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„Interpersonal Conflict at Work and the Role of Psychological Detachment and Rumination Heart Rate Variability during Sleep – A Moderated Mediation Model.“

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1 Introduction

In the contemporary working world, employees are increasingly facing new job demands, which are inducing work stress - a risk factor for serious mental and physical illness (Castaldo et al., 2015; Nixon, Mazzola, Bauer, Krueger, & Spector, 2011; Thayer, Yamamoto, & Brosschot, 2010). Interpersonal conflict at work is known to be a leading source of stress for employees across all age groups and occupations (Ishtiak-Ahmed, et al., 2019; Keenan, & Newton, 1985; Spector & Bruk-Lee, 2008), but especially among nurses within the healthcare settings (Almost, Doran, McGillis Hall, & Spence Laschinger, 2010; Almost, Wolff, Stewart-Pyne, McCormick, Strachan, & D'Souza, 2016). Increasing workload demands, growing diversity of the work force and greater interdependency among team members can contribute to misunderstandings and disagreements, which eventually causes interpersonal conflict (De Dreu, van Dierendonck, & De Best-Waldhober, 2003).

Researchers consistently report that stressful working conditions are associated with increased risk of coronary heart disease (CHD) and cardiovascular mortality (Belkic, Landsbergis, Schnall, & Baker, 2004; Chandola et al., 2008; Thayer et al., 2010). Analyzing individuals heart rate variability (HRV) represents an informative biomarker to measure the physiological influence of workplace stressors (Hernandez-Gaytan et al., 2012), since it measures alterations in the autonomic nervous system (Laitio, Jalonen, Kuusela, & Scheinin, 2007). Autonomic imbalance favoring sympathetic dominance, displayed by a decrease in HRV, is considered to be a common pathway between stressful working conditions and cardiovascular disease risk (Thayer et al., 2010).

Conflict is one of the most common social stressors, expressed by short-term strain reactions such as elevated heart rate, increased respiration and a general state of alertness, which are known to be a functional response of the body to cope with stressful situations (De Dreu, & Gelfand, 2008). Furthermore, when the stressor continues to be cognitively present, even though not physically, it is difficult to relax after work (Sonnentag, Binnewies, & Mojza, 2010a). Thus, short-lived strain reactions can develop into long-term strain reactions in case of impaired recovery, which can eventually result in ill health (Sonntag, Unger, & Nägel, 2013). In relation to the detrimental health outcomes just mentioned, it is of great importance to highlight the essential role that psychological detachment plays in the recovery

process (Sonnentag & Bayer, 2005). Mentally detaching from stressful working conditions during off-job time offers the opportunity to calm down, rebuild affective and energetic resources and therefore facilitates recovery (Geurts & Sonnentag, 2006; Sonnentag, Binnewies, & Mojza, 2010a).

Although a great amount of research exists on the topic of how impaired recovery mediates the relationship between stressor and strain reactions (Kinnunen, Feldt, Siltaloppi, & Sonnentag, 2011; Safstrom & Hartig, 2013; Sonnentag, et al., 2010; Von Thiele Schwarz, 2011), there are only scarce findings on the particular impact of workplace conflict and psychological detachment on nocturnal heart rate variability. Thus, the present study aims to shed light on the direct relationships of the latter mentioned variables, as well as on the mediating role of psychological detachment in linking interpersonal work conflict and reduced HRV at night.

In case of lacking psychological detachment we assume that the stressor continues to be cognitively present. One much discussed cause for this prolonged presence of the stressor is the existence of job-related thoughts (Brosschot, Gerin, Thayer, 2006), also known as rumination. Thus, it is expected that ruminative thoughts functions as a moderator by reinforcing the negative association between interpersonal work conflict and psychological detachment, which in turn leads to a reduction of HRV at night.

Moreover, so far the role of detachment as a mediator has predominantly been investigated with regard to psychological well-being outcomes. The add-on value of this paper is to investigate whether the mediating role of detachment also exist in respect to physiological health outcomes like HRV.

Furthermore, taking rumination into consideration for moderating the mediation has never been investigated before, but is essential to show what hampers detachment after work. The study aims to show that only if people report high levels of rumination, conflict will impact the inability to detach after work, which will in turn result in lowered nocturnal HRV.

Another add-on value of the study is the use of modern methodological approaches to study work stress characterized by repeated measurement in form of a 5-day diary study. The multilevel approach allows to examine daily fluctuating characteristics of the work situation (Ohly, Sonnentag, Niessen, & Zapf, 2010) and takes the interdependence of the daily assessed observations into account (Hox,

2017), which is the key advantage of multilevel analyses compared to conventional statistical approaches (Geiser, 2012). Furthermore, diary studies allow to make inferences about the causal direction (Harris, Daniels & Briner, 2003) of the variables, because of the time lag that exists between the assessment of the independent variables (conflict at work, rumination, psychological detachment) and the dependent variables (RMSSD and LF/HF), which results in the temporal precedence of the independent variables.

2 Theoretical Background

2.1 Workplace Conflict and Health

Interpersonal work conflict is defined as “a dynamic process that occurs between interdependent individuals, groups or both, as they experience negative emotional reactions to perceived disagreements and interference with attainment of their goals” (pp.3, Jerng et al., 2017).

Experiencing conflict at work can have an impact on psychological strain such as depression (Inoue & Kawakami, 2010; Spector & Jex, 1998), burnout (Richardson, Burke, & Leiter, 1992; Sliter, Pui, Sliter, & Jex, 2011) and psychological well-being (Sonnentag et al., 2013). For instance, it was found that social capital in hospitals (i.a. social relationships between members of the organization; Badura & Hehlmann, 2003) functioned as a protective factor against emotional exhaustion in a sample of nurses (Kowalski et al., 2010). Regarding conflict and its relation to physiological outcomes, a meta-analysis of seven studies from Spector and Jex (1998) displayed only a moderate positive correlation between interpersonal conflict at work and somatic symptoms. More recent studies in turn confirmed the association between conflict and physical complaints (Frone, 2000; Meier, Semmer, & Gross, 2014; Nixon et al., 2011) as well as its link to a higher risk for cardiovascular diseases (Yoon & Jae, 2017).

When it comes to employees well-being, studies found an association between conflict and strain (Dijkstra, van Dierendonck, Ever, 2005; Smith & Christensen, 1992; Yoon & Jae, 2017), as well as a link between stressors and HRV (Borchini et al., 2015; Chandola et al., 2008). However, research providing the link between conflict at work and heart rate variability is still scarce (Clays et al., 2011).

2.2 Work Stressor and Impaired Health Assessed by Heart Rate Variability

2.2.1 The allostatic load model. The allostatic load model (ALM; McEwen, 1998) provides a theoretical explanation for the underlying psychophysiological processes which link work-related stress to physiological health problems. One of the most important allostatic systems is the autonomous nervous system (ANS), which regulates bodily functions such as the heartbeat and digestion by means of its two branches the sympathetic and parasympathetic nervous system (Vahle-Hinz, Bamberg, Dettmers, Friedrich, & Keller, 2014). Sympathetic activity occurs in response to stress by immediate secretion of catecholamines (e.g. adrenaline and noradrenaline) which results i.a. in an acceleration of the heart rate (Geurts & Sonnentag, 2006). Parasympathetic stimulation, in contrast, comes into play when the stressor has lessened. It aims to recuperate from the strains of the sympathetic arousal by releasing acetylcholine via the vagus nerve and therefore decreasing the heart rate (Geitel, 2016; Shaffer & Venner, 2013). The body strive for a state of homeostasis, meaning that the organism aims to hold all parameters constant (Sterling & Eyer, 1988). In order to maintain this internal stability, the organism must change parameters and match them according to environmental demands (Sterling & Eyer, 1988). This stability-through-change process is referred to as allostasis (Sterling & Eyer, 1988). According to the allostatic load model the body reacts to stress with an allostatic response, such as increased heart rate (HR) and decreased HRV (Vahle-Hinz et al., 2014). This reaction to stress is only adaptive for a short period of time (McEwen, 2000). When the body is incapable to shut off the allostatic response, even when the stressors has already ceased, allostatic responses accumulate and eventually lead to “allostatic load” (McEwen, 1998). Thus, the core assumption of the allostatic load theory is that chronic activation of an initially adaptive allostatic reaction will results in maladaptive allostatic load in the long term (McEwen, 1998). This maladaptive physiological reaction to stress, indicated by the shift of the autonomic balance towards sympathetic overactivity and parasympathetic withdrawal, is suggested to be one of the reason for the detrimental effects that workplace stressors have on cardiovascular disease (CVD) risk, increased morbidity and all-cause mortality (Thayer et al., 2010).

2.2.2 Heart rate variability. The most common way to assess autonomic imbalance is through analyzing the fluctuation of the RR-intervals between successive heartbeats, also known as the heart rate variability (Kim, Cheon, Bai, Lee, & Koo, 2018; Tarvainen, Niskanen, Lipponen, Ranta-aho, & Karjalainen, 2014; Thayer et al., 2010). A high variability in heart rate is an indication of good adaptability of the autonomic nervous system, which is accompanied by a dominance of parasympathetic modulation occurring during rest and recovery (Pumprla, Howorka, Groves, Chester, & Nolan, 2002). Lower variability, however, displays a sign of insufficient adaptability (Pumprla et al., 2002). Consecutive heartbeats are more synchronous with increasing strain, due to a dominant sympathetic modulation, which is displayed in a reduced HRV (Geitel, 2016; Tarvainen, Lipponen, Niskanen, & Ranta-aho, 2019). Change in HRV pattern towards a reduction of the variability provide an early and sensitive biomarker for several impaired health outcomes in initially healthy individuals, such as cardiovascular disease, systemic inflammation, diabetes, high cholesterol, and renal dysfunction (Brotman et al., 2010; Hillebrand et al., 2013; Jarczok, Koenig, Mauss, Fischer, & Thayer, 2014; Jarczok, Li, Mauss, Fischer, & Thayer, 2013; Thayer et al., 2010).

HRV data can be derived from a non-invasive electrocardiography (ECG) which detects the sharp upward R-spike of the QRS-complex (Laborde, Mosley, & Thayer, 2017). The QRS-complex is composed of an initial downward deflection (Q), followed by a sharp upward deflection due to depolarized cardiac ventricles (R), and a final downward deflection (S; Shaffer & Combatalade, 2013). Depending on what is aimed to be observed, different lengths of ECG can be recorded. Circadian rhythms, core body temperature and metabolism primarily impact the 24-hour HRV recordings (Shaffer & Venner, 2013). Short-term ECG recordings (e.g. 5-minutes) are preferably used to assess sympathetic and parasympathetic modulation of the heart rate (Koskinen, 2009; Shaffer & Ginsberg, 2017), which is the reason for relying on short-term recordings in the present study.

Daily stress can have lasting effects on sleep which can be reflected in nocturnal HRV (Hall et al., 2004). Especially reliving stressful work experiences at home is proposed to prolong the arousal of the autonomic nervous system, which could be one possible pathway whereby stress effects sleep (Brosschot, Pieper, & Thayer, 2005). Sleep comprises two main reoccurring sleeping stages: REM-sleep

and non-REM (Chouchou & Desseilles, 2014). The first cycle of sleep begins with non-REM (initial stage 1) and progresses with deeper non-REM stages (stages 2-4) and goes back to the emergent stage 1, where the first REM episode occurs (Pinel & Barnes, 2018). During the rest of the night non-REM and REM sleep will alternate with a period of approximately 90 minutes (Carskadon & Dement, 2011). Generally speaking, non-REM sleep is characterized by parasympathetic activity, whereas sympathetic activity dominates during REM sleep (Bonnet & Arand, 1997). However, acute stress was shown to lead to decreased levels of parasympathetic arousal during non-REM and REM sleep and increased levels of sympathetic modulation during non-REM sleep (Hall et al., 2004).

2.2.3 Current research on stressor-HRV linkage. During the last three decades, several studies have been focusing on investigating the relationship between work stress and autonomic imbalance assessed by HRV data (Brosschot, van Dijk, & Thayer, 2003; Castaldo et al., 2015; Hjortskov et al., 2004). Although findings do not display a fully consistent picture, the majority of the studies confirm, that HRV reduces in response to work stress (e.g. Borchini et al., 2015; Chandola et al., 2008).

Findings from a diary study suggest that HRV is lower during the night, when participants experienced a high compared to low number of daily stressors on the previous day (Brosschot, van Dijk, & Thayer, 2003). Furthermore, high job demands and low decision latitude were found to be related to lower HRV (SDNN; HF) during the day among participants of the Whitehall II study (Chandola et al., 2008). However, a similar study by Kang et al. (2004) could only support an association of job demands and decision latitude with time-domain measurements of HRV, but not with frequency-domain measurements. Moreover, prolonged job strain including high job demands, low decision latitude and an effort-reward imbalance were associated with time-domain HRV decline (SDNN) among cardiovascular-susceptible nurses on working and on resting days (Borchini et al., 2015). As reported in a systematic review, induced stress situations by means of arithmetic tasks and public speech tasks (Castaldo et al., 2015), as well as computer work (Hjortskov et al., 2004) were consistently associated with decreased values of HRV in a laboratory setting.

Contradictory to the above mentioned studies, other researcher found no

association between job stressor assessed as job demands and decision latitude (Riese, van Doornen, Houtman, & De Geus, 2004), or assessed as work-related overload (Vahle-Hinz, et al., 2014) on the one hand and time-domain HRV assessed during sleep (RMSSD) among healthy subjects on the other hand. It is reasonable to assume that the inconsistent findings are partly caused by different operationalization of work stress on the one hand and different HRV indices, as well as different HRV conditions (sleep vs. day time and short-term vs. long-term recordings).

2.2.4 Current research on work conflict and HRV link. Regarding the very specific relation between conflict at work and HRV, which is going to be the focus of the present study, previous research results are scarce. In a study among healthy male factory worker, stressors such as work pace and difficult professional relations with superiors, colleagues or subordinates were associated with lower HRV (pNN50; HF) on working days (Clays et al., 2011). Another study by Low and McCraty (2018) found that relational tension at work was significantly associated with HRV assessed with means of the percentage of normalized coherence.

Considering the overall state of research, it should be noted that although the majority of the findings are indicative of a stressor-strain link, moderately strong correlations between the conflict-strain link (Spector and Jex, 1998) and inconsistent evidence for the stressor-HRV link (Riese et al., 2004; Vahle-Hinz, et al., 2014) leave room for suggesting that the stressor-strain association might be mediated by a third variable.

2.3 The Role of Recovery

In order to understand the underlying mechanisms that link stress and strain, we need to take the importance of recovery into account. Recovery is a psychophysiological process, which plays an essential role in maintaining health and well-being, since repeated exposure to work stress accompanied by insufficient recovery may lead to impaired health (McEwen, 1998; Sonnentag et al., 2010a). Aim of recovery is the return of the allostatic system back to its initial pre-stressor levels after the stressor has ceased (Geurts & Sonnentag, 2006; Koss, & Gunnar, 2018). Recovery can be distinguished into three separate processes: (1) Behavioral reactions such as engaging in recovery activities, (2) affective reactions like

increased positive affect and (3) cognitive processes like distancing from work-related thoughts (Geurts, 2014). Within the present study we will focus on the latter, since Sonnentag and Fritz (2007) claim that it's not the recovery activity (i.e. reading, taking a walk) itself, but more the underlying mechanisms behind the activity that contribute to recovering from job stress. Among those mechanisms psychological detachment is highlighted as an important recovery experience (Sonnentag & Fritz, 2014).

2.3.1 The recovery resource: Psychological detachment. The most commonly used definition describes psychological detachment as an “individual sense of being away from the work situation” (Etzion, Eden, & Lapidot, 1998, p.579), which includes leaving the workplace behind in a physical manner but more importantly also in mental terms (Sonnentag, Kuttler, & Fritz, 2010b). This mental disengagement from work during off-job time, which implies not engaging in work-related task at home as well as not thinking about job-related issues, is often referred to as “switching-off” (Sonnentag et al., 2010b). Hence, psychological detachment offers the opportunity to rebuild energetic resources which have been depleted during a stressful working day (Sonnentag et al., 2010a). The importance of detachment as a recovery strategy becomes most evident, when we take a look at those cases where employees failed to detach from work, as described in the following chapter.

2.3.2 The stressor-detachment model and the mediating role of detachment. The stressor-detachment model (SDM; Sonnentag & Fritz, 2015) proposes that the exposure to job stressors exacerbate the process of disengaging oneself mentally from work and this lack of detachment in turn directly impacts the development of strain reactions. Thus, impaired detachment as a mediator is seen as one mechanism that explains the link between stressors and strains (Sonnentag & Fritz, 2015). For a mediation to occur, it is necessary to proof that (1) the independent variable is associated with the mediator, in our case it means that stressors (especially conflicts at work) predict a lack of detachment and (2) that the mediator is associated with the dependent variable, meaning that being able to detach leads to an increase in HRV (Baron & Kenny, 1986).

Although social stressors, as predictors of poor detachment, have not been the

primary focus of research so far, the investigation of workplace conflicts is a promising research domain, as the following findings show. A recent meta-analysis of 12 studies confirmed that social stressors in general were significantly negatively correlated with detachment at work (Wendsche & Lohman-Haislah, 2017). More specifically, Sonnentag and colleagues (2013) found a significant negative correlation between relationship conflicts at work and psychological detachment. Furthermore, results from a longitudinal study provided additional evidence that day-level social conflicts with customers at work were significantly negatively related to psychological detachment from work during evening hours (Volmer, Binnewies, Sonnentag, & Niessen, 2012).

Regarding the association between detachment and HRV, theoretical assumptions and empirical evidence diverge. Recovery is seen as a combination of both physiological and psychological processes (Geurts, 2014; Ragsdale, Beehr, Grebner, & Han, 2011). The psychological part of the recovery process (i.e. recovery experiences like detachment) manifest itself on a physiological basis. Restful conditions mitigate sympathetic activity and reinforce parasympathetic activity resulting in rising HRV (Uusitalo et al., 2011). Not being able to detach from work can cause prolonged mental exposure to the stressor which implies that the physiological activation of the sympathetic system is prolonged although the stressor does not physically exist any longer (Geurts & Sonnentag, 2006; Sonnentag & Bayer, 2005).

Despite the profound theoretical considerations, a recent meta-analysis could not find a significant relationship between detachment and a compilation of physiological stress indicators (Wendsche & Lohmann-Haislah, 2017). According to the authors of the meta-analysis the non-significant results could be due to the assessment of diverging physiological stress indicators (HRV, blood pressure, cortisol), which might reflect different physiological subsystems (Wendsche & Lohmann-Haislah, 2017).

In line with the stressor-detachment model previous findings showed that detachment served as a partial and full mediator between job demands and outcomes of psychological well-being such as fatigue (Kinnunen, Feldt, Siltaloppi, & Sonnentag, 2011; Von Thiele Schwarz, 2011), need for recovery and emotional exhaustion (Sonnentag, et al., 2010), as well as perceived stress and life satisfaction

(Safstrom & Hartig, 2013). Another study could confirm that detachment mediated the relationship between coworker-reported workplace aggression and work-family conflict (Demsky, Ellis, & Fritz, 2014). With regards to the mediating role of detachment in predicting physiological outcomes, Pereira and Elfering (2014) have found that social stressors including conflicts with coworkers and supervisors and sleep quality during weekends were partially mediated by psychological detachment. Based on a review about the stressor-detachment-model, Sonnentag and colleagues (2010) concluded that it's not solely the exposure to the stressor itself that causes increased strain levels, but the inability to detach from work-related problems.

2.3.3 The perseverative cognition hypothesis and the moderating role of rumination. So far we can sum up, that based on the presented literature we assume that the negative impact of interpersonal work conflict on the parasympathetic activity is mediated by the inability to detach from work during off-job time. The question remains, what causes impaired recovery, respectively what makes it so difficult to detach when we experience stress at work? Perseverative cognitions (e.g. worry, rumination) is one mechanism that is discussed to play an important role in the prolongation of stress reactions and thus impairment of recovery (Geurts & Sonnentag, 2006; Meier, Gross, Spector, & Semmer, 2014). In line with the allostatic load model (McEwen, 1998), short-term decline in HRV is an adaptive allostatic response to stress, however, it develops into a physiological problem when the autonomic imbalance is prolonged over time, as it is the case in perseverative cognitions (Ottaviani, Thayer, Lonigro, Medea, Couyoumdijan, & Brosschot, 2016).

Rumination is considered a "mode of responding to distress that involves repetitively and passively focusing on symptoms of distress and on the possible causes and consequences of these symptoms" (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008, p. 400). In everyday language, it is often used interchangeably with worry. However, ruminative thoughts are primarily directed towards past events, whereas the term *worry* refers to anticipative thoughts about the future (Nolen-Hoeksema et al., 2008; Watkins, Moulds, & Mackintosh, 2005). Furthermore, moderate correlations between rumination and psychological detachment indicate that there is an overlap between the two terms, however rumination can rather be seen as one extreme form of poor psychological detachment, than as interchangeable concepts (Donahue et al., 2012; Flaxman, Ménard, Bond, & Kinman,

2012; Sonnentag & Bayer, 2005). It is assumed that stress leads to prolonged physiological activation when people have ruminative thoughts about the stressor (Brosschot et al., 2005). Interpersonal conflict at work is likely to induce rumination, because employees are prone to think about conflicts at work and they might even anticipate how they will handle the conflict on the following working day (Girardi et al., 2015). Moreover, rumination is particularly likely to occur, when the event threatens fundamental goals, like the sense for belonging (Meier et al., 2014), as it is the case with interpersonal conflicts. Hence, especially pondering about work conflicts at home might develop into perseverative cognitions (Brosschot et al., 2006; Sonnentag et al., 2013), which eventually leads to prolonged stress reactions.

According to the perseverative cognition hypothesis, recovery can't occur when the mind is still occupied with thinking about the stressor (Brosschot et al., 2006). This extended cognitive representation of the stressor during after work time is the reason for the prolonged predominance of the sympathetic system, which manifest itself in a lowered HRV (Brosschot et al., 2006; Kang et al., 2004). Results from a recent meta-analysis of experimental studies showed that perseverative cognition were significantly associated with decreased HRV (Ottaviani et al., 2016). With regard to recovery it is of special interest to investigate stress-related changes of HRV during the night, since sleep displays an important recuperative period, where psychological and somatic restoration occurs (Brosschot, van Dijk, & Thayer, 2007). It is likely to assume, that cognitive perseveration occurs even unconsciously during the night (Brosschot, 2010). Supposing cognitive perseveration is prolonged during the evening and during sleep, the mind is continuously physiologically activated by stress, which could lead to deficient nocturnal recovery of physiological arousal (Pieper & Brosschot, 2005). In turn, lack of natural restorative break during sleep can have a major impact on health (Pieper & Brosschot, 2005).

Based on the theoretical assumption, that unwinding from stress is impaired in case the stressful experience is relived through rumination during off-job time (Vahle-Hinz, et al., 2014), it is presumed that rumination intensifies distress (Košir, Tement, Licardo, & Habe, 2015). Thus, in the present study it is postulated that on days when people reported intense rumination use, interpersonal work conflict will more strongly lead to the inability to detach during evening time. Further, it is plausible to assume that the strength of the hypothesized mediation of detachment is conditional on the

degree of rumination, in case the moderation hypothesis receives support. Thus, demonstrating a pattern of moderated mediation as illustrated in Figure 1.

2.4 Hypothesis

The following research hypotheses were developed based on the theoretical argumentation:

- H1: Daily interpersonal conflict at work will be negatively related to daily parasympathetic HRV during sleep (H1a: RMSSD) and positively related to daily sympathetic HRV during sleep (H1b: LF/HF-ratio)*
- H2: Daily interpersonal conflict at work will be negatively related to daily psychological detachment.*
- H3: Daily psychological detachment will be positively related with daily parasympathetic HRV during sleep (H3a: RMSSD) and negatively related to daily sympathetic HRV during sleep (H3b: LF/HF-ratio)*
- H4: Daily psychological detachment mediates the relationship between daily interpersonal conflict at work and daily parasympathetic HRV during sleep (H4a: RMSSD) and daily sympathetic HRV during sleep (H4b: LF/HF-ratio).*
- H5: Daily rumination moderates the relationship between daily interpersonal conflict at work and daily psychological detachment, such that the negative relationship between daily interpersonal conflict at work and daily psychological detachment will be weaker for individuals with low daily rumination and stronger for individuals with high daily rumination.*
- H6: Daily rumination will moderate the strength of the mediated relationship between daily interpersonal conflict at work and daily parasympathetic/sympathetic HRV during sleep (H6a: RMSSD; H6b: LF/HF) via daily psychological detachment, such that the mediated relationship will be stronger under high daily rumination than under low daily rumination.*

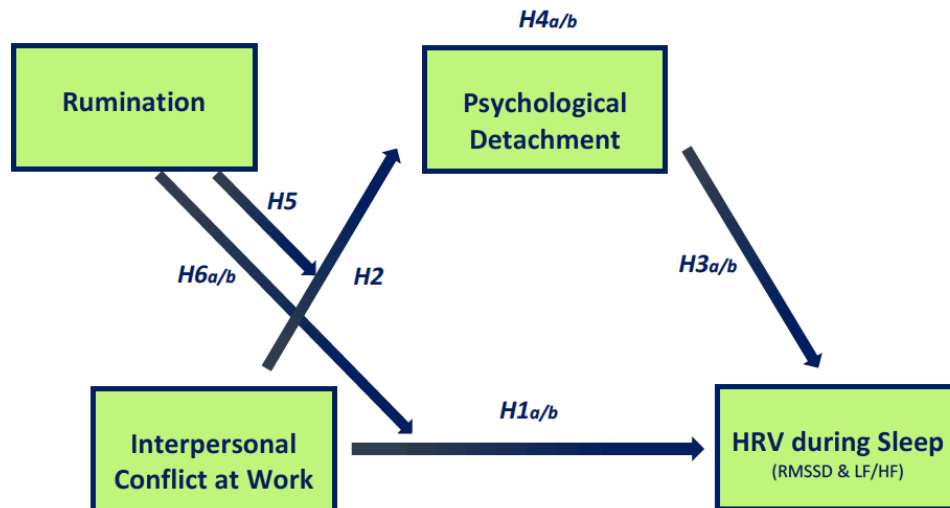


Figure 1. Graphical Illustration of the Hypotheses in a Moderated Mediation Model.

3 Methods

3.1 Sample and Procedure

Target group of the study were nurses from Lower Austrian nursing homes. Data was collected in 11 assessment units throughout the period from January 2018 until September 2018. Participation in the study was completely voluntary. Researchers and research assistants visited each nursing home to assess the general measurement and instruct the participants on the procedure of the diary study and how to use the ECG devices. All scales of the diary study and the general measurement were delivered in paper-pencil format. Demographic characteristics were computed by means of the statistical software SPSS. The sample consisted of a total amount of 75 participants, of which 82.6% were female and 17.4% were male nurses. Mean age of the employees was 41 years ($SD = 10.97$), with a range from 22 to 57 years. On average participants have been employed by the institution since 10 years ($SD = 8.70$). Mean working hours per week including extra hours were 40 among the participants ($SD = 5.51$). A total of 44.8% of the participants reported to have management responsibilities.

The study consisted of two major parts: A general measurement before the diary study and the actual diary study. Non-fluctuating variables like demographic information and control variables were included in the general measurement. The subsequent diary study lasted for five working days, including two daily measurements (after work and before bed) and the HRV assessment during sleep. The nurses were instructed to participate only on daily work shifts, but not on night shifts, thus data was not necessarily collected on consecutive working days. We assessed the independent variable work conflict after work and rumination and detachment before bed. The entire procedure of the study is illustrated in Figure 2.

Participants were excluded from the analysis in case more than two daily measurements from the questionnaire were missing and/or two HRV recordings lacked usable data. Following this rule, 29 participants had to be excluded from the data set ($n = 1$ due to missings from the daily questionnaire and $n = 28$ due to missings from HRV recordings), resulting in a total of 75 nurses who provided complete data sets.

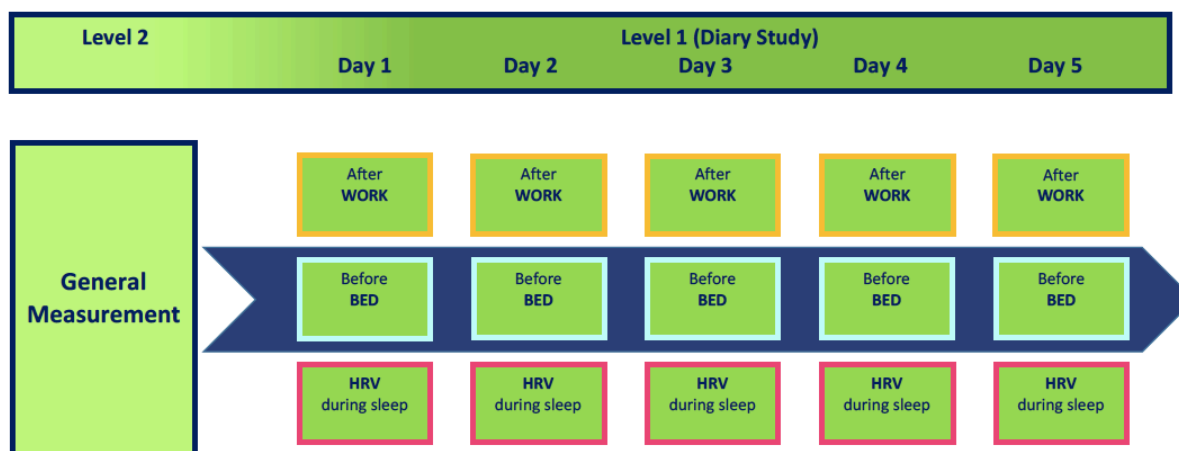


Figure 2. The procedure of the study including the general measurements and the diary study.

3.2 Measurements

3.2.1 Interpersonal conflict at work. Within the present study interpersonal conflict at work was measured with four items from the Interpersonal Conflict at Work Scale (ICAWS) by Spector & Jex (1998). Participants were asked to answer how often the following statements applied to their present working day. Items were scored on a 5-point Likert scale from 1 (*very rarely/never*) to 5 (*very often – several*

times an hour). A sample item from the ICAWS is “How often do you get into arguments with others at work?”. The consistency coefficient Cronbach’s Alpha is .64 for the within reliability and .77 for the between reliability. As demonstrated by a confirmatory factor analysis (CFA), Item 4 (“*How often did someone do mean things to you at work today?*”) of the ICAWS scale had a rather low within factor loading of .40 (Hair, Black, Babin, & Anderson, 2014). However, the within reliability score did not change substantially after Item 4 was removed, which was the reason for retaining all 4 ICAWS items into the scale. Between factor loadings of ICAWS were all above the suggested cut-off of .40 (Hair et al., 2014), indicating that all items load on the latent factor conflict at work.

3.2.2 Psychological detachment. A 4-item scale by Sonnentag and Fritz (2007) was used to assess psychological detachment after work. The scale was adapted to the daily level context by adding “This evening (...)” prior to the original items. Participants were asked to answer how far the following statements apply to their present evening. Items were scored on a 5-point Likert scale from 1 (*does not apply at all*) to 5 (*fully applies*). A sample item from the psychological detachment scale is: “This evening, I distance myself from my work.”. CFA revealed that all within and between factor loadings were above the suggested cutoff of .40 (Hair et al., 2014), indicating that all items load on the latent factor psychological detachment. The consistency coefficient Cronbach’s Alpha is .90 for the within reliability and .99 for the between reliability.

3.2.3 Rumination. The subscale negative rumination of the Negative and Positive Work Rumination Scale (NAPWRS; Frone, 2015) was used to assess how much the participants ruminated about work-related matters after work. The scale was adapted to the daily level context by adding “today” to the original items. Respondents indicated their level of agreement to the question how far the following statements apply to their present evening on a 5-point likert scale ranging from 1 (*does not apply at all*) to 5 (*fully applies*). A sample item of the adapted version of the negative rumination subscale is: “Have you find yourself preoccupied with the negative aspects of your job even after you left work today?”. CFA revealed that all within and between factor loadings were above the suggested cutoff of .40 (Hair et al., 2014), indicating that all items load on the latent factor rumination. The

consistency coefficient Cronbach's Alpha is .88 for the within reliability and .99 for the between reliability.

3.2.4 Heart rate variability. Nocturnal HRV was obtained on the basis of electrocardiogram (ECG) recordings using the ECG device Faros eMotion 180 (Mega Electronics, Kuopio, Finland) with a sampling rate of 1000 Hz. Participants were instructed to activate the device once they go to sleep and deactivate it in the morning after waking up. The ECG signal was recorded using two electrodes that were placed below the clavicle on the right breast (electrode 1) and on the rip-cage of the lower left abdomen (electrode 2). HRV was computed from 5-min segments throughout the first 1,5 hours of sleep with the software Kubios (Version 3.1.0, Biosignal Analysis and Medical Imaging Group, University Kuopio, Finland). Initially, the raw ECG data was visually inspected for artefacts like missing, extra or misaligned beat detection or ectopic beats. In a second step the data was corrected by using a Kubios artefact correction algorithm, which corrected not more than 1 % of the beats. Ectopic beats were either replaced by interpolated values using a cubic spline interpolation (Threshold based correction) or by replacing corrupted RR-intervals with interpolated RR-values (Automatic correction) depending on the choice of correction. Measurements where ectopic beats remained in the data even after correcting for more than 1% of all beats were excluded from the analysis. A subject with less than three usable measurement points were entirely excluded from the analysis. HRV can be described using either time-domain (e.g. RMSSD), frequency-domain (e.g. LF/HF) or non-linear (e.g. Poincaré plot) measurements (Shaffer & Ginsberg, 2017). The present study measured HRV with means of two different indices: RMSSD (time-domain) and LF/HF ratio (frequency-domain). Successive R-spikes intervals were analyzed to compute the root mean square of successive RR-interval differences (RMSSD in ms), a time-domain HRV index, which has been proven to be a valid parameter of cardiac parasympathetic predominance (Thayer & Lane, 2007; Vahle-Hinz et al., 2014). RMSSD was used due to the fact that it is less affected by breathing (Hill & Siebenbrock, 2009; Penttilä et al., 2001) and suitable for measurements of short-term variability (Tarvainen et al., 2014). LF/HF displays the ratio between low frequency and high frequency power bands, reflecting sympathetic arousal (Godfrey et al., 2019). Several studies reported an increase of LF/HF ratio with increasing stress (Castaldo et al., 2015; Kim et al., 2018).

3.2.5 Control variables. Variables which potentially have an impact on HRV are controlled for in the study. In sum, age, gender, alcohol, coffee and nicotine consumption, sportive activity and general medication use as well as sleep medication use were included to the model as suggested by Laborde and colleagues (2017), primarily to examine their association with HRV and to control for possible confounding effects. Age was assessed as a continuous variable and gender as a dichotomous variable (0 = *male*; 1 = *female*). All further control variables were assessed on each day of the diary study right before going to bed. Nicotine, alcohol and caffeine-containing drinks were assessed as continuous variables, whereas sportive activity (min. 20-30 minutes), medication use and sleep medication use were assessed as dichotomous variables (0 = *no*; 1 = *yes*).

3.3 Data Analysis

With means of hierarchical linear modeling (HLM) we can take the two different levels into account, that emerge from collecting data in a diary study. Level 1 data includes the daily repeated measures of conflict at work, rumination, detachment and HRV, whereas level 2 data constitutes the individuals. Thus, individual measurements on each day (level 1) are nested within the person (level 2). Using HLM is recommended in case of a hierarchical data structure, in order to prevent statistical problems like standard error bias due to a lack of independence among measurements (Geiser, 2012; Netzlek, 2001; Raudenbush, & Bryk, 2002).

Prior to the main analysis a null model was tested, which included the computation of the intra-class correlation (ICC) coefficient, to ensure that the variables entail substantial within-individual variance, which would justify the use of hierarchical linear modeling (HLM).

All analyses were conducted with the statistical software Mplus (Version 7.3), unless specified otherwise. We used Maximum Likelihood estimation with robust standard errors (MLR) to estimate the parameters, since MLR is robust to deviation from normality and non-independence of observations (Muthén & Muthén, 2012). Mplus allows to handle missing cases in the data with the Full Information Maximum Likelihood (FIML) algorithm, which directly estimates parameters based on the

available data instead of imputing missing values (Buhi, Goodson, & Neilands, 2008). Control variables were included in all analysis.

4 Results

4.1 Descriptive Statistics

Table 1 provides descriptive statistics (Mean, Standard Deviation, ICC) and intercorrelations among study variables. As can be derived from the table, conflict at work and rumination were not highly prevalent in the present sample, whereas on average participants had the tendency to detach from work. The mean of RMSSD lies within the normal range compared to reference values from 24 h ECG recordings by Jensen-Urstad et al. (1997) reporting on average 33 ms (women) and 35 ms (men) within the age range from 40 to 49 years. The mean of LF/HF in the present sample is slightly lower compared to the reference values for the group of 40-49 year-olds.

The ICC values for the outcome variables were .79 (RMSSD) and .65 (LF/HF). ICC values of all variables can be extracted from the diagonal of Table 1. The results show substantial variance both within and between persons for all HRV outcome measures, which indicates the need for a multilevel approach.

Hypotheses were tested in two interlinked steps. First, a simple multilevel mediation model (Hypothesis 1-4) was examined. Second, the proposed moderator was integrated into the model (Hypothesis 5) and additionally, the overall multilevel moderated mediation model was tested (Hypothesis 6).

Table 1

Means, Standard Deviations and Intercorrelations Among Study Variables

| Variable | M | SD | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|--------------------|-------|-------|---|-----|------------------|------------------|-------|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| 1 Gender | .83 | .38 | - | .10 | -.13 | -.11 | -.27 | -.15 | .21** | .09 [†] | .11 | -.07 | .16 | .02 | -.44* |
| 2 Age | 41 | 10.88 | - | - | -.23 | .07 | .36** | .00 | .12 | .14 | -.25 [†] | .05 | -.04 | -.54** | .38** |
| 3 Alcohol | .28 | .78 | - | - | (.18) | -.15 | -.02 | .21 | .00 | -.07 | .33* | .11 | .03 | .50* | -.01 |
| 4 Cigarette | 4.18 | 6.80 | - | - | .04 | (.95) | .38** | -.13 | -.15 [†] | .20 | -.04 | -.02 | -.01 | -.32** | .23 |
| 5 Coffee | 2.63 | 1.88 | - | - | .00 | .22 [†] | (.86) | .14 | -.18 [†] | .00 | -.16 | .03 | -.04 | -.23* | .51** |
| 6 Sport | .15 | .36 | - | - | .13 [†] | -.00 | -.01 | (.33) | .18 | -.15 [†] | -.29* | .11 | -.21 [†] | .09 | .06 |
| 7 Medication | .15 | .35 | - | - | -.04 | -.00 | .08 | -.05 | (.91) | .21 | .01 | -.23 [†] | .23 | -.11 | -.16 [†] |
| 8 Sleep Medication | .03 | .18 | - | - | -.00 | .08 | -.07 | -.00 | .00 | (.81) | -.04 | -.22 | .32 | -.21 [†] | .07 |
| 9 Conflict at work | 1.25 | .43 | - | - | -.02 | .01 | .04 | .13* | .01 | -.02 | (.48) | -.43** | .54** | .04 | .07 |
| 10 Detachment | 3.79 | 1.12 | - | - | .12 [†] | -.09 | -.09* | -.04 | -.05 | .05 | -.15** | (.67) | -.82** | .12 | .04 |
| 11 Rumination | 1.89 | 1.06 | - | - | -.03 | .14 | .11* | .07 | .10 | -.00 | .26** | -.32** | (.67) | -.08 | -.08 |
| 12 RMSSD | 34.36 | 24.09 | - | - | -.20* | .02 | .05 | -.15* | .20 | .01 | .03 | -.02 | .00 | (.79) | -.52** |
| 13 LF/HF ratio | 2.56 | 2.15 | - | - | .12 | -.01 | .06 | .08 | -.03 | .00 | .03 | .07 | -.05 | -.16** | (.65) |

Note. Estimator = Maximum Likelihood Robust. Gender (male = "0"; female = "1"). Sport (no = "0"; yes = "1"). Medication (no = "0"; yes = "1"). Sleep Medication (no = "0"; yes = "1"). RMSSD = square root of the mean squared differences between successive RR intervals, LF/HF = ratio between low frequency and high frequency band powers resting values. Correlations below the diagonal reflect the within-person associations of the constructs of the same day and correlations above the diagonal reflect the between-person associations of the aggregated daily measures. Intra-class correlation (ICC) coefficients are shown within parentheses on the diagonal of the table.

[†] $p < .1$, * $p < .05$, ** $p < .01$, two-tailed.

4.2 Multilevel Mediation (H1-H4)

All results concerning hypothesis 1 to 4 are summarized in Figure 3 and can additionally be derived from Table 2 (see Appendix B1).

Regarding hypothesis H1_{a/b} (Step 1) results show that conflict at work did neither significantly predict RMSSD nor LF/HF on the within level.

Therefore, hypothesis 1_a and 1_b were not supported.

However, within-individual variance concerning conflict at work significantly negatively predicted psychological detachment while controlling for covariates. The effect size R^2 reveals 5% ($R^2 = .05^*$) of within-individual variance in detachment could be explained by conflict at work and the control variables. Thus, consistent with the expectations, Hypothesis 2 was supported.

For testing H3_{a/b} and H4_{a/b} the mediator psychological detachment was included into the model (Step 2). Results indicate that psychological detachment within-individuals had no significant predictive power in explaining variance in RMSSD and LF/HF. Thus, according to the findings, H3_a and H3_b could not be supported. Although a direct relationship between conflict at work and HRV could not be established, it is still recommended to base the mediational analysis on the significance test of the indirect effect (Cole, Walter, & Bruch, 2008; Rucker, Preacher, Tormala & Petty 2011) rather than the stepwise procedure by Baron and Kenny (1986).

However, results reveal that the indirect effect of psychological detachment was neither significant for RMSSD nor for LF/HF. The findings indicate, that detachment did not mediate the relationship between conflict and HRV, thus H4_a and H4_b could not be supported.

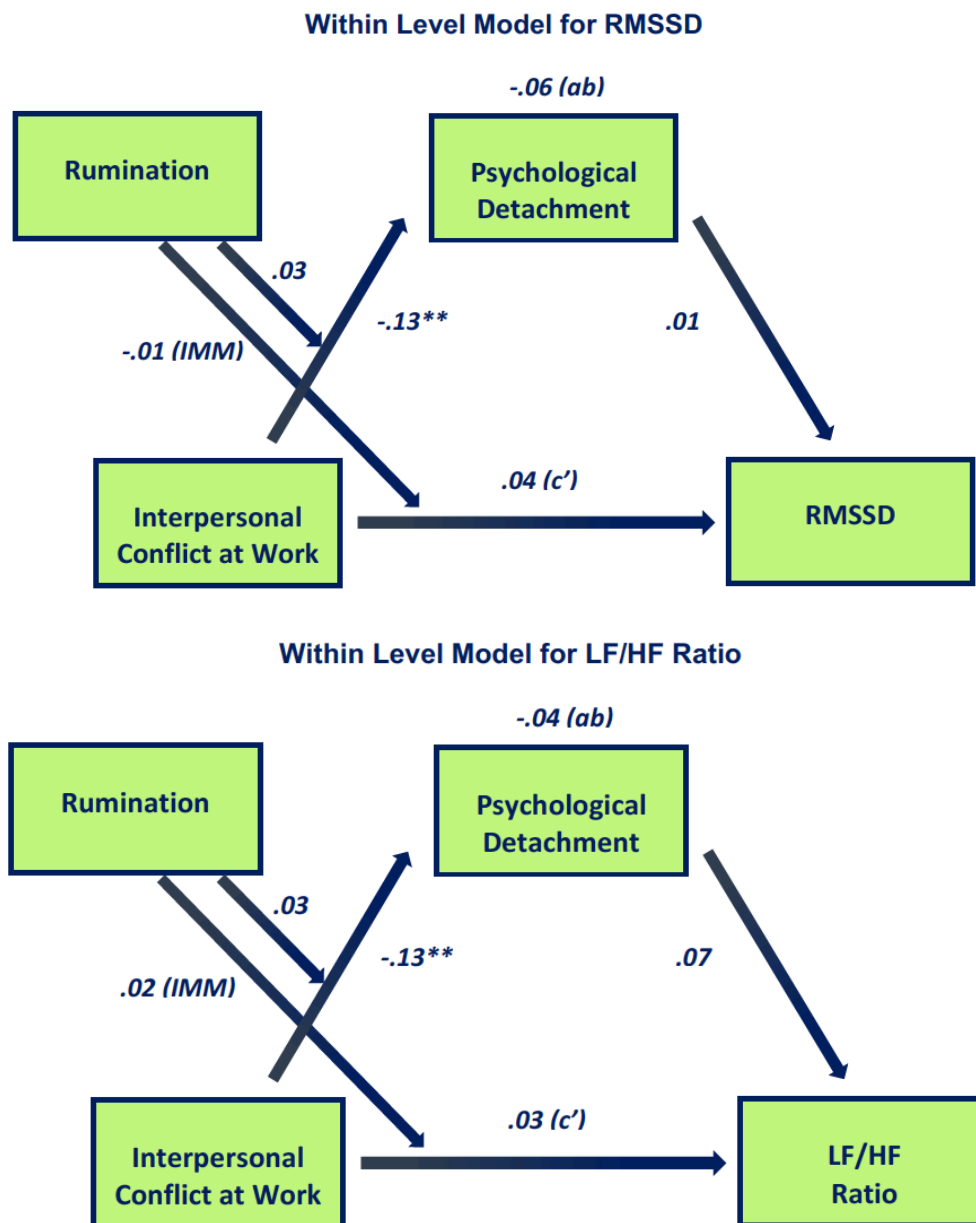


Figure 3. Graphical Illustration of Within-Level Results of RMSSD and LF/HF Ratio.

4.3 Multilevel Moderation (H5) and Moderated Mediation (H6)

For the purpose of testing the moderation (H5) and the moderated mediation (H6_{a/b}), L1 predictors (conflict at work, rumination and detachment) were centered at the respective person mean (group-mean centering) in order to avoid multicollinearity with their product terms (Aiken & West, 1991). Centering is therefore highly recommended prior to the computation of interaction terms (Dawson, 2014). After centering, all between-person variance has been removed, thus interpretation of the results regarding stable differences between persons can be ruled out (Illies,

Schwind, & Heller, 2007; Lischetzke, 2014; Van de Pol & Wright, 2009). Instead coefficients for conflict at work represent the effect of a person having many or few conflicts in relation to their own mean across days (Meier et al., 2014).

All results concerning the moderation and the pre-conditions for the moderated mediation are presented in Table 3 and can be viewed in Figure 3.

Model 1 reveals that no significant interaction between conflict at work and rumination could be found in predicting psychological detachment. Thus, H5 was not supported.

In order to establish a moderated mediation four conditions are necessary according to Preacher, Rucker and Hayes (2007): (1) Significant effects of the predictor (conflict at work) on the outcome (HRV measures), (2) significant interactions between the predictor (conflict at work) and the moderator (rumination) in predicting the mediator (psychological detachment) and significant interaction between the moderator (rumination) and the mediator (psychological detachment) in predicting the outcome (HRV measures); (3) significant effect of the mediator (psychological detachment) on the outcome (HRV measures); (4) different conditional indirect effects of the predictor (conflict at work) on the outcome (HRV measures), via the mediator (psychological detachment), across low and high levels of the moderator (rumination).

As presented in Table 3 (Model 2) conflict at work was not significantly related to either RMSSD nor LF/HF, hence, the findings do not support condition 1 for moderated mediation.

In order to proof the second condition, it was first examined whether the interaction for conflict at work and rumination was significant in predicting psychological detachment. As results of H5 indicate, this was not the case.

Next, it was examined whether the interaction term for rumination and psychological detachment was significant in predicting RMSSD and LF/HF. Results presented in Table 3 (Model 2) show that rumination did not interact with psychological detachment in predicting RMSSD and LF/HF. Therefore, the second condition could not be supported.

Model 2 also reveals that the mediator detachment was not significantly related to either RMSSD nor to LF/HF, showing no support for the fourth condition.

As pre-analysis of the conditions for moderated mediation already indicate, it is not expected to find conditional indirect effects in the present sample. As displayed

in Table 4 (see Appendix B2), possible conditional indirect effects were examined at three values of rumination: The centered mean (0), 1 SD above the mean (1.06) and 1 SD below the mean (-1.06). Across levels of rumination there was no significant conditional indirect effect found for both RMSSD and LF/HF. These findings are also supported by the non-significant results of the index of moderated mediation (IMM).

Table 3

Multilevel Regression Results for Testing Moderation for Psychological Detachment and HRV Measurements.

| Variable and statistic | Model 1 | | Model 2 | | LF/HF |
|-------------------------------|--------------------------|-------------------------|--------------------------|-------------------------|----------------------|
| | Detachment | | RMSSD | | |
| | β_{between} | β_{within} | β_{between} | β_{within} | |
| Age | .14 | | -.43** | | .37** |
| Sex | -.01 | | .13 | | -.40** |
| Alcohol | .12 | .12** | .36 [†] | -.18 [†] | .05 .10 |
| Cigarette | .02 | -.05 | -.23* | .02 | .05 -.02 |
| Coffee | -.09 | -.04 | .04 | .03 | .23 [†] .07 |
| Sport | .10 | -.02 | .02 | -.12 [†] | -.00 .06 |
| Medication | -.24* | -.02 | -.10 | .19 | -.09 -.03 |
| Sleep Medication | -.17 | .05* | -.07 | .01 | .07 .01 |
| Conflict at Work | | -.06 [†] | | .04 | |
| Rumination | | -.27** | | | |
| Conflict at Work × Rumination | | .03 | | | |
| Detachment | | | | -.00 | .05 |
| Detachment × Rumination | | | | .05 | -.03 |
| R ² | .11 | .11** | .51** | .10 [†] | .47** .03 |

Note. Estimator = Maximum Likelihood Robust. β = standardized regression coefficient. p = unstandardized. RMSSD = square root of the mean squared differences between successive RR intervals, LF/HF = ratio between low frequency and high frequency band powers. Model 1 = interaction of conflict at work and rumination in predicting psychological detachment (H5). Model 2 = pre-conditions for testing moderated mediation (H6).

[†] $p < .1$, * $p < .05$, ** $p < .001$, two-tailed.

5 Discussion

The focus of the present study was to examine two major hypotheses as part of a 5-day diary study within a sample of Austrian nurses. On the one hand, the study investigated the role of psychological detachment in mediating the relationship between interpersonal conflict at work and nocturnal HRV (H4a/b). On the other hand, it was tested whether rumination moderates the expected mediation by prolonging the cognitive representation of the stressor (H6a/b).

In order to confirm these main assumptions, several specific hypotheses were proposed, which lead to the main hypotheses.

Results of the first hypotheses have shown that on days of higher interpersonal work conflict, HRV recordings did neither reveal an underactivity of the parasympathetic system (RMSSD) nor an overactivity of the sympathetic system (LF/HF). Thus, both H1a and H1b could not be supported, since it was hypothesized that daily work conflict will be negatively associated with nocturnal RMSSD (H1a) and positively associated with nocturnal LF/HF (H1b).

Results of the second hypothesis are in line with the stressor-detachment model (Sonnentag & Fritz, 2015), which i.a. proposes that work stress hampers the ability to mentally detach from work. It was shown that on days with high conflict at work nurses found it significantly more difficult to mentally switch off from work, which supports H2. Thus, the present findings are consistent with research by Wendsche and Lohman-Haislah (2017), as well as Sonnentag and colleagues (2013).

Contrary to the prediction of the third hypotheses (H3a/b) it was not found that on days where participants were better able to psychologically detach they also revealed higher HRV scores. Thus, both H3a and H3b could not be supported within our sample.

The stressor-detachment model (Sonnentag & Fritz, 2015) states that work stress disables mental detachment, which in turn leads to impaired health. Furthermore, the allostatic load model proposes that allostatic load emerges when the body is incapable to shut off the allostatic stress response. Based on the theoretical foundation of the stressor-detachment model (Sonnentag & Fritz, 2015) and the allostatic load model (McEwen, 1998) we proposed the main mediation assumption, hypothesizing that daily detachment mediates the relationship between daily work conflict and day-to-day nocturnal parasympathetic HRV (H4a) and

sympathetic HRV (H4b). However, results of our sample of Austrian nurses do not support the hypotheses and therefore neither of the theoretical models.

The perseverative cognition hypothesis presumes that the presence of perseverative cognition, such as rumination, contributes to ill health by prolonging the duration of the stressor and therefore persevering physiological activation beyond the general reactivity period of the stressor (Brosschot et al., 2006). The allostatic load model describes this state as “allostatic load” (McEwen, 1998). On the basis of these theoretical assumptions we constructed two hypotheses. The fifth hypothesis, proposing that daily rumination amplifies the expected negative association between daily conflicts and detachment, could not be supported. The major moderated mediation hypotheses, proposing that daily rumination will moderate the strength of the mediated relationship between daily work conflict and day-to-day nocturnal parasympathetic HRV (H6a) and sympathetic HRV (H6b) via psychological detachment, could likewise not be supported by the data. We were unable to show, that daily rumination reinforces the association of conflict on both HRV indices via detachment.

Taken together, this particular study does not lend support to the presumption that repeatedly thinking about stressful conflicts in the past leads to physiological stress responses in terms of reduced HRV.

The non-significant findings regarding our two main hypotheses might be due to several reasons, which are being discussed in further detail:

(1) In contrast to what the stressor detachment model states, it is also possible to argue that the inability to detach is not as detrimental to physiological health as supposed in the literature. Previous research revealed that conflict was especially related to psychological strain, when the interpersonal conflict was managed in a passive way through avoiding (Dijkstra, De Dreu, Evers, & Van Dierendonck, 2009). Thus, we could argue that discussing work problems with the spouse or a friend after work might be beneficial after all. In line with this it was shown that social support played a role in buffering negative effects of job stressors (Frese, 1999). Therefore, it could be of interest to further investigate the downsides of psychological detachment.

(2) A second reason why we could not find a mediation might be due to the fact, that we were not able to find a direct association between interpersonal conflict and HRV in the first place. There are ongoing methodological discussions about

whether it's legitimate to assume a mediation in case the direct path failed to be shown. Whereas the conventional approach claims that indirect effects can not exist without a significant direct path (Baron & Kenny, 1986), newer approaches consider this requirement as too restrictive (Rucker et al., 2011). Without verifying one or another approach, it should be kept in mind that it might have been a problem to find a mediation if there is no overall association to mediate. Nevertheless, based on the conclusive explanation of the SDM on the one hand and numerous empirical findings (Sonnentag & Fritz, 2015) on the other, it is likely to assume that detachment functions as a mediator, however presumably not in explaining variance in heart rate variability, as our results have shown.

(3) Heart rate variability might not be an ideal health indicator due to different reasons, which are being discussed in the following:

First of all, the present results speak against the theoretical considerations that perseverative cognitions work in an unconscious way at night as supposed by Brosschot and colleagues (2007). In line with our non-significant findings, most studies, which failed to show a stressor-HRV connection, recorded heart rate variability during the night (Riese et al., 2004; Uusitalo et al., 2011; Vahle-Hinz et al., 2014). This in turn could be either due to the actual non-existence of unconscious perseverative cognition at night or due to the use of an unsuitable operationalization of physiological stress response during the night. To understand the latter point of critic it is important to bear the natural sleep cycle in mind. Independent of stressful influences, the autonomic nervous system is subject to natural changes within each 90-min sleep cycle (Carskadon & Dement, 2011). In the beginning of the cycle parasympathetic arousal rises along with increasing length of deep sleep phases, which indicates an increase in heart rate variability (Tobaldini et al., 2013). Tobaldini and colleagues (2013) further explain, that with the decline of deep sleep phases towards the REM phase sympathetic arousal increases, which indicates a reduction in heart rate variability. Due to the fact that the sleep cycle changes over the course of the night, it is to be assumed that during the first hours of sleep parasympathetic arousal is predominant (Tobaldini et al., 2013). Whereas towards the end of the night, more frequently reoccurring REM phases lead to an increase in sympathetic modulation (Tobaldini et al., 2013). Keeping this natural sleep cycle in mind, it is of special importance to remark that the HRV measurement should be representative

for the entire night, to rule out the possibility of measuring a natural occurring predominance of either the parasympathetic or the sympathetic system.

Another reason which speaks against the use of HRV could be our female-dominated sample. Former research has shown that the relationship between job stressors and HRV is not as obvious in women compared to men (Riese et al., 2004; Ottaviani et al., 2016). This proposed sex difference regarding HRV changes is of special interest when we recall the high percentage of women who took part in the present study (82.6%). Although we included sex as a control variable, a balanced sample based on sex would be preferable as opposed to statistically controlling for it.

Third, HRV might only be a good health indicator in cardiovascular-susceptible participants or people who already have a history of cardiovascular diseases. According to Siegrist (2015) reduced vagal tone does not pose a threat to cardiovascular healthy people, this is however different in people who already have a damaged cardiovascular system. In this case reduced vagal tone was for example found to be a reliable predictor in post myocardial infarction (MI) risk stratification (Kleiger, Stein, & Bigger, 2005).

Part of the reason why we were unable to find support for the moderated mediation, could be the fact that the sixth hypothesis depends on the outcome of the preceding hypotheses. Since we could not show the mediating role of detachment in the first place, it was unlikely to show the moderated mediation.

5.1 Limitations

A number of study limitations have to be considered, which should be addressed in future research. At first we will discuss measurement-related limitations.

Regarding the measurement of HRV, it should be mentioned that there is still scientific debate about whether LF/HF ratio represents pure sympathetic activation as assumed by the majority of researcher (Task Force, 1996; Yagishita, et al., 2018; Uematsu & Fujimoto, 2019) or whether it's a composition of sympathetic and parasympathetic activation (Billman, 2013; Laborde et al., 2017).

A further measurement-related limitation is the rather low internal reliability for conflict at work on the within ($\alpha_{\text{within}} = .64$) as well as on the between level (α_{between}

= .77). Since we are examining within-individual processes, we are mostly interested in the within-level reliability, which indicates that on average the items of the ICAWS correlated weakly.

Participants in our sample reported averagely low levels of conflict and rumination, as well as high levels of detachment combined with rather low to medium standard deviations. This gives hint to the possibility of underlying floor and ceiling effects, which might have distorted the data. It is plausible to consider whether impression management could have had an influence on the data. Results from self-report surveys always rely on the honesty of each participant. Although it was made sure that participants were informed that anonymity was guaranteed, participants may fear that their answers will be traced back to the individual or somehow be forwarded to the CEO of the institution. This could especially be a problem in job-related research, when an entire institution is being observed, as it is presently the case.

In the following we will discuss limitations related to the design of the study:

First internal validity of the study is rather low. Due to the fact that we did not conduct the study in a laboratory setting, we can't rule out possible distraction that might have occurred during the participation (e.g. breaks, noises, etc.). Furthermore, since we used paper-pencil we can't be certain whether participants completed the questions at the requested times (after work, resp. before bed) and thus the temporal gap between the measurement points of the variables is not guaranteed.

Secondly, reduced statistical power due to a rather small sample size ($N = 75$) could have been responsible for non-significant or borderline significant findings.

Concerning statistical limitations, all independent variables rely on self-reported data, which gives rise to the question of whether common-method variance might exist among the predictor, mediator and moderator.

5.2 Research Implications

In order to measure the construct "interpersonal conflict at work" we used the ICAWS scale (Spector & Jex, 1998), which does not consider the underlying reason

for interpersonal conflict. Jehn (1995) further distinguishes interpersonal work conflict into relationship conflict (e.g. incompatibilities concerning personality differences) and task conflict (e.g. incompatibilities concerning the content of a task). Future research should particularly stress on relationship conflicts, since relationship conflicts produce more severe stress compared to task conflicts (De Dreu & Gelfand, 2008). This could be due to the fact, that relationship conflicts imply a greater threat to the personal identity, since interpersonal rejection contrasts with the fundamental need for belongingness (Baumeister & Leary, 1995; Meier et al., 2014). Additionally, the items should make a distinction between conflict among colleagues versus conflict among nurses and patients, to further clarify the source of the conflict. Future research could apply the relationship conflict subscale of Jehn's (1995) intragroup conflict scale, which yields adequate internal consistency ($\alpha = .92$).

Further investigations should also control for social desirability to rule out the possibility that participants were reluctant to give socially unacceptable answers, especially when dealing with sensitive material, such as admitting conflicts at work.

In addition, future research should rely on computer-based entries, to ensure that the diary entries are made within the designated time slots. It is important to guarantee a temporal gap of measurement points to prevent reverse causation.

In order to increase statistical power, the literature highly recommends to recruit at least 100 participants as suggested by Ohly and colleagues (2010). Thus, a larger sample size should be aimed at in future multilevel studies.

In order to increase the generalizability of the results, further studies should have a more diverse sample, which is balanced regarding gender and different occupational backgrounds. Of particular interest would be occupational groups facing high potential for conflict, especially when employees are working in teams and/or are dependent on each other's work.

In future studies psychological detachment could additionally be assessed by means of spouse-ratings, since collecting data from multiple sources is recommended in reducing common method bias (Lai, Li, & Leung, 2013).

Due to the already mentioned possible occurrence of natural circadian HRV patterns, reflected by lower HRV indices during the day and higher HRV values during the night time (Guo & Stein, 2003; Thayer & Lane, 2007), it would be interesting to assess the effect of stress on long-term HRV (24h) in order to control for the circadian rhythm in future research.

With regards to the high proportion of female nurses within the study, further studies could add participants' menstrual cycle as an additional confounding factor. HRV is known to be increased during the early follicular phase (Saeki, Atogami, Takahashi, & Yoshizawa, 1997). Therefore, Leicht, Hirning, & Allen (2003) suggest to assess HRV at a similar phase of the menstrual cycle in female participants.

Based on the non-significant findings regarding both HRV outcomes it is also suggested to replicate the design of the study with other physiological stress indicators in the future, such as immunosuppressive cortisol measurement (Kirschbaum, 2001). In addition to the objective physiological evaluation of stress it is also suggested to integrate subjective evaluations of psychological well-being such as the WHO-5 (WHO, 1998), to receive a complete picture of individuals physiological as well as psychological well-being.

5.3 Practical Implications

Present findings support the assumption that increased conflict at work impedes the ability to detach after work. Although the present data did not reveal that high levels of conflict and low detachment are associated with decreased levels of HRV, we have to bear in mind that the majority of previous research papers were able to show that impaired recovery in form of low psychological detachment impairs psychological well-being as well as physiological health (Sonnentag & Fritz, 2015; Sonnentag et al., 2013). Based on this literature, it can nevertheless be assumed that detachment plays an important role in the maintenance of health. In the following we will derive practical conclusion based on the present findings that increased conflict at work impedes the ability to detach after work.

In order to address the cause of low detachment, constructive dealing with work conflicts should be addressed on the micro as well as macro level of organizations. Therefore, it is suggested to promote effective conflict management strategies for employees, such as collaborating to find a solution that suits both parties (micro-level; Choi & Ha, 2018; Valentine, 1995). On the macro-level, it is recommended to increase the social capital of the organization, which includes fostering "mutual trust, shared values and standards, and a willingness to cooperate based on reciprocity" (Nitzsche, Kuntz, & Miedaner, 2017, p. 140). By creating a climate of trust

employees feel free to express disagreement without fearing that it will lead to relationship conflicts (Meier et al., 2013). Furthermore, promoting a collaborative conflict culture, in which conflicts are resolved in an open and constructive manner (e.g. active listening and mediation of opposing perspectives, honest and respectful discussion of the conflict) might be beneficial in dealing with conflicts on the broader organizational unit (Almost et al., 2016; Gelfand, Leslie, Keller, & de Dreu, 2012). This can be done by either providing space for team meetings, where team members get the chance to express disagreements, identify and resolve sources of hostility (Almost et al., 2016), or offering informal get-togethers (e.g., employee breakfast, communal gym courses), which promotes team spirit and offers an opportunity to talk about conflict in a rather informal atmosphere.

Since it is not always possible to avoid conflicts at work, especially when the conflict does not arise between colleagues, but between patients and nurses it is of additional importance to encourage employees to detach after work. Implementing interventions in organizations to enhance the ability to unwind from work could include the development of clear mental boundaries between work and non-work domains (Ashforth, Kreiner, & Fugate, 2000; Kinnunen et al., 2016). This for instance can be realized in developing specific routines which draw a clear line between work and home, such as using the commuting time to emotionally unwind from the workday or actively engaging in activities that differ from the work domain to not trigger contextual cues that lead to ruminative thoughts about work (Sonnentag & Fritz, 2015). Moreover, organizations should be encouraged to offer stress management programs to detach after work, such as relaxation and cognitive behavioral techniques (Wendsche & Lohman-Haislah, 2017).

5.4 Conclusion

The key purpose of the study was to examine the role of detachment in mediating the stressor-strain relationship as well as investigating which role perseverative cognition plays in the process of recovery.

Until now, research has rarely focused on the specific impact of workplace conflict on heart rate variability, as well as on the mediating role of detachment in influencing physiological health outcomes.

A distinct feature of the present longitudinal study is the use of multi-level data, which allows to interpret intra-individual variance within the observed variables. Due to the fact, that predictor and outcome variables were assessed at different time points during the course of the day, we can rule out the possibility of reverse causation among the study variables (Vahle-Hinz et al., 2014), which enables us to make causal inferences about the direction of the relationship (Harris et al., 2003). A further strengths of the present study is the use of different methods to assess the independent and dependent variable. The use of self-reported data and physiological measurements (HRV) reduces the possibility of common-method variance.

Given the results of this study, it appears that on days with higher work conflict nurses were less likely to engage in psychological detachment after work. Other than that, statistical analysis revealed that firstly, work conflict as well as psychological detachment had no impact on day-to-day heart rate variability during sleep. Secondly, neither did the inability to detach from work prolong the impact of work conflict on HRV, nor did ruminative thoughts about work reinforce this proposed mediation. Thus, in this specific sample of Austrian nurses we were not able to find support for the prolonged physiological activation of stress in form of HRV decline due to a lack of recovery.

Future work stress research should continue to investigate the role of detachment with regards to further physiological health parameters. Apart from that, results confirm the assumption that work stress in form of conflict impairs psychological recovery after work. Based on the above mentioned significant findings it is recommended to promote collaborative conflict management within organizations, as well as to encourage employees to engage in techniques that enable the individual to mentally switch off from work.

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List of Abbreviations

| | |
|----------|---|
| α | Cronbach's Alpha (reliability coefficient) |
| ANS | Autonomic Nervous System |
| ALM | Allostatic Load Model |
| β | Beta (standardized regression coefficient) |
| CEO | Chief executive officer |
| CFA | Confirmatory Factor Analysis |
| CHD | Coronary heart disease |
| CVD | Cardiovascular disease |
| doi | Digital object identifier |
| ECG | Electrocardiography |
| ed. | Edition |
| Ed./Eds. | Editor/Editors |
| e.g. | Exempli gratia (for example) |
| et al. | Et alii or et aliae (and others) |
| FIML | Full-Information Maximum Likelihood |
| H | Hypothesis |
| HF | Power in high frequency range |
| HLM | Hierarchical Linear Modeling |
| HR | Heart Rate |
| HRV | Heart Rate Variability |
| Hz | Hertz |
| i.a. | Inter alia (among other things) |
| ICAWS | Interpersonal Conflict at Work Scale |
| ICC | Intra-class correlation |
| IMM | Index Moderated Mediation |
| LF | Power in low frequency range |
| LF/HF | Ratio of low frequency power and high frequency power |
| M | Mean |
| MI | Myocardial infarction |

| | |
|----------------|--|
| MLR | Maximum Likelihood Estimator with Robust Standard Errors |
| ms | Miliseconds |
| N | Sample size |
| NAPWRS | Negative and Positive Work Rumination Scale |
| NÖ | Niederösterreich (Lower Austria) |
| p | p-value (unstandardized level of significance) |
| p. | Page |
| PCH | Perseverative Cognition Hypothesis |
| pNN50 | Percentage of intervals over 50 ms different from preceding interval |
| pp. | Pages |
| Q | Initial downward deflection (ECG) |
| QRS | Electrocardiographic complex of Q, R and S waves |
| R ² | Determination Coefficient |
| R | Upward deflection (ECG) |
| resp. | Respectively |
| REM | Rapid Eye Movement |
| RR | Interval of two successive R-peaks |
| RMSSD | Square root of the mean of the squares of successive NN interval differences |
| S | Final downward deflection (ECG) |
| SD | Standard deviation |
| SDM | Stressor-Detachment-Model |
| SDNN | Standard deviation of all normal to normal RR intervals |
| SPSS | Statistical Package for the Social Sciences |
| vs. | Versus |
| WHO | World Health Organization |

Appendix A: Abstract

Appendix A1: Abstract (English Version)

Background: Heart rate variability (HRV) displays an indicator of autonomic nervous system (ANS) deregulation, which is considered a pathway that links occupational stress and the risk for cardiovascular disease. In face of rising job stressors, interpersonal work conflict is known to be a leading source of occupational stress within the healthcare system and especially among nurses. Aim of the study was to examine the role of recovery in the stressor-strain relationship. *Hypotheses:* It was hypothesized that the negative impact of interpersonal conflict at work on heart rate variability (HRV) during the night is mediated by the inability to detach from work during off-job time. Additionally, it was proposed that ruminative thoughts would amplify the expected mediation by prolonging the cognitive representation of the stressor. *Method:* Data was collected by means of a general questionnaire, a 5-day diary study including 2 points of measurement each day and a nocturnal assessment of HRV (RMSSD and LF/HF). The final sample consisted of $N = 75$ nurses from Lower Austria. Multilevel analysis was utilized to test the hypotheses. *Results:* Work conflict was negatively related to psychological detachment. No significant mediation could be found between work conflict and both HRV measures (RMSSD and LF/HF) via psychological detachment. Rumination did not moderate the expected mediation. *Conclusion:* The present study could not find support for the prolonged physiological activation of stress in form of HRV decline due to a lack of recovery. For future research it is recommended to investigate the role of detachment with respect to other physiological health parameter.

Appendix A2: Abstract (German Version)

Hintergrund: Messungen der Herzratenvariabilität (HRV) stellen einen Indikator für die Funktion des autonomen Nervensystems dar, welches wiederum als Bindeglied zwischen beruflichen Stressoren und einem erhöhten Risiko für kardiovaskuläre Erkrankungen gesehen wird. In Angesicht steigender beruflicher Anforderungen, werden interpersonelle Konflikte bei der Arbeit als eine wichtige Quelle beruflichen Stresses, vor allem im Gesundheitssektor bei Pflegefachkräften, angesehen. Ziel der Studie war es die Rolle der Erholung in Bezug auf die Beziehung von Stressoren und physiologischen Erkrankungen zu untersuchen. *Hypothesen:* Es wurde angenommen, dass der negative Effekt von interpersonellen Arbeitskonflikten auf die nächtliche Herzratenvariabilität durch die Unfähigkeit des mental Abschaltens mediiert wird. Zudem wurde angenommen, dass ruminierende Gedanken die zu erwartende Mediation verstärken, in dem sie die kognitive Repräsentation des Stressors verlängern. *Methode:* Daten wurden mithilfe eines Basis Fragebogens, einer 5-tägigen Tagebuchstudie mit jeweils 2 Messzeitpunkten pro Tag und nächtlicher HRV Messungen (RMSSD und LF/HF) über eine Woche hinweg erhoben. Die finale Stichprobe bestand aus $N = 75$ Pflegefachkräften aus Niederösterreich. Zur Testung der Hypothesen wurde eine Mehrebenenanalyse herangezogen. *Ergebnisse:* Es konnte ein signifikant negativer Zusammenhang zwischen Arbeitskonflikt und mentalem Abschalten nach der Arbeit festgestellt werden. Der erwartete Mediationseffekt von Arbeitskonflikt auf beide HRV Parameter über mentales Abschalten konnte nicht nachgewiesen werden. Ebenfalls konnte die erwartete moderierende Wirkung ruminierender Gedanken in Bezug auf die Mediation nicht festgestellt werden. *Schlussfolgerungen:* Die Studienergebnisse geben keine Hinweise auf eine verlängerte physiologische Aktivierung von Stress in Form von verminderten HRV-Werten aufgrund von fehlendem mentalen Abschaltens nach der Arbeit. Für zukünftige Forschung wird empfohlen die Rolle von interpersonellen Arbeitskonflikten und mentalen Abschaltens in Bezug zu anderen physiologischen Gesundheitsparametern zu erforschen.

Appendix B: Tables

Appendix B1: Multilevel Regression Results for Testing the Mediation of Conflict at Work at HRV Measurements via Psychological Detachment

Table 2

Multilevel Regression Results for Testing the Mediation of Conflict at Work on HRV Measurements via Psychological Detachment

| Variable and statistic | RMSSD | | | | | | LF/HF | | |
|------------------------|-------------------|------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------------------|-------------------|
| | Detachment | | Step 1 | | Step 2 | | Step 2 | | |
| | $\beta_{between}$ | β_{within} | $\beta_{between}$ | β_{within} | $\beta_{between}$ | β_{within} | $\beta_{between}$ | β_{within} | |
| Age | .07 | | -.47** | | -.46** | | .40** | | .38** |
| Sex | .06 | | .16 | | .16 | | -.43** | | -.43** |
| Alcohol | .35 [†] | .13** | .48* | -.18 [†] | .52 [†] | -.18 [†] | -.08 | .11 | -.14 |
| Cigarette | .05 | -.09 | -.23 [†] | .01 | -.22 [†] | .02 | .05 | -.02 | .03 |
| Coffee | -.11 | -.06 | .04 | .03 | .03 | .03 | .24 [†] | .06 | .27 [†] |
| Sport | -.10 | -.04 | -.11 | -.12* | -.12 | -.12* | .11 | .06 | .12 |
| Medication | -.20 [†] | -.04 | -.07 | .18 | -.09 | .18 | -.12 [†] | -.03 | -.08 |
| Sleep Medication | -.21 | .05** | -.09 | .01 | -.10 | .01 | .09 [†] | .01 | .12 |
| Conflict at Work | -.59** | -.13** | -.27 | .04 | -.33 | .04 | .30 [†] | .03 | .40 |
| Detachment | | | | | -.09 | .01 | | | .17 |
| Indirect Effect | | | | | 2.80 | -.06 | | | -.42 |
| Total Effect | | | | | -20.97 | 1.37 | | | 1.86 [†] |
| R ² | .37** | .05* | .56** | .09 [†] | .57** | .09 [†] | .53** | .02 | .55** |

Note. Estimator = Maximum Likelihood Robust. β = standardized regression coefficient. p = unstandardized. RMSSD = square root of the mean squared differences between successive RR intervals, LF/HF = ratio between low frequency and high frequency band powers. Step 1 refers to the regression model without the mediator. Step 2 refers to the regression model including the mediator. Coefficients for indirect and total effects are non-standardized. [†] $p < .1$, * $p < .05$, ** $p < .01$, two-tailed.

Appendix B2: Moderated Mediation Results for Conflict at Work Across Levels of Rumination in Predicting HRV Measurements

Table 4

Moderated Mediation Results for Conflict at Work Across Levels of Rumination in Predicting HRV Measurements

| Moderator | Level | RMSSD | | | LF/HF | | |
|------------|--------------|-------------------------------------|-----|-----|-------------------------------------|-----|-----|
| | | Conditional indirect effect β | SE | p | Conditional indirect effect β | SE | p |
| Rumination | Low (-1 SD) | .01 | .27 | .97 | -.03 | .04 | .41 |
| | Medium (M) | .01 | .14 | .97 | -.02 | .02 | .37 |
| | High (+1 SD) | .00 | .01 | .98 | .00 | .02 | .98 |
| IMM | | -.01 | .13 | .97 | .02 | .02 | .50 |

Note. Estimator = Maximum Likelihood Robust. β = standardized regression coefficient. p = unstandardized. Coefficients refer to the within level. Level of Rumination: Low (-1.06), Medium (0), High (1.06). RMSSD = square root of the mean squared differences between successive RR intervals, LF/HF = ratio between low frequency and high frequency band powers. IMM = index of moderated mediation. [†] p < .1, *p < .05, **p < .001, two-tailed.

Declaration of Authorship

I hereby certify that this bachelor thesis I am submitting is entirely my own original work except where otherwise indicated. I am aware of the University's regulations concerning plagiarism, including those regulations concerning disciplinary actions that may result from plagiarism. Any use of the works of any other author, in any form, is properly acknowledged at their point of use.

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(Signature)