels of job control. However, the evidence for this buffer hypothesis is still inconclusive. The main goal of this study is to provide a clear-cut experimental test of this hypothesis, focusing on cortisol responses during work.

Predicting the occurrence of job strain as a function of the work environment, the JDC model argues that job demands and job control are the key variables determining health and well-being. Specifically, it is proposed that job demands are negatively related to well-being and health, whereas high levels of job control promote well-being. Hence, jobs combining high demands with low control (''high strain jobs'') constitute the highest risk of adverse reactions. This has been dubbed the *strain hypothesis*. Importantly, reduced well-being in high strain jobs may be a consequence of both additively associated main effects and a multiplicative interaction of demands and control (Ganster, 1989; see also van Vegchel et al., 2005 for a detailed discussion of this issue). Following the idea of a multiplicative connection, high control has been proposed to attenuate (buffer) the negative effect of high demands. Therefore, this has been referred to as the *buffer hypothesis* (van der Doef and Maes, 1999; Vanroelen et al., 2009).

As the JDC model is an environmental model describing the occurrence of strain in a work context, it does not come as a surprise that the vast majority of researchers have tested the model by conducting correlational field studies. For example, with respect to psychological well-being, well over 100 correlational field studies examining the JDC model have been published between 1979 and 2007 (for reviews, see van der Doef and Maes, 1999; Häusser et al., 2010). In sum, this research provides robust evidence for additive effects, whereas the evidence for the buffer hypothesis is rather weak.

Although the problems associated with cross-sectional designs are widely acknowledged in occupational health psychology, only a small minority of previous studies applied a longitudinal design. Moreover, even though longitudinal studies clearly allow one to arrive at a more conclusive picture regarding causal processes than cross-sectional studies, they do not solve all methodological problems (for reviews, see Zapf et al., 1996; Taris, 2000). These problems include selective attrition (i.e. the tendency of some individuals to be more likely to drop out of a study than others), inappropriate time lags (i.e. the time lag employed in the study may be shorter or longer than the ''true'' time lag of the causal effect), and third variables. As discussed by Zapf et al., third variables may influence stressors and strains by employing the same methods, thereby leading to common method variance, (e.g. negative affectivity or social desirability). Alternatively, third variables may affect stressors and strains independent of the method employed (e.g. occupational status or type of job). In sum, even in longitudinal studies, it might be difficult to draw clear-cut conclusions regarding causation. From a strict methodological point of view, conclusive evidence for causal effects can be obtained best by using experimental designs. More specifically, a deeper understanding of cause–effect relationships arises from the convergence of experimental and epidemiological evidences, based on biological plausibility. Hence, although we are aware of the limitations of laboratory experiments (in particular with regard to their ecological validity), we think that longitudinal research should be supplemented by experimental studies, testing for causal effects of stressors on strain.

To the best of our knowledge, so far, only about a dozen experimental studies have examined the predictions of the JDC model (Perrewe and Ganster, 1989; Parkes et al., 1990; Hutt and Weidner, 1993; Rau, 1996; Jimmieson and Terry, 1997, 1998, 1999; Searle et al., 1999, 2001; Hockey and Earle, 2006; O'Brien et al., 2008; Flynn and James, 2009; Parker et al., 2009), compared to hundreds of correlational field studies. Moreover, the experiments conducted to date, while important, have had at least three methodological limitations. First, in virtually all experiments, the duration of the experimental task did not exceed 30 min (for an exception, see Hockey and Earle, 2006), culminating in durations of less than 10 min (Searle et al., 1999; Flynn and James, 2009). In our view, this is too short for demands and control to show substantial influences on subjective well-being and/or physiological responses.

Secondly, several experimental studies failed to employ independent manipulations of demands and control. For example, in three studies the demand manipulation significantly affected perceived control, that is, participants in the high demands conditions perceived less control than participants in the low demands conditions (Perrewe and Ganster, 1989; Searle et al., 1999; O'Brien et al., 2008).

Finally, previous experimental research has widely neglected physiological variables, even though they are acknowledged as providing continuous, covert, and on-line measures of job strain (for a review, see Chandola et al., 2010). Only four experiments have examined the JDC model with respect to heart rate and blood pressure (Perrewe and Ganster, 1989; Hutt and Weidner, 1993; Rau, 1996; Flynn and James, 2009). Notwithstanding the importance of this research, it has to be noted that increases in blood pressure and heart rate are primarily mediated by the activity of the sympathetic adreno-medullary (SAM) system which is generally linked to pleasant and unpleasant stimulation, rather than specifically reacting to (job) strain (Bradley et al., 2008). Moreover, as noted by Gendolla et al. (2008), cardiovascular activity is related to motivational intensity and effort. Thus, measures of heart rate and blood pressure in JDC research might reflect task difficulty or motivational intensity, rather than mental strain. In contrast, a second physiological stress system, namely the hypothalamic pituitary adrenocortical (HPA) system, is more specifically related to aversive strain (Dickerson and Kemeny, 2004). Prolonged, heightened cortisol activation has been found to be associated with several negative effects, including impairments in immune function and memory, hypertension, and diabetes (for reviews, see McEwen, 1998; Leonard, 2000; Wolf, 2009). Notwithstanding the fact that the exact pathways linking cortisol to illness are still unclear, cortisol can be regarded as an important pre-clinical biological marker of ill-health.