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Relaxation-induced cortisol changes within lunch breaks – an experimental longitudinal worksite field study

Jarek Krajewski[1]*, Martin Sauerland[2] and Rainer Wieland[3]

[1]Experimental Work Psychology, University of Wuppertal, Wuppertal, Germany
[2]Work and Social Psychology, University of Landau, Landau, Germany
[3]Work and Organizational Psychology, University of Wuppertal, Wuppertal, Germany

The aim of the worksite study presented here is to elucidate the cortisol reducing impact of different ways of spending lunch breaks. With the help of the so-called silent room cabin concept it was possible to induce a relaxation opportunity that provides visual and territorial privacy. In order to evaluate its proposed effects, 14 call centre agents were distributed to either 20 min progressive muscle relaxation (PMR) or small talk break group. Participants were analysed in a controlled trial for a period of 6 months (1 day each month with five daily measurements at awakening, awakening +30 min, start of lunch break, end of lunch break, and bedtime) using saliva cortisol measurements as a stress indicator. Results indicated that only the PMR break reduced awakening, lunchtime, and bedtime cortisol response. Although further intervention research is required, our results suggest that post-lunch PMR may sustainably reduce participants' cortisol states in real worksite settings.

The hypothalamic–pituitary–adrenal (HPA) axis is primarily activated when the body responds to physical and mental stress (Miller & O'Callaghan, 2002); it is responsible for the secretion of the stress hormone cortisol. It is hypothesized that prolonged activation of this axis can suppress certain immune functions, can be detrimental to health and increase the risk of disease (Rabin, 2005) or of faster disease progression (Sephton, Sapolsky, Kraemer, & Spiegel, 2000). Furthermore, changes in the cortisol rhythm are discussed in the aetiology of a number of diseases including heart disease, atopic neurodermitis, and osteoporosis (Manelli & Giustina, 2000).

Numerous studies have indicated that the HPA axis may be specifically activated under conditions of social-evaluative threat of the sort that appear daily in professional worksite settings. Since work-related stress has been linked to a wide

*Correspondence should be addressed to Dr Jarek Krajewski, Experimental Business Psychology, Schumpeter School of Business and Economics, University of Wuppertal (Germany), Gaussstraße 20, 42097 Wuppertal, Germany (e-mail: krajewsk@uni-wuppertal.de).

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spectrum of negative health outcomes and impaired well-being (e.g. Wegge, Van Dick, Fisher, Wecking, & Moltzen, 2006), the development of effective worksite stress countermeasures is a central task for applied stress research. A promising approach for stress related interventions is the effective restoration of spent resources within recovery sections (e.g. Binnewies, Sonnentag, & Mojza, in press; Fritz & Sonnentag, 2005; Sonnentag, Binnewies, & Mojza, 2008; Trougakos, Beal, Green, & Weiss, 2008). However, little attention has been paid to the longest and thus probably the most influential, of all breaks within the workday: the lunch break. Thus, optimizing the recovery impact of lunch breaks may be a promising path for solving problems of high stress and the resulting impact on performance, health, and quality of life.

Recent research on relaxation techniques has indirectly provided some ideas for developing recovery intensive lunch break routines. One of the most widely used techniques – progressive muscle relaxation (PMR) – has been shown to be an effective countermeasure in reducing stress in experiments conducted in laboratory and clinical settings (e.g. Schneider *et al.*, 2005). PMR aims at enabling subjects to achieve physical and mental relaxation using exercises to tense and release 16 different muscle groups (legs, arms, shoulders, face, chest, etc.). The commonly used subform, abbreviated progressive relaxation training, is derived from Jacobsen's original PMR and routinely used, both clinically and in research (Carlson & Hoyle, 1993).

Laboratory settings have produced many well-documented recovery effects of PMR on the cardiovascular, neuromuscular, electrodermal, autonomous, and central nervous systems. Furthermore, PMR shows effects on a wide range of psychosomatic disorders (e.g. high blood pressure, sleep disturbance, asthma, rheumatic complaints, atopical neurodermitis – see e.g. Rainforth *et al.*, 2007), as well as on psychological variables such as increased positive moods and physical well-being (Lohaus, Klein-Heßling, Vögele, & Kuhn-Hennighausen, 2001). Moreover, it also increases pain thresholds and decreases inner tension and stress (Emery, France, Harris, Norman, & Vanarsdalen, 2008; Lolak, Connors, Sheridan, & Wise, 2008; Shapiro & Lehrer, 1980). As demonstrated by Pawlow and Jones (2002, 2005), and Nickel *et al.* (2005) PMR even reduces the endocrinological stress marker cortisol.

A theoretical framework explaining such stress-reducing effects of PMR lunch breaks is provided by the cognitive-behavioural model of relaxation (Smith, 1988; Smith, Amutio, Anderson, & Aria, 1996). This model suggests that focusing (the ability to maintain focus on simple stimuli), tension relief (positive sensations associated with reduced cognitive and somatic arousal), and passive disengagement (the ability to stop unnecessary goal directed and analytic activity; cf. Sonnentag, Mojza, Binnewies, & Scholl, 2008) are the basic components of all forms of effective relaxation. Similarly, Meijman and Mulder (1998) have determined that effective recovery is enhanced by low task-related physical, mental, and emotional demands and low external stressor frequency and intensity. Moreover, drawing on literature from Trenberth and Dewe (2002), break time should guarantee distraction from work-related ruminative thought, for instance by strongly focusing on involving tasks (Cropley & Purvis, 2003). Furthermore, physical distance from the workplace and the resulting detachment are relevant to effective recovery processes in non-working time (Hartig, Johansson, & Kylin, 2007). Additionally, as demonstrated by Fastenmeier, Gstalter, and Lehnig (2003), obligatory activities seem to have a reduced recovery value. Nearly, all the theoretical and empirical claims made for recovery intensive lunch break routines can be taken into account with PMR lunch breaks.

Previous empirical research has independently demonstrated the stress-reducing short-term effects of PMR. However, few attempts have been made to capture the stress-reducing effects of PMR for more than a few hours. Furthermore, studies have so far only shown stress reducing effects of PMR in artificial experimental or clinical settings. To the best of our knowledge, no study has been conducted to replicate laboratory findings within the context of real worksites, adding such information as chronic strain indicators (cortisol awakening responses, CARs), involving employees (instead of students) as participants, and testing the long-term stability of the proposed recovery effects over half a year in a real life setting. To enable this kind of research, sustainable organizational solutions for implementing PMR into daily worksite routines had to be offered. The major difficulties associated with incorporating PMR were solved by the infrastructural framework of the silent room.

Infrastructural framework for implementing relaxation techniques into worksite settings

As shown above, numerous studies have documented the recovery potential of systematic relaxation techniques in non-worksite research fields. In fact, implementing these procedures into organizational contexts faces several problems. One serious problem is related to the general security and privacy needs of deep relaxation, which requires eye closure and a horizontal lying position. Another problem refers to the professional setting in which relaxation activities take place. To satisfy these needs a relaxation setting should ensure visual, auditory, and territorial privacy. In order to fulfil the described demands in a worksite setting a room-in-room concept, called 'silent room' has been developed. The core features of this conception consist of lockable cabins and medical daybeds (see Figure 1). The silent room is an intimacy maintaining and stressor-free place that protects privacy by noise subdued and opaque cabins coupled with a hygienic dental-medical appearance. Moreover, a flexible acoustic

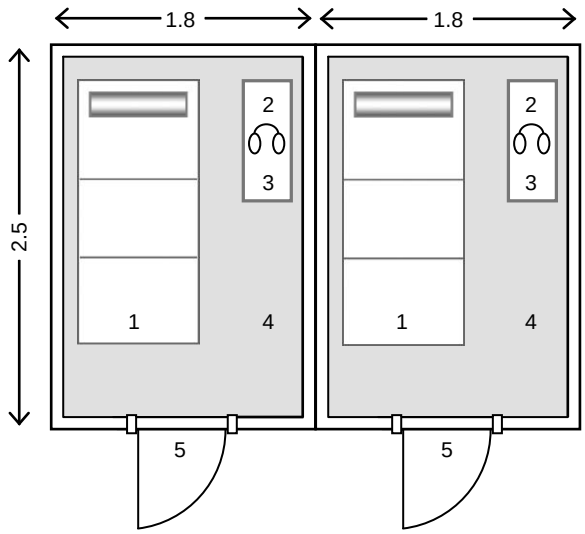

Figure 1. Inner view of the silent room cabin module (length and width are displayed in metres). 1, medical daybed; 2, music system with PMR instruction; 3, eye mask, alarm clock; 4, noise subdued floor; 5, lockable cabin door.

system offering standardized PMR instructions is integrated into the room. By installing the silent room in a call centre, it was possible for us to integrate PMR into daily worksite lunch break routines.

The scarcity of experimental evidence in this area of worksite implementation of PMR breaks highlights the need for more detailed research. Hence, the focus of the present study is to analyse the immediate (+10 min), spillover effects (+10 h; see e.g. Pawlow & Jones, 2005), and the 'quasi-chronic' changes of cortisol over a longer period (+42 h; chronic stress marker CAR; Nickel *et al.*, 2005) due to PMR lunch breaks within daily worksite settings. Thus, it is hypothesized that PMR breaks reduce cortisol states more efficiently than the usual small talk (ST) breaks.

Method

Participants

All participants (14 call centre agents) took part voluntarily. Due to the study's focus on measuring cortisol in typical call centre employees, the following inclusion criteria had to be met: (a) had worked as call centre agents for more than 6 months, with a regular 5 day and 40 h workweek and a fixed daily work schedule from 8:00 to 17:00; and (b) had no prior experience in systematic depth relaxation procedures. Of the 14 participants, seven age-and-gender matched pairs were created (range ±4 years). Each member of a pair was randomly assigned to either an ST or PMR group. Both groups consisted of 4 male and 3 female participants.

Procedure

After identifying lunch breaks as important recovery occasions within a pre-survey interested parties were invited to an informative meeting. Here, employees were asked to participate in an experimental study. All subjects were screened in a short personal interview in order to assure that they corresponded to our criteria of selection. Participants were informed about the purpose of the study. After that, participants received a short summary with important information including a 'don't' list (e.g. not to drink any alcoholic beverages 6 h prior to sampling time) before taking part in our study. These instructions were given in order to reduce the influence of possible confounders related to cortisol measurement. We received written informed consent from all participants. In return for participation, reports about individual stress profiles, as well as the overall findings, were promised. Participating employees were not compensated for their services. In a first appointment, the procedure and the use of the material (collection devices, compliance monitor, diary, and questionnaires) were explained to them and practiced intensively.

At the beginning of a 6 months period (from September to April), 14 call centre agents were randomly allocated to experimental lunch break groups: either (a) 20 min of PMR, or (b) 20 min ST break. The lunch break was scheduled between 12:00 and 13:00. The experimental PMR session (12:15–12:45) of the break took place (for the PMR group) in a noise-subdued, dimly-lighted (10 lux), opaque, lockable cabin, called 'silent room', where participants wore eye masks. PMR instructions were given via wireless headphones (including calm instrumental background music) while participants lay on medical daybeds. The ST break was located in the company's staff room and conducted with three to four self-chosen colleagues. Instructions were given to follow the usual

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choice of ST topics. Since cortisol measurement can be influenced by food intake no lunch was consumed on measurement days during the break. However, small snacks were allowed when participants were back at their desk (13:05–14:00). On the other hand, snacks were consumed between 12:00 and 12:30 on non-measurement days within the 6 months period.

Participants were instructed to use their allocated break every workday over a period of 6 months. Exceptionally, there were no PMR sessions on the day before the measurements to exclude direct spill over effects to the following day and determine 'quasi-chronic' changes of cortisol (see Figure 2). Cortisol measurements were taken on 8 fixed days ($d_0 = -0.25$ months, $d_1 = +0.25$ months, $d_2 = +1.25$ months, $d_3 = +2.25$ months, $d_4 = +3.25$ months, $d_5 = +4.25$ months, $d_6 = +5.25$ months, $d_7 = +6.25$ months). The pre-measurement d_0 (ST for both groups) served as baseline. On each measurement day samples of cortisol were (self-) administered at awakening and awakening +30 min then 11:55, 13:05, and bedtime. Altogether, this procedure resulted in a Treatment (between-subject factor: ST, PMR) × Time (within-subject factor: t_1 = awakening, t_2 = awakening +30 min, $t_3 = 11:55$, $t_4 = 13:05$, t_5 = bedtime) × Measurement Day (within-subject factor: d_0, d_1, … ,d_7) design.

Measurements

To collect saliva samples, participants used a device called a 'salivette' (Sarstedt; Nümbrecht, Germany). Participants woke up as usual (at times ranging from 6:00 to 7:15) roused by their own alarm clocks. Participants were instructed to provide five samples over the course of a normal workday. The appropriate time for the saliva collection (especially for the post-lunch time 13:05 measurement) was chosen with regard to the delayed response of cortisol to acute stress. Previous studies had shown that salivary cortisol reaches its maximum about 10–20 min after acute stress reaction (Hammerfald *et al.*, 2006).

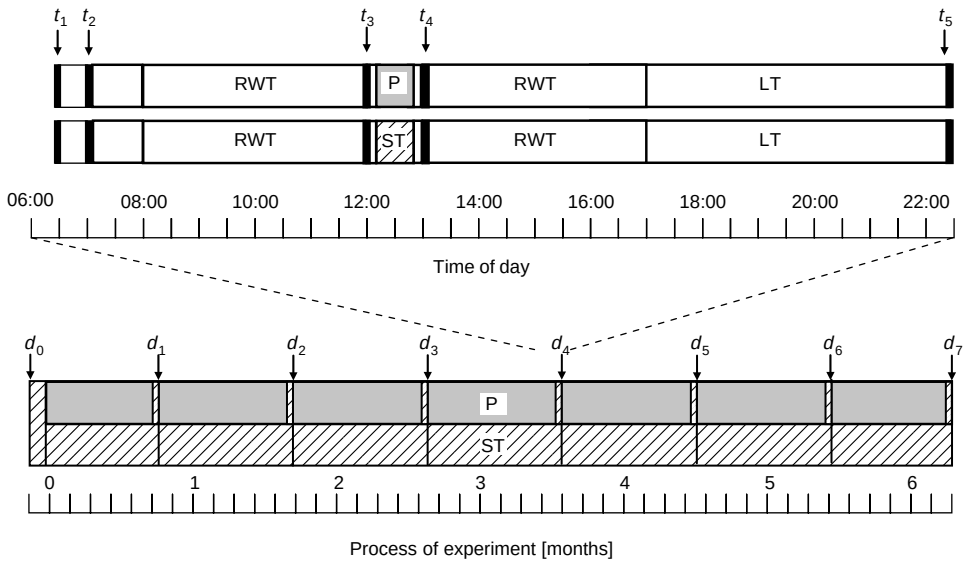

Figure 2. Time schedule of the experiment. (RWT, regular work task; P, PMR break; ST, small talk break; LT, leisure time; t_1–t_5, time of cortisol measurement; d_0–d_7, measurement day).

In order to avoid interference with experimental effects, participants were instructed to refrain from eating, smoking, strenuous physical exercise, brushing teeth, and consuming acidic drinks or caffeine for at least 1 h prior to testing, and from consuming alcohol for at least 6 h prior to testing. None of the samples had to be excluded due to non-compliant behaviour.

Regular saliva sampling by participants is prone to measurement error due to a lack of compliance in taking the sample at the prescribed time. To monitor compliance with the salivary cortisol collection protocol, we removed the sampling swabs from their original plastic tubes and put them in an electronic drug exposure monitor (Smart Caps, eDEMTM; Aardex Ltd., Switzerland). This monitor recorded the time at which the box containing the cotton rolls was opened. The employment of this device strengthened the compliance of the participants and prevented invalid cortisol profiles in non-compliant participants (Kudielka, Broderick, & Kirschbaum, 2003). Sufficient compliance was defined as taking the saliva sample (i.e. opening the cap of the compliance monitor) within a time frame of 5 min before and after the prescribed time. Applying this criterion, the compliance rate was 98.6%, which is in accordance with the data from Kudielka *et al.* (2003). Salivary free cortisol concentrations were determined employing a chemiluminescence assay with high sensitivity and inter-assay and intra-assay variations $< 10\%$ (University of Düsseldorf, Germany).

Cortisol parameter

The CAR in saliva is increasingly regarded as a non-invasive and reliable method for detecting subtle changes in the HPA axis. It allows repeated assessment and has been shown to have a high intra-individual stability (Hellhammer *et al.*, 2007). Furthermore, an enhanced CAR has been found in healthy subjects under chronic stress either manifested as high workload or social stress (Wüst, Federenko, Hellhammer, & Kirschbaum, 2000). CAR_{delta} was determined by calculating the difference between awakening $+30$ min and awakening, and CAR_{mean} by the mean of the two awakening samples. Furthermore, lunch break cortisol (LBC) reductions indicating immediate effects of PMR and ST were calculated as the difference of $13:05 - 11:55$ cortisol values. Spillover effects of PMR and ST were determined by collecting bedtime cortisol values. In sum, the participants provided 543 cortisol samples (97%; 560 total samples, 14 participants $\times$ 8 days $\times$ 5 samples per day). The missing data of a specific sample (e.g. participant 6, t_5, d_3) were replaced by the total mean of the corresponding time of day and measurement day over all remaining participants (mean of all participants in t_5, d_3).

Manipulation check

In addition to the application of Smart Caps, we checked the compliance and quality of relaxation method realization by means of (a) a checklist of relaxation symptoms (for PMR breaks), which involved, e.g. questions about the feeling of heaviness in the 16 different muscle groups; (b) informal questioning by a neutral person (was not associated with the study); and (c) a masked observation sample (by a peer colleague) on the measurement days. Non-compliant behaviour (non-adherence to the lunch break-mode) could be extrapolated from the above-mentioned questioning and observation. Furthermore, reporting less than 50% of the relaxation symptoms served as an exclusion criterion. None of the participants fell below this criterion. Moreover, the results of the informal questioning showed that the average percentage of PMR breaks

on the measurement days was 100% and the average number of PMR breaks during 6-month measurement period was 3.6 per week ($SD = 0.2$). The major reasons for not conducting a PMR break on non-measurement days were private obligations (banking, administrative tasks), social obligations (solving within-group conflicts, emotional support for colleagues), and falling asleep while practising PMR (under 20% of the whole PMR break trials, but none on measurement days). Due to the very high number and accurate collection of samples, high compliance with the sampling protocol, a high level of general compliance could be assumed.

Statistical analysis

Before performing analyses, the raw cortisol values were positively skewed and log-transformed to approximate normal distributions. However, in order to be physiologically meaningful, Figure 3 shows absolute cortisol values. One three-way repeated measure analysis of variance (ANOVA) was carried out to examine the interaction effects of treatment (PMR, ST), time (t_3, t_4), and measurement day (d_0–d_7) on pre- and post-lunchtime cortisol. Moreover, three ANOVAs were computed to determine the interaction effects of treatment (PMR, ST) and measurement day (d_0–d_7) on the remaining cortisol parameters. To control for possible effects of age, sex, intake of contraceptive medication, wake-up times, and sleep duration, these variables were

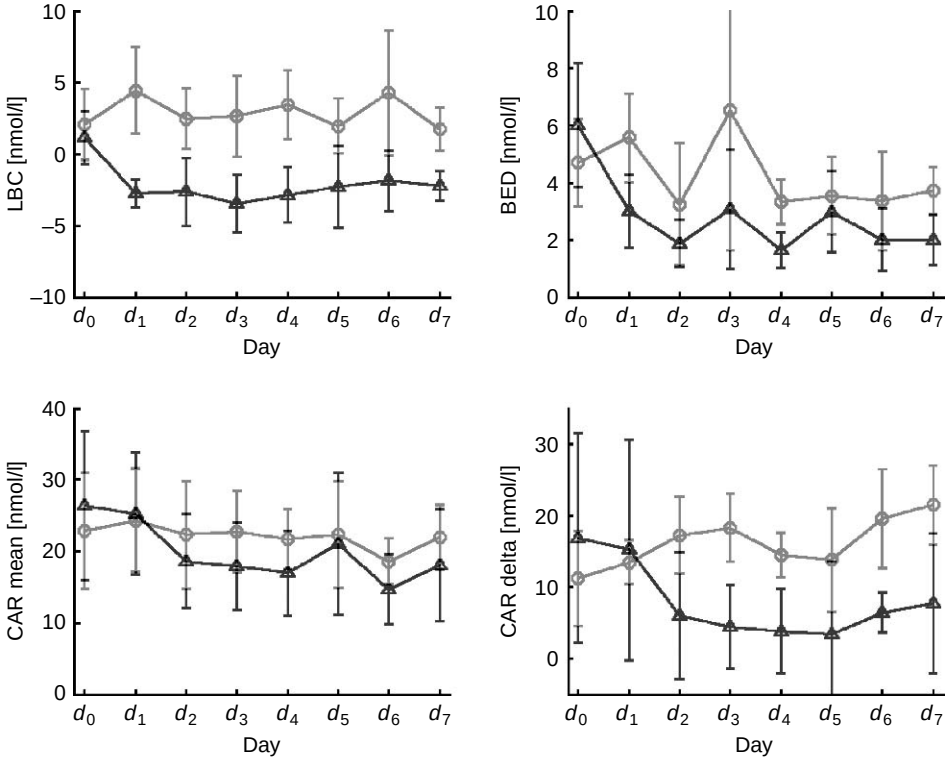

Figure 3. Cortisol parameter (LBC, BED, CAR_{mean}, and CAR_{delta}) of the pre- (d_0) and seven post-measurement days (d_1–d_7) for PMR and ST break. Data are shown as mean ± *SD*. PMR break, triangle marker; ST break, circle marker.

included as covariates in the ANOVAs. Moreover, unpaired t tests were used to examine short- (d_1) and long-term (mean of d_6 and d_7) differences between ST and PMR groups. A significance level of $p \leq .05$ was used.

Furthermore, we conducted an *a priori* power analysis for repeated measure ANOVA to determine the statistical power. Based on an estimated medium effect size, an alpha level of .05, and a sample size of seven subjects per cell (total sample size: $8 \times 5 \times 2 \times 7 = 560$), it was computed that the power exceeds the necessary 80% for the significance tests. The statistical analyses were conducted with SPSS for Windows release 17 (SPSS, Inc., Chicago, Illinois, USA).

Results

Sample characteristics and preliminary analyses

Table 1 shows the main characteristics of the sample separately for the PMR and ST groups. The groups were statistically indistinguishable with regard to several cortisol influencing variables (age, gender, ethnicity, use of contraceptives, awakening time, and sleep duration), and cortisol sample values of the pre-measurement day. These findings support the interpretation of treatment group differences as being caused by the experimental factor treatment.

Table 1. Sample characteristics ($N = 14$)

	PMR ($N = 7$)		ST ($N = 7$)		p
Age [years]	34.71	(7.43)	42.00	(9.51)	ns
Female [%]	57.1		57.1		ns
BMI [kg/m$_2$]	24.26	(1.71)	21.90	(2.10)	ns
Caucasian ethnicity	100		100		ns
Contraceptives [%]	42.8		42.8		ns
Awakening time [h]	6.40	(0.24)	6.31	(0.29)	ns
Sleep duration [h]	8.17	(0.56)	7.95	(0.34)	ns
Cortisol t_1 [nmol/l]	16.53	(5.21)	15.80	(5.46)	ns
Cortisol t_2 [nmol/l]	23.83	(7.00)	24.16	(7.28)	ns
Cortisol t_3 [nmol/l]	7.14	(3.66)	5.63	(3.70)	ns
Cortisol t_4 [nmol/l]	8.29	(4.15)	7.74	(4.19)	ns
Cortisol t_5 [nmol/l]	6.01	(2.16)	4.70	(1.53)	ns
Q5 CAR_{delta} [nmol/l]	7.30	(3.34)	8.361	(5.18)	ns
CAR_{mean} [nmol/l]	0.18	(5.94)	9.97	(5.89)	ns
LBC [nmol/l]	1.14	(1.84)	2.11	(2.47)	ns

Note. Cortisol t_1, awakening; t_2, awakening + 30 min; t_3, 11:55; t_4, 13:05; t_5, bedtime.

Cortisol indicators

Effects on post-lunch break cortisol

The LBC effects (cortisol level at 13:05 minus cortisol level at 11:55, LBC) revealed significant different time courses for the PMR and ST groups as depicted in Figure 3. The results obtained from a Treatment (between-subject factor: ST, PMR) × Time (within-subject factor: $t_3 = 11:55$, $t_4 = 13:05$) × Measurement Day (within-subject factor: $d_0, d_1, \ldots, d_7$) threee-way interaction effect, $F(7, 96) = 2.56, p < .05$, indicate the

divergent pre- and post-lunchtime cortisol values of PMR and ST group. LBC effects can be observed for both short-term (d_1) and long-term (mean of d_6 and d_7) perspective, $t(12) = -5.92$, $p < .001$, $t(12) = -4.97$, $p < .001$, respectively.

Effects on bedtime cortisol

A two-way ANOVA (2 Treatment × 8 Measurement Days) showed systematic differences in bedtime cortisol levels between the PMR and ST groups, $F(7, 96) = 1.99$, $p < .10$ (see Figure 3). The bedtime cortisol effects (BED) reached significance within both short-term and long-term perspective, $t(12) = -3.38$, $p < .01$, $t(12) = -3.21$, $p < .01$, respectively.

Effects on CAR

The CAR_{mean} revealed no significant difference in time course for the PMR and ST groups, as depicted in Figure 3, $F(7, 96) = 1.15$, $p > .10$. Accordingly, no short-term or long-term effects were found, $t(12) = 0.22$, ns, $t(12) = -1.44$, ns, respectively. In contrast to this result, the CAR_{delta} values showed – referring to the significance criterion of the two-way ANOVA (2 Treatment × 8 Measurement Day) treatment-by-measurement day interaction effect – a substantial effect, $F(7, 96) = 3.73$, $p < .001$ (see Figure 3). In contrast to the pattern observed above, CAR_{delta} values reached significance not from short term but from long-term perspective, $t(12) = 0.29$, ns, $t(12) = -4.34$, $p < .001$.

Discussion

The aim of the 6-month experimental worksite study presented here is to elucidate the cortisol reducing impact of different ways of spending lunch breaks. We expected that PMR lunch breaks would elicit smaller cortisol responses than ST lunch breaks, and the results do indeed document the cortisol decreasing effect of PMR lunch breaks. The main finding apparent in the data is the strong reduction of lunchtime and awakening cortisol states in response to the PMR break. Cortisol states at bedtime seem to be less influenced by the chosen type of lunch breaks. The highest cortisol reduction and largest effects were found for immediate post-lunch break cortisol states. This corresponds to laboratory-based results concerning immediate cortisol reduction due to PMR stress reduction (Pawlow & Jones, 2005). A theoretical framework explaining such stress reducing effects of PMR has already been provided (see Meijman & Mulder, 1998; Smith, 1988; Trenberth & Dewe, 2002). In contrast to the lunchtime and bedtime effects, a reduced CAR_{delta} can not be observed in the short run (after 0.25 months), only in the long run (after 5–6 months). According to Fries, Dettenborn, and Kirschbaum (2009), who link CAR to prospective and anticipated demands of an upcoming day, we assume that chronic stress as measured by CAR_{delta} was not reduced immediately since attitudes towards anticipated workload of the upcoming day are unlikely to change in short term. This result corresponds with the resisting inertia of CAR_{delta}, which reflect rather long-term psychophysiological processes, and is associated with chronic stress states (Thorn, Hucklebridge, Evans, & Clow, 2006). Besides, the above-mentioned potential recovery effects of PMR, the specific characteristics of the silent room-based worksite implementation selected for this experiment could be responsible for the results. Based on long-term implementation,

the study at the same time provided familiarization with PMR procedures and its silent room setting for participants. These factors might have enabled them to experience deep and effective relaxation during the lunch break and thus explain the effect sizes obtained by the PMR-based breaks. In contrast, the ST break might have shown increased cortisol levels due to interpersonal and situational characteristics such as social-evaluative threats, unpredictability, uncontrollability, and the anticipation of negative consequences. Freely choosing a preferred small talk partner may, on the other hand, have diminished these effects and led to the observed nearly normal circadian rhythm as expected from the literature.

In general, our results correspond to the hypothesis made at the beginning. Similar results concerning the cortisol reducing effects of PMR have been found in artificial laboratory contexts. However, this is to the best of our knowledge the first report on a longitudinal implementation of systematic relaxation techniques in a real work setting with daily lunch break routines.

One limitation of this study refers to the cortisol-based approach that was selected. It is well-known that cortisol measurement faces several confounder-related threats with reference to validity. However, cortisol levels throughout the experiment fell within the expected range for normal, healthy adults showing a normal circadian rhythm, as expected from the literature (see Westermann, Demir, & Herbst, 2004). Furthermore, the observed compliance (derived from Smart Caps and self-report measures) confirms the reliability of the measurements. Nevertheless, caution is warranted in the interpretation of these data. Hence, future research might attempt to use other non-obtrusive (electro-physiological, acoustic, or behavioural) stress measures.

In general, methodological difficulties may only disturb slightly the realization of the experimental PMR break or manipulate its conditions. Participants' compliance can be considered high. This suggestion is supported by the fact that ST breaks serve as the most common and natural form of lunch break. Participants' compliance in the PMR break condition was confirmed by random observations and informal questioning at the end of the experiment. Nevertheless, it may be a matter of debate whether the observed cortisol reducing effect resulted from placebo effects, characteristics of the 'silent room' (e.g. silence, darkness), from short periods of napping during PMR or from pure PMR. Napping itself has already proved its effectiveness in industrial settings (Takahashi, Nakata, Haratani, Ogawa, & Arito, 2004). Furthermore, imitation of the PMR break might have occurred in the leisure time of the ST group. But informal interviews gave no hint of this, and even if this imitation had occurred, the real difference between bedtime and awakening cortisol of ST and PMR would have been underestimated. A further uncertainty refers to the explanation BED and CAR_{delta} results, which might be induced by mediator effects of changed activity pattern (see Geurts & Sonnentag, 2006) or irritation level at home rather than directly influenced by PMR breaks. Moreover, Hawthorne effects could be responsible for the results. Even, if the latter might be less probable due to the long experimental period of 6 months and the fact that cortisol (in contrast to performance levels) cannot be enhanced by voluntary effort. Nevertheless, due to habituation effects it remains unclear to what extent we can extrapolate the 6 months effects on to real long-term effects ($<$ 6 months). In addition, when extending to a longer period seasonal effects might become more obvious. Again, this potential confounder would only change the absolute cortisol level; the relative distance between ST and PMR should remain stable.

Although in comparison to large-scale cross-sectional correlation designs the sample size in this study is quite small, it is still within the typical range of experimental

worksite field studies (see Takahashi *et al.,* 2004). Moreover, repeated measurements ensured the robustness, internal validity, and significance of the results. Furthermore, no group differences in cortisol influencing variables or cortisol sample values of the pre-measurement day could be found, which confirms the *a priori* equivalence and baseline-specific superiority of PMR experimental groups.

The present study was carried out in a real, but small-sized worksite. In order to judge external validity properly, it is evident that clarification concerning the ability to generalize the results is needed. The extent to which we can extrapolate from this call-centre context to other professional sectors remains unclear. With the limiting factors described above in mind, our present findings should be viewed as preliminary ones that warrant more controlled research. Some possible starting points and questions for future research might be concerned with improving measurement instruments for intervention studies (What physiological, behavioural, and acoustic instruments can detect stress non-obtrusively and without interrupting the primary work task?; Krajewski, Batliner & Golz, 2009) or o*ptimizing the recovery value of worksite lunch breaks* (Which combination of different break usages as, e.g. napping or pharmaceuticals improves the intensity and sustainability of the recovery process best?; Wesensten, Killgore, & Balkin, 2005).

In sum, the longitudinal field-experiment results indicate that PMR lunch breaks may reduce cortisol states significantly. Additionally, the current study extends prior research by addressing cortisol reduction problems in real work settings. Finally, this study builds evidence suggesting the acceptance, sustainability, and success of the silent room as an implementation module enabling PMR within daily lunch break routines.

References

Binnewies, C., Sonnentag, S., & Mojza, E. J. (in press). Recovery during the weekend and fluctuations in weekly job performance: A week-level study examining intra-individual relationships. *Journal of Occupational and Organizational Psychology.*

Carlson, C. R., & Hoyle, R. H. (1993). Efficacy of abbreviated progressive muscle relaxation training: A quantitative review of behavioural medicine research. *Journal of Consulting and Clinical Psychology, 61*, 1059–1067.

Cropley, M., & Purvis, M. L. J. (2003). Psychological contracting: Processes of contract formation during interviews between nannies and their 'employers'. *Journal of Occupational and Organizational Psychology, 76*, 213–241. doi:10.1348/096317903765913713.

Emery, C. F., France, C. R., Harris, J., Norman, G., & Vanarsdalen, C. (2008). Effects of progressive muscle relaxation training on nociceptive flexion reflex threshold in healthy young adults: A randomized trial. *Pain, 138*, 375–379.

Fastenmeier, W., Gstalter, H., & Lehnig, U. (2003). Was empfinden Menschen als Freizeit? – Emotionale Bedeutung und Definitionen [What is leisure time? Emotional meaning and definitions]. In Institut für Mobilitätsforschung (Ed.). *Motive und Handlungsansätze im Freizeitverkehr*. Berlin: Springer Verlag.

Fries, E., Dettenborn, L., & Kirschbaum, C. (2009). The cortisol awakening response (CAR): Facts and future directions. *International Journal of Psychophysiology, 72*, 67–73.

Fritz, C., & Sonnentag, S. (2005). Recovery, health, and job performance: Effects of weekend experiences. *Journal of Occupational Health Psychology, 10*, 187–199.

Geurts, S. A. E., & Sonnentag, S. (2006). Recovery as an explanatory mechanism in the relation between acute stress reactions and chronic health impairment. *Scandinavian Journal of Work, Environment and Health, 32*, 482–492.

Hammerfald, K., Eberle, C., Grau, M., Kinsperger, A., Zimmermann, A., Ehlert, U., & Gaab, J. (2006). Persistent effects of cognitive-behavioral stress management on cortisol responses to acute stress in healthy subjects – a randomized controlled trial. *Psychoneuroendocrinology*, *31*, 333–339.

Hartig, T., Johansson, G., & Kylin, C. (2007). The telework tradeoff: Stress mitigation vs. constrained restoration. *Applied Psychology: An International Review*, *56*, 231–253.

Hellhammer, J., Fries, E., Schweisthal, O. W., Schlotz, W., Stone, A. A., & Hagemann, D. (2007). Several dailymeasurements are necessary to reliably assess the cortisol rise after awakening: State and trait components. *Psychoneuroendocrinology*, *32*, 80–86.

Krajewski, J., Batliner, A., & Golz, M. (2009). Acoustic sleepiness detection – framework and validation of a speech adapted pattern recognition approach. *Behavior Research Methods*, *41*, 795–804.

Kudielka, B. M., Broderick, J. E., & Kirschbaum, C. (2003). Compliance with saliva sampling protocols: Electronic monitoring reveals invalid cortisol daytime profiles in noncompliant subjects. *Psychosomatic Medicine*, *65*, 313–319.

Lohaus, A., Klein-Heßling, J., Vögele, C., & Kuhn-Hennighausen, C. (2001). Relaxation in children: Effects on physiological measures. *British Journal of Health Psychology*, *6*, 197–206.

Lolak, S., Connors, G. L., Sheridan, M. J., & Wise, T. N. (2008). Effects of progressive muscle relaxation training on anxiety and depression in patients enrolled in an outpatient pulmonary rehabilitation program. *Psychotherapy and Psychosomatics*, *77*, 119–121.

Magkos, F., & Kavouras, A. (2004). Caffeine and ephedrine, physiological, metabolic and performance enhancing effects. *Sports Medicine*, *34*, 871–889.

Manelli, F., & Giustina, A. (2000). Glucocorticoid-induced osteoporosis. *Trends Endocrinology Metabolism*, *11*, 79–85.

Meijman, T. F., & Mulder, G. (1998). Psychological aspects of workload. In P. J. D. Drenth, H. Thierry, & C. J. des Wolff (Eds.), *Handbook of work and organizational psychology* (Vol. 2, pp. 5–33). Hove: Psychology Press.

Miller, D. B., & O'Callaghan, J. P. (2002). Neuroendocrine aspects of the response to stress. *Metabolism*, *51*, 5–10.

Nickel, C., Lahmann, C., Tritt, K., Loew, T. H., Rother, W. K., & Nickel, M. K. (2005). Stressed aggressive adolescents benefit from progressive muscle relaxation: A random, prospective, controlled trial. *Stress and Health*, *21*, 169–175.

Pawlow, L. A., & Jones, G. E. (2002). The impact of abbreviated progressive muscle relaxation on salivary cortisol. *Biological Psychology*, *60*, 1–16.

Pawlow, L. A., & Jones, G. E. (2005). The impact of abbreviated progressive muscle relaxation of salivary cortisol and salivary immunoglobulin. *Journal of Applied Psychophysiology and Biofeedback*, *30*, 375–387.

Rabin, B. S. (2005). Stressor-induced alteration of health across the life span: There is more to it than immunology. *Clinical and Applied Immunology*, *5*, 207–224.

Rainforth, M. V., Schneider, R. H., Nidich, S. I., King, C. G., Salerno, J. W., & Anderson, J. W. (2007). Stress reduction programs in patients with elevated blood pressure: A systematic review and meta-analysis. *Current Hypertension Reports*, *9*, 520–528.

Schneider, R. H., Alexander, C., Staggers, F., Orme-Johnson, D. W., Rainforth, M., Salerno, J., … Nidich, S. I. (2005). A randomized controlled trial of stress reduction in the treatment of hypertension in African Americans during one year. *American Journal of Hypertension, 18*, 88–98.

Sephton, S. E., Sapolsky, R. M., Kraemer, H. C., & Spiegel, D. (2000). Diurnal cortisol rhythm as a predictor of breast cancer survival. *Journal of the National Cancer Institut*, *92*, 994–1000.

Shapiro, S., & Lehrer, P. M. (1980). Psychophysiological effects of autogenic training and progressive relaxation. *Biofeedback and Self-Regulation*, *5*, 249–255.

Smith, J. C. (1988). Steps toward a cognitive-behavioral model of relaxation. *Biofeedback and Self-Regulation*, *13*, 307–329.

Smith, J. C., Amutio, A., Anderson, J. P., & Aria, L. A. (1996). Relaxation: Mapping an uncharted world. *Biofeedback and Self-Regulation*, *21*, 63–90.

Sonnentag, S., Binnewies, C., & Mojza, E. J. (2008). Did you have a nice evening? A day-level study on recovery experiences, sleep and affect. *Journal of Applied Psychology*, *93*, 674–684.

Sonnentag, S., Mojza, E. J., Binnewies, C., & Scholl, A. (2008). Being engaged at work and detached at home: A week-level study on work engagement, psychological detachment and affect. *Work and Stress*, *22*, 257–276.

Takahashi, M., Nakata, A., Haratani, T., Ogawa, Y., & Arito, H. (2004). Post-lunch nap as a worksite intervention to promote alertness on the job. *Ergonomics*, *47*, 1003–1013.

Thorn, L., Hucklebridge, F., Evans, P., & Clow, A. (2006). Suspected non-adherence and weekend versus week day differences in the awakening cortisol response. *Psychoneuroendocrinology*, *31*, 1009–1018.

Trougakos, J. P., Beal, D. J., Green, S. G., & Weiss, H. M. (2008). Making the break count: An episodic examination of recovery activities, emotional experiences, and positive affective displays. *Academy of Management Journal*, *51*, 131–146.

Trenberth, L., & Dewe, P. (2002). The importance of leisure as a means of coping with work related stress: An exploratory study. *Counselling Psychology Quarterly*, *15*, 59–72.

Wegge, J., Van Dick, R., Fisher, G., Wecking, C., & Moltzen, K. (2006). Work motivation, organisational identification, and well-being in call centre work. *Work and Stress*, *20*, 60–83.

Wesensten, N. J., Killgore, W. D. S., & Balkin, T. J. (2005). Performance and alertness effects of caffeine, dextroamphetamine, and modafinil during sleep deprivation. *Journal of Sleep Research*, *14*, 255–266.

Westermann, J., Demir, A., & Herbst, V. (2004). Determination of cortisol in saliva and serum by a luminescence-enhanced enzyme immunoassay. *Journal of Clinical Laboratory Analysis*, *50*, 11–24.

Wüst, S., Federenko, I., Hellhammer, D. H., & Kirschbaum, C. (2000). Genetic factors, perceived chronic stress, and the free cortisol response to awakening. *Psychoneuroendocrinology*, *25*, 707–720.

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