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Co-variation of fatigue and psychobiological stress in couples' everyday life

Johanna M. Doerr[a,*], Urs M. Nater[a,b], Ulrike Ehlert[c], Beate Ditzen[d,*]

[a] Clinical Biopsychology, Department of Psychology, University of Marburg, Gutenbergstrasse 18, 35032 Marburg, Germany
[b] Clinical Psychology, Department of Psychology, University of Vienna, Liebiggasse 5, 1010 Vienna, Austria
[c] Clinical Psychology and Psychotherapy, Department of Psychology, University of Zurich, Binzmuhlestr. 14, 8050 Zurich, Switzerland
[d] Institute of Medical Psychology, Center for Psychosocial Medicine, Heidelberg University, Bergheimer Str. 20, 69115 Heidelberg, Germany

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ABSTRACT

Objective: There is limited knowledge about how fatigue develops and worsens and what influences fluctuations in daily fatigue. Stress was found to influence fatigue, and being in a relationship seems to either increase or decrease stress depending on the couple interaction. In this study, co-variation of fatigue, self-reported stress, and biological stress markers in couples' everyday lives was investigated. Specifically, we examined a) whether momentary couple interactions moderated dyadic outcomes and b) whether and how stress and relationship measures influenced individual momentary fatigue.
Methods: Forty heterosexual couples (age: 28 ± 5 years) reported subjective fatigue and stress levels 4 times a day for 5 consecutive days (1600 measures). Furthermore, participants reported whether they had interacted with their partner since the last data entry and, if so, they rated the valence of this interaction. Salivary cortisol (a measure of HPA axis activity) and alpha amylase (a measure of ANS activity) were analyzed as biological stress markers from saliva samples obtained at the same time points. Moment-to-moment data were analyzed using dyadic multilevel models to account for the nested design.
Results: Stress (women and men: $p \leq 0.001$) and fatigue (women: $p = .003$, men: $p = .020$) showed patterns of co-variation within couples, especially if partners had interacted with each other since the previous data entry. Cortisol was also found to co-vary between partners (women: *unstandardized coefficient* (*UC*) = 0.12, $p \leq .001$, men: $UC = 0.18$, $p \leq .001$), whereas the regulation of alpha-amylase levels depending on the partner's levels was only present in women ($UC = 0.11$, $p = .002$). Valence of couple interaction was negatively associated with fatigue (women: $UC = -0.13$, $p \leq .001$, men: $UC = -0.06$, $p = .011$). There was no momentary association of fatigue with an individual's own or the partner's subjective or biological stress markers.
Conclusions: Fatigue and stress levels during the day seem to co-vary within couples. These associations were particularly strong when the partners had interacted with each other since the last measurement. These data underline the importance of social factors in fatigue and stress in everyday life.

1. Introduction

Fatigue is a subjective phenomenon that can be defined as a state of exhaustion, tiredness, weakness, and lack of energy (Schwarz et al., 2003). Fatigue at non-clinical levels is part of a wide array of normal experiences in everyday life and is assumed to have the purpose of triggering resting behavior in order to achieve recovery (although other purposes, focusing on motivational processes, have recently been discussed, e.g. Hockey, 2011). Thus, fatigue levels tend to be higher in the morning (directly after awakening) and evening, at least partly depending on how restful the night's sleep and how strenuous the day has been (Dahlgren et al., 2005; Buysse et al., 2007). Fatigue during the day may interfere with productivity and well-being (Riley et al., 2010). Furthermore, chronically increased and clinically relevant fatigue levels can pose a significant burden on society in terms of health care utilization as well as sickness leave days (e.g. Ricci et al., 2007; Skapinakis et al., 2003). In order to reduce societal as well as personal burden caused by fatigue, it is important to determine intervention and prevention strategies. Thus, it is important to uncover the underlying psychological and biological mechanisms that can explain changes in fatigue. Although fatigue is an almost ubiquitous phenomenon, these mechanisms are not well understood and might help to develop targeted interventions to improve chronically fatigued individuals' lives.

Stress may be a critical factor precipitating and/or facilitating fatigue. Previous studies have found that stress has the potential to influence fatigue levels in clinical samples (Kato et al., 2006) as well as in

* Corresponding authors.
E-mail addresses: johanna.doerr@staff.uni-marburg.de (J.M. Doerr), beate.ditzen@med.uni-heidelberg.de (B. Ditzen).

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the everyday life of non-clinical samples (Akerstedt et al., 2014). In a recent study, the results suggested that not only does stress positively predict fatigue, but that increases in fatigue also predict increases in stress experienced by young healthy adults (Doerr et al., 2015). However, most research on stress and fatigue has been conducted with only one time point of measurement (e.g. Brown and Thorsteinsson, 2009), with the consistent finding of more stress being associated with increased fatigue levels. Thus, although the question of causality remains not fully answered, stress was found an important risk factor for increases in fatigue.

Activation of the autonomic nervous system (ANS) and hypothalamic pituitary adrenal (HPA) axis are part of the biological stress response (Sapolsky et al., 2000). Given the close association between stress and fatigue, it can be assumed that the biological stress responses of the HPA axis and the ANS play an important role in the biological foundation of changes in fatigue severity (Nater et al., 2010). However, results regarding the influence of the activity of the HPA axis and the ANS on fatigue are inconsistent. Some studies indicate that fatigue is associated with a reduction of cortisol variability across the day (e.g. Dahlgren et al., 2009). Furthermore, Adam and colleagues (2006) found an association between low morning cortisol values and high fatigue levels throughout the day in a sample of older adults whereas Eek and colleagues (2012) found positive associations between cortisol increases in the morning and several aspects of fatigue (lack of energy, lack of motivation, physical exertion). There are several additional studies suggesting changes in the HPA axis and ANS functioning in persons suffering from chronic fatigue syndrome, hinting towards a decreased responsiveness of the HPA axis (for an overview see Powell et al., 2013) and enhanced ANS activity (although some studies found no differences, for an overview see Nater et al., 2012) in this group. In sum, stress is most likely an important risk factor for increased fatigue. However, the assumed association of the activities of both HPA axis and ANS with changes in everyday life fatigue was not conclusively shown, so far.

More recently, health research has become increasingly aware of social influences on individual psychobiological functions, namely central nervous system mechanisms, hormones, and stress-sensitive autonomic markers (for an overview see McCall and Singer, 2012). This social perspective has strong implications for diverse health outcomes and treatment programs (Kirby and Baucom, 2007; Whisman and Beach, 2012). Most explanatory models on the effects of social relationships on health focus on couple relationships, with the partner as a source of social support to buffer stress, but also as a potential stressor (Ekmann et al., 2012; Robles et al., 2014). As a consequence, being in a close relationship can lead to both activation or buffering of the body's stress systems, including HPA axis and ANS (Ditzen and Heinrichs, 2014). Indeed, co-regulation of mood as well as activity of the body's stress systems have been found in couples. This co-regulation within attachment bonds is thought to maintain psychobiological homeostasis (Sbarra and Hazan, 2008; Coan and Sbarra, 2015) where the partners serve as "social zeitgebers" (Stetler et al., 2004). In line with this concept, emotional similarity and convergence were found in adults who are close to each other (Anderson et al., 2003; Butner et al., 2007; Schoebi, 2008). Furthermore, cortisol levels have been found to co-vary in spouses, particularly when the partner was present (Saxbe and Repetti, 2010). In this context, it is important that co-regulation or "attunement" is based on different concepts, definitions and statistical approaches to calculate the level of co-variance or synchrony between individuals or between different outcome measures (c.f. Bernard et al., 2017; Butler, 2011). A broad range of psychobiological processes determine co-regulation in emotions, behavior, and/or physiological outcomes. To adequately capture these dynamic processes calls for a multi-person setting, frequent repeated-measures assessment, and elaborated statistical models. The specific time-patterns of each predictor and outcome need to be acknowledged (i.e. specific emotions might trigger ANS and HPA outcomes at different time points). While longer-term adaptation processes can be investigated during the course of the day, short-term changes need more frequent assessment. In an everyday life context with repeated but limited measures during each day we, thus, use the term "co-variation" in order to capture a central aspect of co-regulation. Co-variation of cortisol has also been found in ambulatory as well as laboratory studies (Liu et al., 2013; Laurent and Powers, 2007). Concerning the co-regulation of autonomic outcomes, experimental laboratory studies suggest equivocal results (Ferrer and Helm, 2013; Reed et al., 2013). To our knowledge, no everyday life data on co-variation of ANS outcomes between partners are available, yet.

In sum, fatigue is a prevalent phenomenon that − at clinically relevant levels − can pose considerable societal burden. However still, mechanisms which influence fatigue fluctuations and which might be targeted by prevention strategies are not well understood. Stress (including HPA axis as well as ANS functioning) has repeatedly been associated with fatigue, and co-variation of psychobiological stress parameters as well as mood have been found within romantic partners. Therefore, it can be suspected that fatigue levels also co-vary within couples. Moreover, previous studies suggest that being in a relationship has beneficial effects on stress, and as a consequence couple interaction might also have beneficial effects on fatigue.

Therefore, the aim of this study was to investigate co-variation of fatigue within couples. It was expected that a) fatigue levels would co-vary within couples, b) subjective stress and HPA axis activation would be co-varying, thereby replicating previous studies. In parallel to these data, one assumption was that (as compared to HPA axis) ANS − or more specifically sympathetic (SNS) − activation would co-vary in couples' everyday lives, and c) own as well as partner's stress levels would be positively associated with fatigue. Another, secondary, aim of the present study was to determine whether these relationships would be stronger when partners actually interacted (i.e. were in touch with each other in any way) as well as if positive couple interaction would reduce fatigue levels. Of course, variance in fatigue levels will not only be influenced by couple interaction but also by shared lifestyle (sleeping patterns, sports, eating habits, etc.). These behaviors were, thus, included as control variables into the data analyses.

2. Methods

2.1. Participants

Couples were recruited via flyers, information brochures, internet ads, mailing lists of the University of Zurich, and social media. Inclusion criteria comprised being between 21 and 45 years old, exclusive dating and relationship duration between one and 15 years, and cohabitation. Participants were excluded if they had children, had a current or chronic physical or psychiatric illness (based on self-report during an initial phone contact), or currently used medication (except for hormonal contraceptives) or drugs (no alcohol intake on a daily basis, or smoking more than five cigarettes a day). Women not using hormonal contraception were studied during the early follicular phase of the menstrual cycle in order to minimize effects of the cycle on HPA axis and ANS activity. All participants gave written informed consent. The study protocol was approved by the ethics committee of the Canton of Zurich and the study was monitored by the Clinical Trials Center Zurich. The research was conducted in accordance with the Declaration of Helsinki.

Current analyses are based on a sub-sample (placebo group) that took part in the "Oxytocin, Couple Interaction, and Wound Healing" study (more information: clinicaltrials.gov, identifier NCT01594775). Eighty couples were included in the parent study. Each couple received 500CHF (about 510 USD) for study completion. The sub-sample used in the current analysis consists of 40 couples who (both members of each couple) provided data sets. Couples were randomized into two groups, one of which was instructed in a short verbal positive interaction intervention they should implement in their everyday lives during the