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An experimental study of the job demand—control model with measures of heart rate variability and salivary alpha-amylase: Evidence of increased stress responses to increased break autonomy

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Summary We assessed in an experimental design whether the stress response towards a work task was moderated by the autonomy to choose a break during the assigned time to complete the task. This setting is defined in accordance with the theoretical framework of the job-demand—control (JDC) model of work related stress. The findings from naturalistic investigations of a stress-buffering effect of autonomy (or 'buffer hypothesis') are equivocal and the experimental evidence is limited, especially with relation to physiological indices of stress. Our objective was to investigate if increased autonomy in a particular domain (break time control) was related with adaptive physiology using objective physiological markers of stress; heart rate variability (HRV) and salivary alpha amylase (sAA). We used a within-subject design and the 60 female participants were randomly assigned to an autonomy (free timing of break) and standard conditions (fixed timing of break) of a word processing task in a simulated office environment in a random order. Participants reported increased perceptions of autonomy, no difference in demand and performed worse in the task in the break-time autonomy versus the standard condition. The results revealed support for the manipulation of increased autonomy, but in the opposing direction. Increased autonomy was related with dysregulated physiological reactivity, synonymous with typical increased stress responses. Potentially, our findings may indicate that autonomy is not necessary a resource but could become an additional stressor

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when it adds additional complexity while the amount of work (demands) remains unchanged. Further, our findings underscore the need to collect objective physiological evidence of stress to supplement self-reported information. Self-report biases may partially explain the inconsistent findings with the buffer hypothesis.

1. Introduction

The job demand—control model (JDC; Karasek, 1979) posits that two components of the workplace; job demand and job control, are key influences in determining stress and ill-health in employees. In particular, it is proposed that jobs with low control, and high demands (strain hypothesis) place employees at the greatest risk of subsequent poor health. The JDC, as assessed by its sub-components of skill discretion and job autonomy, is said to moderate the experience of work demands. This notion is regarded as the 'buffer hypothesis' (Van der Doef and Maes, 1999; Vanroelen et al., 2009) and it has received mixed support from hundreds of cross sectional and prospective epidemiological studies, whereas the strain hypothesis has been largely supported in studies assessing psychological well-being (for reviews see, van der Doef and Maes, 1999; Häusser et al., 2010). The purpose of the present investigation however, was to assess the buffer hypothesis using an experimental design with physiological indices of heart rate variability (HRV) and salivary alpha amylase (sAA); a first in this area of research.

Only a handful of studies have used experimental designs to manipulate the JDC constructs (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; Häusser et al., 2011, 2014), and this is not surprising as the JDC is contextualised in work settings. However, issues surrounding causality in cross-sectional naturalistic designs are well known, and further, even prospective designs in naturalistic settings have their flaws. Zapf et al. (1996) outlines a number of these but we will point only to common method variance, selective attrition of participants and error estimation in time lags (i.e., identifying the best distance between assessments). Experimental techniques also have their flaws including low ecological validity, but they remain the best design to infer causality between variables.

The experimental designs used to test the JDC are not exempt from methodological problems, most are based on experimental tasks of less than 30 min, which impacts their ability to elicit alterations in well-being or physiological states (Häusser et al., 2011) and only five of these fifteen studies assessed physiology. These included heart rate and blood pressure (Perrewe and Ganster, 1989; Hutt and Weidner, 1993; Rau, 1996; Flynn and James, 2009), and cortisol (Häusser et al., 2011). While these investigations are useful, they are problematic as they employ between-group designs to assess differences in physiological reactivity. Given individual variations in diurnal rhythms and physiology, where possible, within-group designs are the preferred option.

The JDC investigations that used experimental designs with physiological assessments reveal inconsistent support for the JDC. For instance, Perrewe and Ganster (1989) utilised a mail sorting task and measured heart rate and skin temperature of their participants but report no differences in physiological arousal evoked by manipulations of task demand or control. Two decades later, Flynn and James (2009) used differing versions of a computerised mental arithmetic task, measured heart rate and blood pressure, and found participants in the high demand group exhibited greater baseline-to-task increases in heart rate and systolic blood pressure relative to low-demand participants.

The most comprehensive assessment of the JDC using an experimental design with physiological indices was conducted by Häusser et al. (2011). Participants were tested in a simulated office environment. Job demands were operationalised in terms of time pressure (participants in low demand condition only had to process 70% as many customer requests as those in high demand condition) and job autonomy was operationalised in terms of pacing control (machine paced versus self-paced). The findings support the strain hypotheses of the JDC model; with participants in the high strain condition (high demand and low control) showing significantly higher cortisol responses compared to the other three lower-strain conditions. However, neither main nor interaction effects of control or demands were found with regard to the subjective measures of intrinsic motivation, mood and mental fatigue; suggesting support for the JDC model regarding endocrinological but not psychological measures (Häusser et al., 2011). These findings of stronger associations of task manipulation with objective physiological evidence are important and may be furthered by a consideration of sAA responses.

As acute stressors tend to elicit sympathetic responses and direct observation of salivary adrenaline and noradrenaline do not reflect sympatho-adrenal medullar (SAM) responses (Schwab et al., 1992), the present investigation sought to capture sAA as an indirect marker of SAM activity (Nater and Rohleder, 2009; Filaire et al., 2010). Further, in acute stress testing, sAA is often preferred to the hormone cortisol for its shorter time lag between stress exposure and salivary secretion and for its ability to return to basal states quickly post-exposure (Takai et al., 2004; Gordis et al., 2006). It has been proposed that sAA may be differentially related to stressors than cortisol (given the lack of correlation between cortisol and sAA), and that a multifaceted approach to physiological stress assessment may