Rydstedt, L.W., Cropley, M., & Devereux, J.J. (2011). Long-term impact of role stress and cognitive rumination upon morning and evening saliva cortisol secretion. *Ergonomics*, **54**, 430-435.

Long-term impact of role stress and cognitive rumination upon morning and evening saliva cortisol secretion

The long-term impact of role stress (conflict and ambiguity), cognitive rumination and their interaction were analyzed upon morning and evening saliva cortisol secretion. The sample consisted of 52 male and 24 female British white-collars who had participated in a survey study on psychosocial working conditions 3.5 years earlier. Saliva cortisol secretion was measured over seven consecutive days with two measures: in the morning on awakening and at 10 PM. Stepwise linear multiple regression analyses was used for the statistical analyses. Role ambiguity at baseline and the interaction between role ambiguity and trait rumination contributed to explaining elevations in morning saliva cortisol secretion 3.5 years later ($R^2=0.045$; $F=4.57$; $p<.05$), while role conflict at baseline significantly predicted increases in long-term evening saliva cortisol ($R^2=0.057$; $F=8.99$; $p<.01$). The findings supported a long-term relationship between chronic stress exposure and saliva cortisol secretion and some support for the assumption of cognitive rumination moderating the stressor-strain relationship.

Key words: Longitudinal, Role Stress, Rumination, Cortisol.

The sudden global economic decline in the last three years has put considerable pressure on work organisations experiencing the worst profit decline in years to downsize by restructuring in order to decrease production, increase operating efficiency, reduce human resource cost and restructure borrowing costs. This also led to sudden changes in working practices such as flexible working, reduced working hours, outsourcing and the use of contractors to provide services no longer provided 'in house'. A recent systematic scientific literature review concluded that downsizing is associated with negative health and risk factors for "survivors" (Westgaard & Winkel, 2010). The review also shows that it is important to manage organizational downsizing carefully, as exposure to repeated downsizing further increases risk and that worse health is experienced among workers most affected by the downsizing process. During downsizing, job roles and responsibilities **can** get suddenly altered and pressure increases from having to assume new job roles. New job roles can lead to higher exposure to a job stressor described previously in the literature as role stress. Role stress is considered to be a characteristic of the work system and describes the stressors in relation to the demands and constraints produced from social interactions apart from the person's reaction to them (Beehr & Glazer, 2005).

From a role stress perspective, mental stress can be understood as being caused by work role conflict and role ambiguity. Rizzo, House, and Lirtzman (1970, p. 151) define work role conflict as "when the behaviours expected of an individual are inconsistent" and work role ambiguity to be at hand "if an employee does not know what he has the authority to decide, what he is expected to accomplish, and how he will be judged"(Ibid). Similarly role ambiguity has been claimed to occur "when employees are unclear about role requirements and performance standards" and "role conflict to occur "when two or more requirements of an employee's role are conflicting; that is when complying with one role requirement makes it

more difficult to comply with another” (Jex, Adams, Bachrach, & Sorensen, S. 2003, pp. 172-173). Role stress has been shown to predict the onset of mental work-related stress associated with mental strain, clinical depression and work absence lasting longer than 5 days in a prospective study of 3000 workers in the UK (Devereux, Rydstedt, Kelly & Buckle, 2004).

The effect of role stress may be moderated by individual differences. One factor that has gained more attention in the literature recently has been the concept of rumination. It is often regarded as a state measure characterised by persistent focus on the occurrence, causes and consequences of negative emotions and symptoms and it is associated with poor adjustment. It is regarded as a form of perseverative cognition between job stressors and psycho-physiological reactivity and may prolong the reactivity even in the absence of the stressor eventually leading to perceived job stress and ill health. A number of recent studies from the “Job Strain and Cognitive Rumination” project (Rydstedt & colleagues, 2009; 2010; In Press) suggest that cognitive rumination may act as a moderator in the job stressor - strain relationship, by amplifying strain reactions under high-stress conditions. Rumination has also been associated with delayed recovery after exposure to job stressors (Roger & Najarian, 1998) as well as increased cortisol secretion in the long term (Rydstedt et al., 2009).

The hypothalamic pituitary adrenal-cortical (HPA) system, controlling cortisol secretion, constitute a main component of physiological stress response (e.g., Kristenson, Eriksen, Sluiter, Starke, & Ursin, 2004; Lundberg, 2005). Cortisol secretion is associated with increased energy release, and with suppression of the inflammatory and immune responses and one of its most important functions is to protect the organism against its own self-defence systems (Kristenson et al., 2004). The HPA system follows a clear circadian rhythm with highest levels in the early morning and continuous decrease over the course of the day to reach its nadir after midnight (e.g., Baum & Grunberg, 1995). Association between job strain

and elevated morning cortisol secretion have been frequently reported (e.g., Lundberg & Hellström, 2002; Steptoe, Cropley, Griffith, & Kirschbaum, 2000; Steptoe, Cropley, & Joekes, 1999). Cortisol secretion has also been found to increase in situations that evoke feelings of uncertainty, anxiety, negative experiences or rumination (e.g. Roger & Najarian, 1998; Steptoe et al., 1999).

Cortisol has been described as “the primary mechanism through which chronic stressors get inside the body to bring about disease” (Miller, Chen, & Zhou, 2007, p. 25). Stress induced over-activity, or disturbances of the HPA system have been related to e.g. cardiovascular disease, cognitive impairment (Lundberg, 2005), metabolic dysregulation (Chandola, Brunner, & Marmot, 2006), clinical depression, and upper respiratory infection following viral exposure (Miller et al., 2007). In a recent study comparing patients admitted to hospital with acute myocardian infarction (AMI) with a control group, elevated hair cortisol concentrations, indicating chronic stress, was found to be the strongest predictor of AMI (Pereg, Gow, Messeri et al., 2010).

On the other hand, a reduction in cortisol secretion - hypocortisolism - in relation to long-term stress exposure (e.g. Heim, Ehlert, & Hellhammer, 2000) or when participants perceived higher stress (e.g., Loft et al., 2007; Roy, 2004) have also been frequently reported. In their review, Miller et al. (2007) argued that the time since onset of the stressor may determine the nature and direction of the cortisol response and that chronic stress exposure may be associated with a weakened diurnal cortisol cycle characterized by reduced morning cortisol but increased evening cortisol concentrations.

The purpose of the present study was to analyse the long-term impact of role stress and cognitive rumination on morning and evening saliva cortisol secretion. The hypotheses proposed were:

1. Role stress (conflict and ambiguity) will affect morning saliva cortisol secretion

2. Role stress (conflict and ambiguity) will increase evening saliva cortisol secretion
3. High cognitive rumination will interact with role stress to increase the impact on saliva cortisol secretion

Method

Participants. The participants were white-collar workers from six organizations across England who had previously completed a longitudinal survey on stress and musculoskeletal disorders (Devereux et al., 2004). Extensive longitudinal data on working conditions, strain reactions and a number of personality traits had been collected four years earlier. Letters were sent to 561 potential participants (white collar workers from the participating organizations that had completed the previous questionnaires) inviting them to volunteer for the study. The initial intention was to recruit 100 persons to the study, which according to a previous power analysis would give an estimated power above 0.90. Due to downsizing and high turnover in some of the organizations we were able to only recruit in total, 81 participants. Data from four of these persons were later excluded, two failed to complete the saliva sampling and one person was found to have been misclassified in regard to occupational status. Furthermore, from the diary entries it became clear that one participant had completely misunderstood the procedural instructions for saliva sampling.

The sample for this study consisted of 76 persons, since one person had not completed the rumination scale at baseline. In all 52 (68%) men and 24 (32%) women participated, with a mean age of 45.8 years. In terms of occupational classification, the majority of the participants (57%) worked in professional occupations, one in four (24%) were classified as semi-professionals, 11% held managerial positions while the remaining 8% worked in secretarial/administrative professions. The participants on average worked 39.9 hours per week at baseline and 38.4 at the follow-up. A comparison between the participants in the study and non-participants in the initial sampling pool revealed that there were no significant differences in age nor there were any differences in baseline job strain, negative affect (NA), need for recovery from work or trait rumination. The proportion of women differed although significantly ($\chi^2=8.65$, $df=1$, $p<.01$) between the participants in this study (32%) and the sample pool (48%).

Questionnaire data. Information on demographic and occupational factors were taken from the 2001 baseline questionnaire of the Stress and MSD study (Devereux et al., 2004) and a questionnaire distributed to participants for the present field study.

Trait rumination was assessed with the Inhibition-Rumination Scale (I-RS); a scale of 18 items with true/false alternatives, developed by Roger, Guarino and Olason (2000). Examples of items include: ‘‘I’m often preoccupied with worries about my future,’’ ‘‘my failures give me a persistent feeling of remorse.’’ (Three items were reversed coded). A 0 or 1 was coded for each item and then additively scored giving an I-RS range between 0 and 18 where a higher value indicated higher rumination. The mean value for the rumination scale was 5.30 (Sd 4.86) and the alpha coefficient was .82.

Role Conflict and Ambiguity were measured by a shortened version of the Role Conflict and Ambiguity Scale (NIOSH; Rizzo et al., 1970) and overall scores were constructed similar to trait rumination. This scale contained a total of 12 items, comprising 8 items on conflict ($\alpha = .76$) e.g. ‘‘do you receive incompatible requests from two more persons?’’ and 4 items on ambiguity ($\alpha = .78$) e.g. ‘‘do you feel certain how much authority you have?’’ This scale has been extensively used to study chronic role stress (King & King, 1990).

Psycho-endocrinological measures. Saliva cortisol secretion (measured in nanomoles per litre) was utilized as an indicator of psycho-endocrinological response and was measured over seven consecutive days to include a full working week and the weekend. Individuals were contacted by telephone and/or e-mail and meetings were arranged with a research assistant at each participant’s place of work. At the meeting, each participant was given a paper questionnaire, a seven-day paper diary, 14 saliva collection tubes and instructions on how to use the research materials. After seven days the materials were collected by the research assistant.

Two measures were taken each day: one in the morning on awakening and one at 10 PM. Saliva samples were collected with salivettes. The time of going to bed, the time of awakening and the exact time of every saliva sampling was recorded in a diary. Participants were instructed not to brush their teeth or drink tea, coffee, or caffeinated beverages before the morning saliva sampling and were also instructed not to consume alcohol or citrus drinks one hour before the evening saliva sampling. They stored their samples in a re-sealable plastic bag in the freezer compartment of their home refrigerator. The samples were then collected and stored at -20C until transported and assayed in the laboratory at Technical University Dresden, Germany.

For the statistical analyses stepwise multiple linear regression analysis was performed following mean centring and the creation of a multiplicative (cross-product) term (Aiken & West, 1991). This was to eliminate the possibility of multicollinearity between the main effects and the interaction effects on cortisol. Only those independent variables that contributed to the increased significance in the prediction of the dependent variable were kept in the final equation.

Results

INSERT TABLE 1 ABOUT HERE

In Table 1 where the correlations between the variables in the equation are presented, it is shown that morning saliva cortisol secretion was significantly correlated to the main effects of role ambiguity as well as to the interaction between role conflict and rumination, while evening saliva cortisol secretion was significantly correlated to the main effects of role conflicts and to rumination. It can also be seen that morning and evening saliva cortisol secretion were moderately but significantly correlated. Not unexpectedly, Table 1 further reveals a strong correlation between role conflict and ambiguity as well significant correlation between cognitive rumination and both role stress measures.

In Table 2, the outcomes of the linear multiple regression analyses are presented. As shown in the upper part of Table 2, role ambiguity at baseline ($\beta=0.159$; $p<.05$) and the interaction role ambiguity and cognitive rumination at baseline ($\beta=0.164$; $p<.05$) significantly contributed to the prediction of morning saliva cortisol secretion about 3.5 years later ($R^2=0.045$; $F=4.57$; $p<.05$).

In regard to the long-term impact of baseline perceived role stress and rumination on evening saliva cortisol secretion, only role conflict was finally kept in the equation, as shown in Table 2. The proportion of explained variance by the model on evening saliva cortisol secretion was somewhat stronger compared to the morning measure ($R^2=0.057$; $F=8.99$; $p<.01$).

INSERT TABLE 2 ABOUT HERE

Discussion

The overall results from this study supported the theory that there was a long-term impact of role stress upon saliva cortisol secretion. More specifically, it was shown that perceived baseline role ambiguity significantly related to morning saliva cortisol 3.5 years later. The relationship was positive, thus, indicating increased morning cortisol secretion in response to relatively high role ambiguity. This is the only significant long-term stressor relationship to morning saliva cortisol that has been found in the present data set (Rydstedt and colleagues, 2008; 2009; 2010).

While no main effects from cognitive rumination upon morning saliva cortisol were found, a significant interaction effect was observed between cognitive rumination and role ambiguity on morning saliva cortisol secretion. A graphical analysis of this interaction revealed significantly elevated morning cortisol secretion only for those participants reporting high trait rumination in combination with high role ambiguity. Thus, these findings offer some support to the suggested role of cognitive rumination as a potential amplifying

moderator in the stressor-strain relationship. Here, of course, additional future research is needed to further analyze the role of rumination in the stress process.

Perceived role conflict at baseline related significantly to evening saliva cortisol secretion and the impact of baseline stress exposure in terms of explained variance was somewhat stronger for this relationship than for morning cortisol secretion. This finding was also consistent with earlier findings from the data set, showing that baseline stress exposure significantly predicted elevated evening saliva cortisol levels (Rydstedt & colleagues, 2008; 2009; 2010) as well as with the suggestion by Miller et al., (2007) that chronic stress exposure may result in a disturbed cortisol diurnal pattern – with elevated evening cortisol secretion. Although the present study did not relate saliva cortisol secretion to any health outcomes, the recent findings on the strong relationship between elevated chronic cortisol and AMI (Pereg et al., 2010) highlights need for further knowledge on the pathway between chronic stress and health outcomes.

A shortcoming of the study was that morning saliva cortisol was only measured by a single measure at wake-up rather than by the full Cortisol Awakening Response (CAR). While it probably would not have been possible to collect three or four morning cortisol measures in a sample of working participants over a full week, the lack of complete morning data may anyway have led to an underestimation of the long-term stress effects on morning saliva cortisol secretion. Another limitation of this study was that role stress was only measured at baseline and not at the time of the field study, the same may also be claimed for I-RS (although this scale refers to trait rumination which can be assumed to be more stable). The only reason for this was that other psychosocial work factors related to the job strain model were measured during the field study as a priority.

Nevertheless, to our knowledge no other studies have been based on data with such a prolonged time lag between exposure and cortisol measures and the results raise some

interesting questions about the importance of role stress in the work stressor literature as well as the relationship between work stressors and physiological strain outcomes.

Cognitive factors, such as poor executive function, have also been acknowledged as important in the experience of work stress (Bridger, Brasher, Dew, Sparshott, & Kilminster, 2010). This paper also supports this view and suggests cognitive rumination may also have an important role.

This research has important implications for the management operations that can lead to role stress. Work organisations are continuously being restructured and the organisational change is often contingent upon pre-existing or foreseeable economic market forces. The latest financial and economic crisis has required many work organizations to undergo major changes (eg. job losses and plant shut downs) to reduce cash flow requirements and reduce earnings depreciation.

Typically, during downsizing or merger and acquisition strategies, workers may find themselves often competing to maintain employment within the organisation and may often find themselves in a new or modified work role that requires additional training but it is not provided. Furthermore, the tasks in the new role may not match existing skills and work experience. For example, a management role is very different from a leadership role. Planned goals and objectives can be unclear at the outset and lines of responsibility are not clearly communicated. These situations provide a high degree of work role ambiguity.

There are other problems normally associated with new or modified work roles that can create role conflict. For example, in an organisation that has been acquired, the systems and process of the acquiring work organization are sometimes implemented. This can create a situation in which there is conflict in the way the role should be performed as a result. Good communication and participation in the change process is needed. Particularly during downsizing, tasks may have to be performed without the adequate resources in place or there

may be incompatible requests from different line managers that have to share available resources. There may even be tasks to perform that conflict with personal values. This can be common in Human Resource roles where significant job losses have to be made. With fewer resources there may also be the requirement to work overtime frequently and this can generate work/home conflicts.

The role stress created from a combination of work role ambiguity and role conflict can lead to long term psycho-physiological responses associated with chronic ill-health and negative well being. Threats to employees well being may have negative effects on work performance (Brockner et al., 2004). Avoiding work role ambiguity and work role conflict should therefore be part of a stress management system.

In 2009, role stress was held accountable for a high number of suicides in a French Tele-communications company that did not have appropriate consultation and support systems in place during organisational restructuring. It is an issue that needs to be taken seriously in the workplace. Management need to be aware of the potential threats of role stress in the workplace especially during restructuring and/or downsizing operations and should ensure that potential threats are identified early and provide appropriate support for workers through management supervision, consultation and participation, HR and occupational health and safety support services.

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Table 1.

Means, standard deviations and inter-correlations for saliva cortisol secretion and the independent variables; N=76.

	M	sd	1	2	3	4	5	6
1. Morning cortisol (nmol/l)	18.9	6.67	-					
2. Evening cortisol (nmol/l)	1.97	1.06	.19*	-				
3. Role conflict	2.48	0.62	.04	.24**	-			
4. Role ambiguity	2.41	0.80	.18*	.05	.51**	-		
5. Rumination	5.30	4.86	.01	.17*	.30**	.21*	-	
6. Conflict*Rumination	0.04	0.24	.09	-.02	.07	.00	.28**	-
7. Ambiguity*Rumination	0.05	0.20	.18*	-.12	-.01	.11	.16*	.50**

*p<.05 **p<.01

Table 2.

Multiple linear regression analysis, stepwise procedure: Role stress, rumination and their interactions at baseline in relation to morning and evening saliva cortisol secretion about 3.5 years later. N=76

	SS	df	MS	F
<i>Morning Saliva Cortisol</i>				
Regression	390.06	2	195.03	4.57*
Residual	6527.02	149	42.68	
$R^2=0.045$				
Significant variables:			β	
Role Ambiguity			0.159*	
Role ambiguity*rumination			0.164*	
<i>Evening Saliva Cortisol</i>				
Regression	9.56	1	9.56	8.99**
Residual	159.54	150	1.06	
$R^2=0.057$				
Significant variable:			β	
Role Conflict			0.238**	
*p<.05 **p<.01				