

Sleep Deprivation in Negotiations:  
A Mixed-Method Investigation

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Emma Halfmann

aus Frankfurt am Main

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Dekan/in: Prof. Dr. Christiane Hermann vertr. d. Prof. Dr. Martin Kersting

1.Berichterstatter/in: Prof. Dr. Jan A. Häusser

2.Berichterstatter/in: Prof. Dr. Andreas Mojzisch

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I also thank my little family for having my back when things got a little stressful. I am aware of the irony of writing a doctoral thesis on the effects of sleep deprivation while having a baby at home. Even though I hope the outcome of my work was not negatively affected due to compensatory efforts (spoiler alert), I am very glad to inform all of you: This self-experiment is hereby completed.

## **Abstract**

Negotiations are often used as conflict resolution in a society that is increasingly sleep-deprived. Yet, not much is known about how sleep deprivation affects negotiations. In this dissertation, I present and test a theoretical framework for understanding and investigating the effects of sleep deprivation on various negotiation processes and outcomes, particularly joint economic outcomes, individual economic outcomes, social perceptions and emotions, and impasses. Focusing on integrative negotiations, I identified cognitive capacities and epistemic motivation to be highly relevant psychological processes, affected by sleep deprivation in negotiation. These impairments deteriorate effective information exchange and hamper information processing, which reduces the quality of (integrative) agreements.

In four quantitative studies and one qualitative study, the hypothesized effect of sleep deprivation on the quality of negotiation agreements in terms of joint economic outcomes was tested. In three experiments (total  $N = 398$ ), sleep-deprived versus well-rested dyads participated in (Studies 1 and 2) or observed (Study 3) an integrative negotiation. In all three studies and a Bayesian meta-analysis across these, there was no effect of sleep deprivation on agreement quality. These findings contradict theoretical predictions and also laypersons' expectations (Study 4). However, there was an indication for compensatory effort that could account for the absence of a substantial negative effect of sleep deprivation. To gain further insights, qualitative interviews with 22 German elected politicians were conducted (including head of state and federal ministers) who are experienced in negotiations under sleep deprivation (Study 5). Their responses shed light on the nature of compensatory strategies that might help to cope with sleep deprivation in real-life negotiations.

To explain the findings, potential moderators on the task, the individual, and the inter-individual level are discussed, which help to understand how sleep deprivation-induced impairments could be compensated for.

In sum, my dissertation aims to advance the understanding of how sleep deprivation negatively affects negotiation outcomes.

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## **List of Abbreviations**

EM	Epistemic motivation
GIE	Effect of Grouping on Impairments and Enhancements (Model)
JO	Joint economic outcome
SD	Sleep deprivation/ sleep-deprived
SR	Sleep restriction/ sleep-restricted
TSD	Total sleep deprivation
WMC	Working memory capacity
WR	Well-rested

## Chapter 1: General Introduction

### 1.1. Introduction

Sleep deprivation is very common in important negotiations, especially in politics and business. For example, coalition negotiations and collective bargaining between trade unions and employees are regularly concluded in overnight negotiations. It is not uncommon for these negotiations to result in essential minimal agreements late at night which fall short of expectations—or fail to find an agreement altogether. Prominent examples of late-night and overnight negotiations that failed or reached sub-optimal outcomes can be found in collective bargaining, for example, between a trade union and the airline *Laudamotion (Ryanair Austria)*, on the international stage, for example, when the European Union and the United Kingdom tried to settle on the “*Brexit*”-deal, and in national-political disputes, for example, the German coalition formation after federal elections 2017 (so-called “*Jamaica-Coalition*”) (see *Table 2* in Chapter 2 for an exemplary overview).

Media coverage sometimes attributes failed negotiations or suboptimal outcomes to a lack of sleep (cf. Weaver, 2015). For example, when the German federal-state’s overnight negotiations on the COVID-19 pandemic lockdown resulted in a highly disputed plan for a strict lockdown over Easter which was canceled just a day after the measures were announced, the topic of negotiating under sleep deprivation became salient in the German media (e.g., Sehn, 2021). But does sleep deprivation impair the agreement quality of negotiations? The compelling—and plainly obvious—common-sense theory, that sleep deprivation *must* affect negotiating outcomes, has not been scientifically addressed yet. But, there is robust evidence that sleep deprivation impairs various domains of psychological functioning, like cognitive performance (cf. Lim & Dinges, 2010; Pilcher & Huffcutt, 1996), motivation (cf. Engle-Friedman, 2014; Webster et al., 1996), decision-making processes (cf. Harrison & Horne, 2000; Killgore et al., 2006), and communication (cf. Harrison & Horne, 1997; Holding et al., 2019). In my dissertation I will integrate the research on sleep deprivation with research on negotiations and build—as well as test—a framework for investigating the effects of sleep loss in negotiations.

The framework is built on psychological processes that are highly vulnerable to sleep deprivation and influence negotiation processes as potential mediators.

This dissertation project, therefore, aims to close a highly relevant research gap and focuses on the effect of sleep deprivation on the outcomes of integrative negotiations. It consists of four main parts: (1) In the first part of the dissertation the current research question and its boundary conditions are introduced. I present mechanisms that are susceptible to sleep deprivation on the one hand and determine negotiation success on the other. (2) The second part provides a comprehensive theoretical framework that describes the hypothetical effects of sleep deprivation on negotiation processes and various outcomes. (3) In the third part, the central research question of the theoretical model is subjected to an extensive empirical test (three experimental studies) and supplemented by qualitative data from an interview study with experienced negotiators and a study on subjective beliefs of laypersons about the effects of sleep deprivation in negotiations. (4) In the general discussion—the last part—research goals and results are summarized. I also discuss potential explanations for the findings, and moderators that may have eased the allocation of compensatory effort. Future research directions and practical implications conclude the dissertation.

## **1.2. Sleep Deprivation and Social Processes**

### **1.2.1. Sleep (Loss)**

Periods of wakefulness during the day and sleep at night (the human *sleep-wake cycle*) seem to result from two interacting processes: The homeostatic and the circadian (Blume et al., 2019). The homeostatic *sleep pressure* accumulates with increasing time spent awake (cf. Holst & Landolt, 2015). This *homeostatic process* is interlinked with the body's natural fluctuations in alertness (higher during the day) and sleepiness (higher at night) throughout the 24-h rhythm of a day (*circadian process*) (cf. Borbély, 1982; Daan et al., 1984). Disruptions of these processes like *total sleep deprivation*, *sleep restriction*, and *disrupted sleep quality* can result in psychophysiological impairments, for example, impaired motivation and cognitive functioning, which will be the focal factors in the following theoretical analyses. While 7-8 hours of sleep have usually been described as sufficient to function optimally during the day (Banks & Dinges, 2007; Reynolds & Banks, 2010), sleep deprivation (SD)

refers to a state of insufficient sleep inflicted by, for example, limiting the optimal sleep duration or completely inhibiting it. *Total sleep deprivation* (TSD) is the absence of sleep in one (acute TSD) or several nights. *Sleep restriction* (SR) is described as the reduction of the sleep duration by 1 to 6 hours for one or several nights (i.e., chronic SR) (Ben-Simon et al., 2020; Reynolds & Banks, 2010). The impairing effects of chronic sleep restriction add up over time (Belenky et al., 2003; Cote et al., 2009) and can produce cumulative cognitive performance deficits equivalent to total sleep deprivation (cf. Banks & Dinges, 2007; Van Dongen et al., 2003). To assess or quantify sleep several practical methods exist. With sleep loss, individuals experience a heightened drive to sleep and consequently report feeling sleepy (Lo et al., 2012). Feeling sleepy—a very salient symptom of sleep loss—is described as the physiological state with a heightened desire to sleep and difficulty staying awake. Sleepiness is inversely proportional to the hours slept (Breslau et al., 1997). In ambulatory situations sleep is commonly measured as a combination of self-reports like subjective sleepiness and sleep diaries and objective measures of sleep quality and quantity. For example, actigraphy devices can measure a body's physical activity at night and translate them via validated sleep-wake scoring algorithms into indicators of how many minutes an individual was asleep (*sleep quantity*) and objective *sleep quality* (Sadeh et al., 1994; Tryon, 2004). Next to the total sleep time and sleep quality there are several other parameters that can be taken into account, but are beyond the scope of this introduction (e.g., sleep efficiency, wake after sleep onset, sleep onset latency; cf. Gordon et al., 2017). There are also individual factors that could influence the degree of cognitive and motivational impairment associated with sleep loss. The so-called *chronotype* is the biologically driven inclination to be more alert and perform optimally in physical or cognitive tasks at a certain time of the day which differs between individuals (*synchrony effect*, Horne et al., 1980; May and Hasher, 1998). Circadian misalignment can negatively influence individual and social decision-making (see Correa et al., 2020 for an overview). Additionally, individuals have been found to show discrepancies in vulnerability to sleep deprivation in prior studies, especially regarding resilience to cognitive impairments and maintained alertness during sleep deprivation (Leprout et al., 2003; Saksvik et al., 2011; Van Dongen et al., 2004).

Several experimental studies have shown how insufficient sleep impacts various domains of individual (psychological) functioning (cf. memory: Leong et al., 2019; Lipinska et al., 2019, or mood: Short & Louca, 2015; Short et al., 2020). In particular, the negative effects of sleep loss on cognitive functioning have received much research attention (see, for example, Pilcher & Huffcutt, 1996 and Satterfield & Killgore, 2019 for overviews). Cognitive higher-order processes are built upon fundamental processes like attention, vigilance, and alertness. The ability to sustain attention and alertness is profoundly impaired by sleep loss (Doran et al., 2001; Dorrian et al., 2005), and attentional lapses are more likely to occur (Van Dongen et al., 2003). With increasing time-on-task performance variability will increase, which is a typical symptom of sleep loss (Van Dongen et al., 2011a; Van Dongen et al., 2011b). *Executive functioning (EF)* is a collection of various higher-order skills which are useful to coordinate and control goal-oriented behavior (Miller & Wallis, 2009). Its various sub-characteristics were found to be impaired by sleep loss, for example, the ability to suppress distractors or inhibit inappropriate or wrong responses or behaviors (*inhibitory control*, cf. Demos et al., 2016; Drummond et al., 2006; Guarana et al., 2021; Sagaspe et al., 2012). Also the ability to switch tasks (cf. Couyoumdjian et al., 2010; Nakashima et al., 2018) or multi-task (Haavisto et al., 2010) or the ability to update information and implement new information into the mental representation of a situation (*information updating*, Durmer & Dinges, 2005; Lim & Dinges, 2010; Killgore et al., 2006) and abandon suboptimal problem-solving strategies (*cognitive flexibility* Harrison & Horne, 2000; Honn et al., 2019). *Working memory (WMC)* is the capacity to maintain, manipulate and organize information in immediate memory and underlies executive functioning. Working memory performance is profoundly impaired due to sleep loss (regarding accuracy and reaction times) (cf. Frenka & Fenn, 2016; Reichert et al., 2016; see also the meta-analysis by Lim & Dinges, 2010). Taken together, sleep loss has profound negative effects on a wide range of cognitive domains.

The systematic processing of information—as in negotiations—requires sufficient cognitive resources as well as the will or motivation to exert effort. It has previously been found, that sleep loss reduces the motivation for cognitive performances and that perceived effort expenditure progressively increases

with time-on-task (Engle-Friedman, 2014; Odle-Dusseau et al., 2010). The alteration of subjective motivation and effort is task dependent and is not necessarily parallel (Drummond et al., 2005a; 2005b) (see Section 1.2.4. for boundary conditions).

More specifically, sleep deprivation could cause impairment of the negotiators' *epistemic motivation*. As part of a broader classification of motivation in negotiations (cf. Carnevale & De Dreu, 2006; De Dreu, 2003) *epistemic motivation (EM)* is described as “the desire to develop and hold accurate and well-informed conclusions about the world” (De Dreu, 2004, p. 121; see also Kruglanski & Webster, 1996). It has been shown that mental fatigue—which is a common characteristic of sleep deprivation (Durmer & Dinges, 2005)—impairs epistemic motivation (Webster et al., 1996). Heightened sleepiness and sleep deprivation are also associated with a decrease in motivation for social activities (Axelsson et al., 2020).

In summary, sleep deprivation impairs the subjective motivation to perform while at the same time performance is perceived as more effortful. For a more detailed description of cognitive and motivational impairments due to sleep deprivation see Chapter 2.

### **1.2.2. Sleep and Social Processes**

Insufficient sleep has not only been found to affect individual capacities such as motivation and cognitive functioning but is also related to various aspects of social life. Nevertheless, the links between sleep and social processes are still being researched and the importance of this area has been increasingly recognized. Recent reviews concentrate on the ties between sleep and affective processes and socio-emotional functioning (i.e., person perception, emotional reactivity, expression) (Beattie et al., 2015; Ben-Simon et al., 2020; Van der Helm et al., 2010). Others have focused on social relationships (i.e., romantic, between peers, coworkers, and leadership-subordinate) (i.e., Barnes et al., 2015; Gordon et al., 2017; 2021; Gunia et al., 2021). There are few studies examining the effect of sleep loss in social contexts but they address individual decisions with a focus on prosocial behavior (cf. Anderson & Dickinson, 2010; Clark & Dickinson, 2020; Dickinson & McElroy, 2017; Holbein et al., 2019), empathy (Guadagni et al., 2014), aggression towards others as response to frustration (Kahn-Greene et al.,

2006, advice taking (Häusser et al., 2016), stereotypic social judgments (Bodenhausen et al., 1990), and interpersonal conflict resolution (Dickinson et al., 2022; Gordon & Chen, 2014). Moreover, the impairing effects of sleep on decision-making in groups have been addressed theoretically (Barnes & Hollenbeck, 2009; Faber et al., 2017). Empirically, the relationship between sleep deprivation and team performance has only been examined as a comparison between teams with sleep deprivation (additive tasks) and sleep-deprived individuals, with mixed findings (Baranski et al., 2007; Hoeksema-van-Orden et al., 1998) (see also Sections 1.2.4. and 4.2.3.). A well-rested control group was not included in either of the studies.

Overall, little research has been conducted on the effects of sleep deprivation on social processes, particularly with respect to interdependent social decisions. For negotiations in particular, this means that there is less evidence on which to base predictions. Moreover, integrative negotiations are particularly characterized by the potential to expand and optimize joint economic outcomes. These outcomes have been found to be influenced by negotiators' cognitive functioning and motivation, which—as mentioned earlier—are strongly affected by sleep deprivation. These and other characteristics of integrative negotiations are discussed in more detail in the next section.

### **1.2.3. Negotiations**

To be able to detect adverse effects of situational factors such as sleep loss, it is not only necessary to specify the impairing effects of sleep deprivation on human functioning but also the processes that enhance optimal negotiation outcomes. A negotiation is a mixed-motive communication process where at least two negotiators cooperate and compete to optimize individual outcomes through mutual decision making (cf. Lax & Sebenius, 1986; Fisher & Ury, 1981; Pruitt, 1983). Negotiations can be distributive, integrative, or—most commonly—a combination of both (Walton & McKersie, 1965; Raiffa, 1982). In distributive negotiation settings, the parties have to allocate scarce resources (zero-sum outcome). Integrative negotiations bear the potential for expanding the amount of dividable resources to the mutual benefit of both negotiation parties (variable-sum outcome) (e.g., Thompson & Hastie, 1990). The *joint economic outcome (JO)* is the crucial measure to quantify the quality of an

agreement and specifies whether the negotiators have found the optimal, mutually advantageous and most integrative solution, or whether they fall short of it. In integrative negotiations, the joint outcome can, for example, be expanded by recognizing compatible interests (Thompson & Hrebec, 1996) and by making mutually beneficial concessions which are built within the specific priority structure of the negotiation (i.e., *log-rolling*, Froman & Cohen, 1970; Thompson & Hastie, 1990). Negotiators have to identify different—but potentially interchangeable—priorities between issues or identical preferences within issues to tap into the so-called *integrative potential* (Walton & McKersie, 1965). The (partial) compatibility of interests must be recognized and the knowledge must consequently be used to tradeoff low- and high-value issues (Froman & Cohen, 1970) to make mutually beneficial agreements beyond mere compromises and thereby increasing the joint economic outcome. The key to unlocking the integrative potential is the effective exchange and processing of information (Fairfield & Allred, 2007; Thompson, 1991; Zerres et al., 2013). Negotiators can uncover the integrative potential by directly asking and providing information on the priorities between or preferences within issues (*interest-related-information-exchange*; Hüffmeier et al., 2019; Thompson, 1991). Indirectly, they can also draw inferences regarding the interest of the negotiation partner by unsystematically exchanging offers and counteroffers, and observing the negotiation partner's reaction to it (*trial-and-error approach*, Pruitt & Lewis, 1975).

There are many different negotiator (trait) characteristics that have been studied concerning successful negotiation (cf. Barry & Friedman, 1998; Mazei et al., 2015; Sharma et al., 2018). Nevertheless, for the current research, it is central to identify factors that are on the one hand susceptible to situational impairments like sleep deprivation, and on the other hand shape negotiation processes: Factors like cognitive abilities and motivation (see Elfenbein, 2015; 2021; Elfenbein et al., 2008; 2018; Sharma et al., 2013 for reviews).

Negotiations are cognitively taxing situations (Bazerman et al., 1999; De Dreu et al., 2006), where negotiators have to engage in systematic information processing to be able to uncover the integrative potential. Unfortunately, negotiators tend to overlook the integrative potential within a negotiation because they persist in the misconception that the negotiation is a zero-sum

situation and interests are per se incompatible (*fixed-pie-perception*, cf. De Dreu & Carnevale, 2003; Thompson & Hastie, 1990). By overestimating the existing conflict of interest, they fall short of realizing the full integrative potential. As a low resource-demanding heuristic, the fixed-pie-perception is only revised if the negotiators have the *skill and will* to do so when the corresponding information is exchanged.

As postulated in dual-process theories (see Chaiken & Trope, 1999 for an overview) like the *Elaboration Likelihood Model* (cf. Petty & Wegener, 1999; Petty et al., 2017) individuals are generally motivated to come to correct conclusions and judgments. Whether individuals engage in a thoughtful deliberative assessment of information (System-2 processing) or rely on effortless heuristics and routines (System-1 processing) is determined—among other factors—by individual characteristics. More specifically, motivation and ability determine how much elaboration, that is, the extent of thinking, is exerted in any given situation (Petty & Wegener, 1999). When individuals are on the high end of the elaboration continuum, and both motivation and ability are high, individuals will presumably engage in a cognitive effort to elaborate and process information thoroughly. If the ability and willingness to process the information available are low (e.g., due to situational impairment like sleep deprivation) individuals should examine less information or the same information less carefully as compared to when elaboration is high (Petty & Wegener, 1999). At the lower end of the elaboration continuum, individuals mostly rely on less resource-demanding processes, such as the use of heuristics (e.g., expertise of the sender) (Chaiken, 1987; Petty et al., 1981).

Taken together, whether negotiators revise the fixed-pie-perception, engage in systematic processing of information, and put in effort to gain additional insight into the opponent's interest structure depends on their ability and willingness to do so. In support of this rationale, cognitive functioning—for example, working memory—has been found to be positively related to better joint negotiation outcomes (Fulmer & Barry, 2004; Sharma et al., 2013). Moreover, a high level of willingness to process information—more precisely epistemic motivation—is required to reach optimal solutions in integrative negotiations—as found by Ten Velden et al. (2010)—while lower levels result

in less systematic and more heuristic processing of information (cf. De Dreu et al., 1999).

Since—as laid out—successful integrative negotiation highly depends on sufficient cognitive resources and high epistemic motivation, which are both likely to be impaired by sleep deprivation, it can be predicted that the amount and direction of thinking (bias) of negotiators should be negatively affected by sleep deprivation. In line with this, there is indication that sleep-deprived individuals tend to rely more on heuristics (Engle-Friedman et al., 2018), and thus should be less likely to revise the fixed-pie-perception. Negotiators should be less able and motivated to exchange and process information to obtain valid mental representations of the conflict of interests, in that they are unable to use log-rolling or trail-and-error strategies to increase joint economic outcomes. The reduced extent of exchange and processing of information should therefore not suffice to find the optimal—fully integrative—solution.

Taken together, based on the empirical findings and theory on cognitive and motivational impairments, it is highly likely that the exchange and processing of information are negatively affected by sleep loss, therefore resulting in a suboptimal mutual economic outcome. A more detailed theoretical argument and collection of empirical findings, as well as concrete research questions, and hypotheses can be found in Chapter 2.

#### **1.2.4. Boundary Conditions**

Although it seems plausible to predict that sleep deprivation impairs the outcome in integrative negotiations there are specific boundary conditions that might limit the generalizability of my theory. Specifically, increased effort and strategies to compensate for own or group members' performance might modify the effects of sleep deprivation in the negotiation context.

As formerly established in research on the effects of stress and fatigue on performance following the *Compensatory Control Model* (cf. Hockey, 1997, 2011, 2013; Hockey et al., 1998), there is a possibility that compensatory effort mitigates sleep deprivation-related impairments, thereby counteracting negative effects on joint economic outcomes. *Compensatory effort* can be understood as the attempt to protect performance and exert attentional control by further engaging beyond basic functioning to meet the needs of the task requirements when attentional or motivational resources are limited by sleep

loss, and performance goals become increasingly difficult to attain (see Engle-Friedman, 2014 and Massar et al., 2019a, for reviews). Imbalances between an external demand and an inadequate “budget” of effort could therefore be managed by (strenuous) short term investment of regulatory effort (Hockey et al., 1998).

Such an effortful protection of performance after sleep deprivation seems to be a function of task characteristics such as interestingness on the one hand, and partially under voluntary control on the other (Hockey, 2011; Massar et al., 2019a; Wickens et al., 2015). To explain the maintenance of performance under sleep loss, it has been argued that cognitive performance deficits following sleep deprivation are due to a decline of arousal, due to limitation of energy resources to maintain performance, or due to increased negative mood and declined willingness to put in effort (see Massar et al., 2019a for an overview).

Individuals seem to be aware of their impaired performance (see Boardman et al., 2021 for a meta-analysis). Nevertheless—as postulated by Hull (1943) originally—individuals are motivated to meet the perceived demands of a situation. Consequently, individuals could be motivated to put in additional effort and adopt strategies to counteract impairments and thereby protect high-priority goals (Engle-Friedman, 2014; Hockey et al., 1998; Rogers et al., 2003). If possible, they will first seek out external stimulation (environments or task) and engage in compensatory effort if that is not possible or sufficient (cf. Fisher et al. 2008). How much effort is allocated depends on how easily effort can be invested and how important the task is. Supporting this, sleep-deprived individuals tend to report increased effort on the task as compared to well-rested ones (Ode-Dusseau et al., 2010; Pilcher & Walters; 1997).

Furthermore, the findings of impairments due to sleep loss are less consistent for more complex tasks as compared to simple tasks (Lim & Dinges, 2010; Lowe et al., 2017). This may be partly attributable to a heightened intrinsic and extrinsic motivation. Performance deficits under sleep loss could be partially counteracted by the motivation to voluntarily allocate compensatory effort (cf. Harrison & Horne, 1999). The allocation of effort could be triggered by different task characteristics: Face-to-face negotiations are usually

perceived as interesting and are highly interactive (cf. Thompson & Leonardelli, 2004). Interestingness or subjective importance as well as tasks that involve additional incentives such as financial reward or feedback could increase motivation to perform well despite potential obstacles, and by that performance decrements could be buffered or prevented (cf. Horne & Pettitt, 1985; Wilkinson, 1961). Interesting and complex tasks could therefore be considered to be insensitive to sleep deprivation (Harrison & Horne, 2000). Long and monotonous tasks on the other hand could potentiate the decrease in arousal (cf. Wilkinson, 1961). It is, therefore, possible that only in situations in which there is no—or no more—potential to generate additional effort, performance would decline. On top of this, the additional allocation of effort is strenuous, cannot be maintained over a long period of time, and does not fully counter all underlying impairments (cf. Earle et al., 2015; Hockey, 2013). As a result, task goals could be adjusted downwards or less complex information-processing strategies could be chosen (Hockey et al., 1998). It has been found that although no effects of sleep deprivation on primary task performance were observed, sleep deprivation still interfered with lower-level activities such as reaction times (cf. Dinges & Kribbs, 1991; Hockey et al., 1998). Additionally, an increase in individual effort results in fatigue after-effects, exhaustion or strain (Hockey, 1997). Therefore, even though stressors like sleep deprivation may fail to decrease task performance, regulatory effort to protect performance comes at a cost (Hockey, 2013).

In addition to compensating for performance decrements through individual effort, it is also possible that social interaction enables mutual compensation. A straightforward account would conclude that individual impairments under sleep deprivation are mirrored on the group level. But research on team performance under sleep deprivation as compared to individual performance under sleep deprivation has shown mixed results (Baranski et al., 2007; Hoeksema-van-Orden et al., 1998; more details see below). The findings suggest that one cannot rely solely on findings on how individuals perform under sleep deprivation but must also consider social processes within the group. Integrative negotiations are fundamentally relational and dynamic: The strategic decision-making process is interdependent and (perceived) conflict is resolved through communication.

The behavior of both negotiators shapes the negotiation dynamics (see, for example, the *Relational Process Modell of Negotiation* by Elfenbein, 2021). The integrative potential in negotiations is demonstrable (Hüffmeier et al., 2019) and integrative negotiations can therefore be interpreted as disjunctive group tasks (Steiner, 1972). Supporting this, it was found that only one person in a negotiation group is sufficient to identify the integrative potential for optimizing the joint economic outcome (Hüffmeier et al., 2019). Once a negotiation task is understood as a group task, one can argue that individual-level impairments might not necessarily translate into performance decrements in social situations and that groups could be relatively unaffected by impairments in contrast to individuals. Faber et al. (2017; see also Faber & Häusser, 2022 for a discussion) include compensatory effects due to group monitoring in their *Effect of Grouping on Impairments and Enhancements* (GIE) model, and consider process gains and losses in motivation and coordination. They argue, as Abrams et al. (2006) postulated with the *group monitoring hypothesis*, that findings from impairment or enhancements on the individual level cannot be generalized to group performance, but add that grouping could help to overcome or even deteriorate impairments based on group monitoring and compensatory effort. The GIE framework has not been empirically tested yet, but there is some supporting evidence. Hoeksema-van-Orden et al. (1998) showed that sleep deprivation led group members to contribute less to the group outcome and hence promoted "social loafing" (Latané et al., 1979), especially if feedback on individual performance was not provided publicly. Yet, there is also empirical evidence that working in a sleepy team in which they received information about their mutual performance leads to motivational gains compared to working on a task alone (Baranski et al., 2007), which the authors attributed to social compensation, meaning that individuals were trying to compensate for the low performance of other sleep-deprived team members. It has also been found that groups compensate for the disrupted cognitive flexibility of individuals in problem-solving tasks under sleep deprivation (Frings, 2011). Individual impairments due to sleep loss might therefore be modulated in the social context of the negotiation. More clearly, negotiations might allow for mutual compensation: Individuals who are more resilient to the negative effects of sleep deprivation or are more motivated to protect performance goals,

could compensate for the individual deficits of the negotiation partner, and still be able to detect the partial compatibility of interest.

Taken together, due to the relational characteristics of negotiations and the potential of the allocation of compensatory effort, it is possible that inter-individual and group processes mitigate the expected impairing effect of sleep deprivation on integrative negotiation outcomes.

### **1.3. Research Goals and Contributions**

In the present research, I seek to address one focal research question: Does sleep deprivation affect integrative negotiation outcomes? Specifically, I aim to explore theoretically and empirically whether joint economic outcomes of integrative negotiations can turn out to be suboptimal due to sleep deprivation. Therefore, this dissertation contributes to the literature in the fields of sleep and negotiation research. Specifically, this dissertation has six contributions.

(1) The theoretical model and its predictions were derived from theory and prior empirical evidence from sleep as well as negotiation research, and are additionally supported by laypersons' expectations (Study 4). Given the high degree of predictability of the research hypothesis, the consistent lack of substantial effects across studies is surprising. The findings appear robust and are very likely generalizable to other settings of sleep deprivation in the laboratory and the field.

(2) By using a mixed-method approach to address the focal research question, it was possible to draw inferences that could help to explain the findings. The present work highlights compensatory effort as a potentially intervening factor and suggests that impairments could be (voluntarily) compensated for through regulatory effort in social situations (cf. Hockey, 2013; Hockey et al., 1998). Especially the qualitative interview study seems to be a fruitful endeavor to identify specific cognitive and behavioral strategies to counteract the psychophysiological impairments inflicted by sleep loss on the task, the individual, and inter-individual level.

(3) This dissertation's focal research question builds upon seminal work on cognitive and motivational impairments in the field of sleep research. Yet, despite the growing attention, less is known about how sleep states impact social processes in interdependent situations like negotiations (see Section

1.2.2.). In a broader sense, this dissertation contributes to the theoretical knowledge of the existing—nevertheless scarce—research on the link between sleep and social interactions. More specifically, the research helps to broaden the conventional focus on individual impairments, with compelling implications for social contexts.

(4) The dissertation is therefore a (even more general) contribution to the knowledge of how individual-level impairments play out in social situations, and extends the existing evidence that individual limitations do not necessarily translate into inter-individual performance decrements (cf. Faber & Häusser, 2022; Faber et al., 2017).

(5) In addition, this dissertation also contributes to the negotiation research. Negotiations are often used as conflict resolution in the real world—a world that, all in all, is increasingly sleep deprived (cf. Khubchandani & Price, 2020; US Centers for Disease Control and Prevention, 2015). Nevertheless, the quality of negotiation agreements reached late at night under sleep deprivation has not yet been subjected to empirical investigation. Sleep deprivation has been found to decrease motivation and cognitive functioning (cf. Engle-Friedman, 2014; Lim & Dinges, 2010), which in turn are positively related to better joint economic outcomes in negotiations (cf. Elfenbein, 2021; Sharma et al., 2013). With the introduction of a prevalent contextual factor known to impair individual states predictive of negotiation success, external validity is increased, and more can be learned about the processes that shape successful negotiations.

(6) Finally, the research bears important practical implications. The results indicate that individual effort and inter-individual dynamics embedded in the negotiation context prevent a decline in performance. Valuable practical experience from politicians (Study 5) demonstrates that there might be prearrangements, as well as individual, and inter-individual strategies that facilitate or even enable compensation for the negative effects of sleep loss.

#### **1.4. Dissertation Outline**

The dissertation examines the relationship between sleep deprivation and integrative negotiation outcomes. The next section of the dissertation presents a theoretical framework and provides a comprehensive overview of the empirical status of the assumptions made therein to investigating the effects

of sleep loss in negotiations. The potential impact of sleep deprivation on various negotiation outcomes will be analyzed. In Chapter 3 the model is tested and the empirical investigation is composed of four empirical studies and one qualitative study: Two laboratory experimental studies with one night of TSD as manipulation of sleep, one online experiment with sleep restriction, a survey on laypersons' beliefs, and a qualitative interview study with political experts. The two laboratory studies consistently found no substantial (that is, medium sized) effects of experimentally induced sleep deprivation on the quality of the integrative negotiation agreements. The additional online study confirmed the robustness of the finding with a further manipulation of sleep deprivation. The three experimental studies suggest that this finding may be due to compensation efforts for sleep deprivation-related deficits by negotiation participants. In Study 4, a survey is conducted to test lay beliefs about the theoretical assumptions. Since lay conceptions expect a declining performance after sleep deprivation, this finding could be interpreted as a precondition for the allocation of additional effort. If sleep-deprived individuals anticipate performance decrements, they might try to counteract them in order to achieve their performance goals. Additionally, a qualitative interview study with experienced negotiators (professional politicians) was conducted, for a further elaboration of the theoretical model. Table 1 presents an overview of the empirical studies in Chapter 3.

Finally, Chapter 4 summarizes and integrates the main findings and provides implications for the theoretical framework of Chapter 2. I discuss practical implications and future directions to explore the relationship between sleep and negotiation outcomes, and efforts to compensate for impairments.

**Table 1**  
Overview on Empirical Studies

	N	Sleep manipulation	Manipulation check	Negotiation task	Dependent measures	Additional measures	Summary of results
Study 1	80	1 night of TSD at home	Hourly mails Subjective tiredness	<u>4 issues<sup>a</sup></u> : 2 distributive 2 integrative	JO (range: 8.000-12.800 points)	Energetic Arousal	SD sig. more tired than WR No effect of TSD on JO Heightened Energetic Arousal after task
Study 2	174	min. 26 h TSD in laboratory	Subjective tiredness (pre and post nego.) Impairments Activity Tracker	<u>6 issues<sup>b</sup></u> : 1 distributive 5 integrative	JO (range: € -450,000 - € 150,000)	Compensatory effort	SD sig. more tired and more impairments than WR Tiredness lower after task No effect of TSD on JO SD sig. more effort than WR group
Study 3 (online)	144	2 nights 50 % of habitual sleep at home (SR)	Subjective tiredness (pre and post nego.) Impairments SMS reminder for sleeping times	(Observation) <u>8 issues<sup>c</sup></u> : 2 distributive 6 integrative	JO as sum of difference between proposed and optimal option (range: 0-28)	Compensatory effort Compensatory strategies	SD sig. more tired and impairments than WR Tiredness does not decrease No effect of SR on JO SD sig. more effort Anecdotal strategies
Study 4 (online)	152	Lay perception on results of Study 2		see Study 2	Estimate of JO of SD group in €	Estimation of performance quality of SD nego. compared to WR nego. and of own performance under TSD	Estimation of JO of SD group in € was sig. lower than WR group and estimation of performance sig. lower than center of scale

Note. TSD = total sleep deprivation, SR = sleep restriction, SD = sleep deprived, WR = well-rested, JO = joint outcome, nego. = negotiation(s), sig. =  $p < .05$ .

<sup>a</sup> Thompson & Hastie (1990). <sup>b</sup> Hüffmeier et al. (2019). <sup>c</sup> Thompson et al. (1996). The results of Study 5 are summarized in Table S4.

## Chapter 2: Theoretical Framework

**Publication status:** The following Chapter 2 represents an article with the title “*Negotiating through the night: How sleep deprivation can affect negotiation processes and outcomes*”, which is published at *Negotiation and Conflict Management Research*.<sup>1</sup>

### 2.1. Introduction

Many high-stakes negotiations in the political world and in business are conducted under severe sleep deprivation. Think, for example, of negotiations at international summits (e.g., the Conference of the Parties [COP26] in Glasgow negotiating climate-related measures in 2021 or the Greek debt negotiations in 2015) or forming a government (e.g., after the federal elections 2013 and 2017 in Germany). In such negotiations, sleep deprivation is very likely to occur, because these negotiations often a) span several days with long working hours, b) extend deep into the night, c) are scheduled at short notice due to urgency, and d) are affected by jet lag in the case of international negotiations. Table 2 provides some examples of high-stake negotiations conducted under sleep deprivation.

But what are the consequences of lack of sleep on negotiation outcomes? Surprisingly, although the effect of sleep loss in negotiations is highly relevant from an applied perspective (and also from a theoretical perspective as we will show in this article), we are aware of only one empirical manuscript and no theoretical accounts on this topic. Although negative outcomes may intuitively be expected, it is still unclear whether and to what degree, as well as through which mechanisms, sleep deprivation may affect negotiation outcomes. If severe negative effects invariably unfold, negotiating under sleep loss should not be seen as a viable option due to its general ineffectiveness. However, the prevalence of sleep deprivation in high-stakes negotiations emphasizes the need to understand the potential mechanism and

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<sup>1</sup> Häusser, J. A.\*, Halfmann, E.\*, & Hüffmeier, J. (2022). Negotiating through the night: How sleep deprivation can affect negotiation processes and outcomes. *Negotiation and Conflict Management Research*. <https://ncmr.lps.library.cmu.edu/article/id/575/> \*equal contributions

**Table 2***Examples of Prolonged and Late-Night Negotiations*

Year	Negotiation topic	Negotiating parties	Location
1991	Maastricht Treaty	European Communities	Maastricht; Netherlands
1997	French truck driver strike	Union & employer's group	Paris; France
2000	COP6-Climate Change Conference	United Nations	the Hague; Netherlands
2008	Wall street bailout	U.S. Congress	Washington, D.C.; U.S.A.
2012	Arms Trade Treaty	United Nations	New York; U.S.A.
2013	German coalition negotiation	German political parties CDU/CSU & SPD	Berlin; Germany
2015	Greek government debt bailout	Eurozone head of states	Brussels; Belgium
2015	Iran Nuclear Deal Framework	Iran Foreign Minister, P5+11, EU	Lausanne; Switzerland
2015	Minsk II – war in Ukraine	Heads of state of Ukraine, Russia, & OSCE	Minsk; Belarus
2015	COP21-Climate Change Conference	United Nations	Paris; France
2017	German coalition negotiation	German political parties SPD, FDP, & Green Party	Berlin; Germany
2019	Party merge and change of leadership	Union of right wing parties in Israel	Tel Aviv; Israel
2019	Collective bargaining	Union & B.C. Maritime Employers Assoc.	Vancouver; Canada
2019	Brexit negotiations	U.K. & EU	Brussels; Belgium
2019	Execution of death row inmate	U.S. Supreme Court	Washington, D.C.; U.S.A.
2019	U.S. federal government shutdown	U.S. Congress & President Trump	Washington, D.C.; U.S.A.
2019	COP25-Climate Change Conference	United Nations	Madrid; Spain
2020	Collective bargaining	Vida trade union & Laudamotion airline	Vienna; Austria
2020	COVID-19 Pandemic Crisis Support	EU finance ministers	virtual
2020	Reform of Agricultural Policy	EU Ministers of Agriculture	Luxembourg
2021	COP26-Climate Change Conference	United Nations	Glasgow; U.K.
2021	COVID-19 Lockdown	German Federal Minister-presidents	Berlin; Germany
2022	Collective bargaining after strike	Transport unions & Jammu/Kashmir admin.	Jammu; India
2022	Fossil fuels car ban	EU environmental ministers	Luxembourg
2022	12th WTO Ministerial Conference	Members of WTO	Geneva; Switzerland

*Note.* List of illustrative examples of late- or all-night negotiations (sometimes over several days) that may have resulted in acute and chronic sleep deprivation among negotiators.

moderators of the relationship between sleep deprivation and negotiation outcomes.

The first pertinent manuscript [*Chapter 3*] showed in several studies that sleep deprivation does not necessarily result in worse negotiation outcomes, but could be compensated for by different measures. These measures are located at different levels (e.g., individual or inter-individual level). We will discuss potential moderation and compensation in this paper.

The key objective of this paper is to present a framework for understanding and investigating the potential effects of sleep loss in negotiations. In view of the vast lack of empirical studies directly testing such effects, we review previous empirical findings on the psychological effects of sleep deprivation that can play a role in negotiations. We built our framework on an analysis of specific psychological and cognitive processes that are, on the one hand, highly prone to being affected by sleep deprivation and, on the other hand, shape negotiation outcomes. Technically speaking, such processes are potential mediating mechanisms linking sleep deprivation to negotiation outcomes. Specifically, in our analysis, we will focus on the joint economic outcomes in bilateral negotiations and show that *cognitive capacities* and *epistemic motivation* (i.e., the motivation to exert cognitive effort to obtain an accurate understanding of things) are likely to play a crucial role for this negotiation outcome when negotiating under sleep deprivation. These mediation paths point to a general prediction of why sleep deprivation should negatively affect joint economic outcomes. In addition to joint economic outcomes, we will address a range of negotiation outcomes potentially affected by sleep deprivation, including individual economic outcomes, socio-emotional outcomes, and impasses (i.e., non-agreements). Here we will also discuss sleep-deprivation-induced emotions as a process linking sleep deprivation to socio-emotional outcomes and impasses. Furthermore, we will discuss reasons for why no uniform negative effects on joint economic outcomes should be expected and we focus here on potential compensatory mechanisms. When doing so, we will present conditions on the task, the individual, and the inter-individual level under which the negative effects should be less likely to occur.

Our paper integrates research on sleep deprivation with research on negotiations. To the best of our knowledge, our analysis is the first to

theoretically examine how sleep deprivation can affect negotiations. Although earlier theoretical accounts targeting the impacts of sleep deprivation on human functioning also emphasize the 'social side' of sleep, these earlier accounts are a broader collection of potentially relevant social contexts (Gordon et al., 2017), or specific to the contexts of group performance (Faber et al., 2017) or group decision making (Barnes & Hollenbeck, 2009). Hence, they do not account for relevant processes in inter-personal negotiations and do not allow specific predictions to be derived on this type of social interaction. Our theoretical model contributes to the literature in both fields, sleep research and negotiation research. Regarding sleep deprivation research, it provides new insights into the yet under-examined social effects of sleep in organizations (cf. Christian & Ellis, 2011; Faber et al., 2017). Regarding negotiation research, with the introduction of sleep deprivation, we contribute to the literature by spotlighting a—yet neglected—prevalent and potentially powerful context factor.

### **2.1.1. Sleep Deprivation**

Insufficient sleep is highly prevalent in modern societies, and has therefore been dubbed a public epidemic by the U.S. Centers for Disease Control and Prevention (2015). Sleep deprivation refers to a state of insufficient sleep, either acute (also termed *total sleep deprivation*), in which individuals are usually awake for more than 24 hours, or chronic, which means less-than-normal sleep for several consecutive nights. Generally, the psychological effects of acute and chronic sleep deprivation are similar (Banks & Dinges, 2007). In our analysis, we therefore refrain from distinguishing between both forms of sleep deprivation. Sleep deprivation has been found to have impairing effects on human functioning, on the individual level (i.e., the cognitive level; for a review, see Alhola & Polo-Kantola, 2007) as well as on the inter-individual level (i.e., the social level; for a review, see Gordon et al., 2017)—clearly, impairments on both levels are highly relevant for negotiations.

### **2.1.2. Negotiations**

Negotiations are interactions between at least two parties in which the common goal is to achieve an agreement concerning a (perceived) conflict of interest (e.g., Pruitt & Carnevale, 1993). A negotiation is therefore characterized as a mixed-motive situation because, on the one hand, each party is motivated to act competitively to realize own interests ("claiming value"), while on the

other hand, there are also incentives to be cooperative and realize not only the own, but also the other party's interests to accomplish the mutual task of coming to an agreement ("creating value"; Hüffmeier et al., 2019). A useful and commonly accepted distinction has been made between distributive and integrative negotiations (Walton & McKersie, 1965). Whereas distributive negotiations are zero-sum situations (i.e., any gain for one party corresponds to an equivalent loss for the other party), in integrative negotiations, joint outcomes can, for instance, be increased by mutual concessions building on different priority structures (i.e., between-issue valuation) and/or identical preference structures (i.e., within-issue valuation) of the negotiation partners. Integrative solutions can only emerge if a negotiation provides possibilities to expand the total amount of dividable resources, benefiting all negotiation parties (e.g., Thompson & Hastie, 1990).

### **2.1.3. Joint Outcomes in Integrative Negotiations**

Most negotiations contain at least some degree of integrative potential (Raiffa, 1982; Thompson & Hastie, 1990). In such negotiations, the joint economic outcomes, that is, the mutual pay-off the negotiation partners receive based on the achieved agreement, are an important indicator of the success of a negotiation. Joint outcomes are the crucial measure of how integrative or mutually advantageous, in other words, objectively good, an agreement is. As the interests of both parties are at least partly compatible in integrative negotiations, it is possible to create additional value if the *integrative potential* is unlocked via recognizing the (partial) compatibility of the parties' interests and then using this knowledge. Making use of a negotiation's integrative potential to increase joint outcomes requires the exchange and processing of information, which can occur via three different approaches.

First, by using a heuristic trial-and-error approach, negotiators can draw inferences regarding the interests of the negotiation partner from an unsystematic exchange of offers and reactions to these offers (Pruitt & Lewis, 1975; Yao et al., 2021). These inferences can help to uncover the negotiation's integrative potential even without a direct and trustful information exchange about the parties' interests. For example, if a negotiation partner is highly reluctant to concede on a specific issue, the other negotiation partner could infer that this specific issue is of high priority for the negotiation partner.

Second, the integrative potential can also be tapped by using multi-issue offers, which can range from two to all negotiation issues (Weingart et al., 1999; Yao et al., 2021). When negotiators make a series of multi-issue offers and receive answers to these offers from their counterparts, all parties can glean information on the respective interests (Pruitt, 1981; Yao et al., 2021). For example, one could infer that negotiators have different priorities towards certain issues if they are willing to concede on one, but not on another issue in such a package offer.

The two aforementioned approaches can be effective in gaining valuable insights into the partner's priorities and preferences. However, in addition to information exchange, these approaches require systematic information processing and a valid interpretation to identify underlying priorities and preferences. As a third approach, negotiation parties can also engage in *interest-related information exchange* by directly providing interest-related information and by asking interest-related questions to unlock the integrative potential (Bazerman & Neale, 1982; Pruitt & Lewis, 1975; Thompson, 1991). For example, a negotiator could tell the other negotiator that a specific issue in the negotiation is more important to them than another issue.

All three approaches illustrate that the processing and exchange of information is crucial to understand and unlock the integrative potential of a negotiation and therefore is the key for optimizing joint outcomes (Fairfield & Allred, 2007; Thompson, 1991; Zerres et al., 2013). Any type of information exchange increases the likelihood to detect a negotiation's integrative potential, but the exchange of interest-related information most directly enables negotiators to understand the underlying priorities and preferences of the negotiation partner, as it explicitly provides relevant information. A correct understanding of the underlying priorities and preferences in turn can be used for *log-rolling*, that is, a systematic trade-off of low- and high-value issues (Froman & Cohen, 1970) and for exploiting compatible preferences (Thompson & Hrebec, 1996), thereby increasing the joint economic outcomes.

## **2.2. Effects of Sleep Deprivation on Joint Economic Outcomes**

Negotiations are complex and multi-faceted social interactions with a multitude of relevant outcomes (e.g., Cai et al., 2000; Curhan et al., 2006; De Dreu & Carnevale, 2003; Thompson, 1990). In this article, we put an emphasis

on the joint economic outcomes of negotiation partners in integrative negotiations. In such negotiations, processing large amounts of inter-related information is the key to arriving at optimal joint economic outcomes. A useful theoretical lens to understand the depth of information exchange and information processing in negotiations is dual-process models (e.g., Petty & Wegener, 1999). According to such dual-process models, individuals, or in our case negotiators, operate in two distinct *modi operandi* regarding information processing: Automatic and fast processing, using heuristics and routines (System-1 processing) versus slow and deliberative processing, using systematic and more complex approaches (System-2 processing). System-2 processing is cognitively effortful and presupposes a motivation for deep processing (Stanovich et al., 2014). Thus, if negotiators lack sufficient skills (cognitive capacities) and sufficient will (motivation) required for System-2 processing in a certain situation, they will not engage in systematic processing of interest-related information, or will fail to induce this type of information from the unsystematic exchanges of offers and counteroffers or multi-issue offers.

Based on theory and research on cognitive and motivational impairments due to sleep deprivation and as explained in detail below, we predict that sleep deprivation should be negatively related to information exchange and effective information processing in negotiations. We argue that this, in turn, should impair joint economic outcomes in integrative negotiations (see the *Propositions* 1.1 and 1.2 below and Figure 1).<sup>2</sup> Thus, we put forward the following general proposition:

*Proposition 1: Sleep deprivation should reduce joint economic outcomes in integrative negotiations.*

In the following, we will provide theoretical arguments and empirical findings that back up and specify this proposition. In particular, taking the dual-process perspective, we identified impaired *cognitive capacities* and reduced

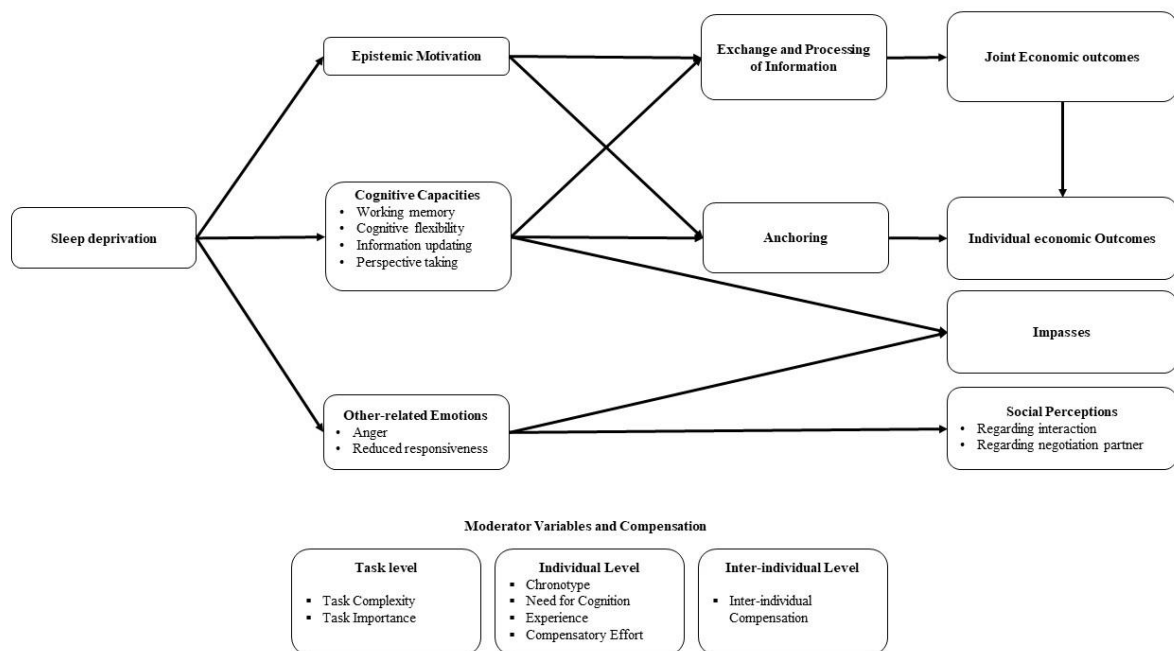
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<sup>2</sup> In purely distributive negotiations (i.e., zero-sum negotiations), joint economic outcomes are fixed, and therefore, by definition, sleep deprivation (as with any other factor) cannot have an impact on joint outcomes in this type of negotiation. However, in such negotiations, sleep deprivation should still have an impact on individual economic outcomes and impasses via different processes as we will show below.

*epistemic motivation* as crucial psychological pathways linking sleep deprivation to negotiation outcomes (see Figure 1). Each of these two broad pathway comprise different specific mediation mechanisms, which we will outline in detail below.

**Figure 1**

*Conceptual Model of Proposed Links between Sleep Deprivation and Negotiation Outcomes.*



*Notes.* The effect of sleep deprivation on joint economic outcomes is mediated by reduced cognitive capacities (Proposition 1.1) and reduced epistemic motivation (Proposition 1.2) via impaired exchange and processing of information. The effect of sleep deprivation on individual economic outcomes is mediated by increased anchoring due to reduced cognitive capacities and reduced epistemic motivation (Proposition 2), and—in the case of integrative negotiations—dependent on joint economic outcomes. The effect of sleep deprivation on more negative perceptions is mediated by more negative other-related emotions (Proposition 4). The effect of sleep deprivation on an increased likelihood of impasses is mediated by reduced cognitive capacities and more negative other-related emotions (Proposition 3).

### **2.2.1. Effects of Sleep Deprivation on Cognitive Capacities in Integrative Negotiations**

We expect that acute sleep deprivation will impair cognitive capacities that are relevant for exchanging and processing information in integrative negotiations, which reduces the likelihood of (fully) integrative joint economic outcomes. Because negotiations are cognitively taxing tasks involving the processing of a large amount of information (e.g., data, documents, terms,

schedules, verbal information, non-verbal information; Bazerman et al., 1999; De Dreu et al., 2006; Neale & Bazerman, 1991), they strongly claim cognitive processes such as working memory functions (Sharma et al., 2013).

By disrupting the executive functioning of the prefrontal cortex, acute sleep deprivation negatively affects various cognitive processes. Sleep deprivation, for instance, has a strong negative effect on vigilance and attention ( $d = -0.76$ , see Lim & Dinges, 2010, for a meta-analysis). These processes are, as Lim and Dinges (2008) argue, fundamentally important for all more complex forms of cognition. In particular, *working memory (WM)*, the "maintenance and manipulation of relevant information over a brief period" (Lim & Dinges, 2010; p. 381), is impaired. In a pertinent meta-analysis by Lim and Dinges (2010), aggregated moderate effects of  $g = -0.56$  for WM accuracy and  $g = -0.52$  for WM speed were reported, with a clear dose-effect relationship evident in increasing effect sizes with more hours awake (see also Philibert, 2005). The parietal cortex and other brain regions associated with verbal working memory show a decreased cortical response under sleep deprivation (Mu et al., 2005), suggesting that sleep-deprived individuals have less cognitive resources for paying attention to verbal cues.

Processing of verbal information is crucial in negotiations. Particularly, cues that are related to interest-related information are highly relevant for negotiations. Thus, the decreased cortical response represents an obvious obstacle to effective information processing. This notion is confirmed by a meta-analysis (Sharma et al., 2013), which found cognitive abilities ( $r = 0.20$ ) to be significantly predictive of joint economic outcomes. Moreover, it has been argued that WM functioning should be positively related to better negotiation outcomes (e.g., Fulmer & Barry, 2004). Hence, when cognitive capacities are impaired due to sleep deprivation, negotiations may result in suboptimal agreements. This is because sleep-deprived negotiators would be less effective in exchanging information and in drawing valid inferences from this information, which impairs unlocking a negotiation's integrative potential.

In addition to attention and working memory, several other cognitive functions that are relevant for information processing in negotiations are impaired due to sleep deprivation. The ability to incorporate new information into existing mental representations of a situation (*information updating*) is also

impaired by sleep deprivation (Durmer & Dinges, 2005; Lim & Dinges, 2010; Killgore et al., 2006). Moreover, it has been found that the ability to abandon previously optimal and now suboptimal problem solving strategies (*cognitive flexibility*, see Luchins, 1942) as well as the ability to generate new ideas is lower for severely sleep-deprived compared to well-rested participants (Frings, 2011; Horne, 1988).

In negotiations, common misconceptions are assumptions of incompatible interests and the fixed-pie-perception (e.g., De Dreu & Carnevale, 2003; Thompson & Hastie, 1990). Negotiators with a fixed-pie-perception assume that negotiations are—in general—zero-sum situations, thereby possibly overlooking a negotiation's integrative potential and many negotiators enter a negotiation with this misperception (Thompson & Hastie, 1990). Cognitive inflexibility and increased persistence of mental representations due to sleep deprivation should prevent such dysfunctional assumptions from being revised. In other words, even if relevant new information is made available through information exchange in the course of a negotiation, sleep-deprived negotiators may not (fully) revise their initial assumptions. Thus, a more correct representation of the underlying conflict of interest would not result (i.e., the negotiation would still be perceived as fixed-sum even though it is variable-sum).

Finally, we further predict that sleep deprivation should impair perspective taking, and reduced perspective taking should limit the exchange and processing of (interest-related) information, thereby decreasing joint outcomes. Perspective taking (Davis, 1983) is defined as the cognitive process of considering the world from another person's viewpoint, which allows reasoning about beliefs, intentions, and thoughts of others as well as anticipating their behavior and reactions (Galinsky et al., 2008). Taking another person's perspective is a cognitively complex and effortful procedure (Epley & Caruso, 2008) and it is therefore likely to be affected by sleep deprivation. In line with this, research outside the negotiation domain provides tentative evidence for the idea that sleep deprivation impairs perspective taking, for example, in spatial perspective taking (Deliens et al., 2018) or sarcasm detection (Deliens et al., 2015).

With respect to negotiations, perspective taking has been argued to be an antecedent of the exchange and processing of interest-related information, because perspective taking is crucial to arrive at valid inferences regarding the other party's—potentially divergent—interests (e.g., Neale & Bazerman, 1983; Kemp & Smith, 1994). Supporting this theoretical notion, Trötschel et al. (2011) found that inducing a perspective-taking mindset in negotiations alleviates the risk of partial impasses and improves joint outcomes. These results are in line with Galinsky et al.'s (2008) findings that perspective taking helps to reach higher joint economic outcomes as compared to a focus on the own perspective.

With regard to cognitive capacities, we put forward the following proposition:

*Proposition 1.1: The negative effect of sleep deprivation on joint economic outcomes should be partially mediated via impaired cognitive functions, which result in a less effective exchange and processing of information and a higher proneness to the fixed-pie-perception.*

More specifically, we state that the most crucial impaired cognitive functions acting as concrete potential mediating mechanisms are a) working memory capacities, b) cognitive flexibility, c) information updating, and d) perspective taking.

### **2.2.2. Effects of Sleep Deprivation on Epistemic Motivation in Integrative Negotiations**

In addition to cognitive impairments, *motivational effects* of sleep deprivation can also negatively influence information exchange and processing, thereby jeopardizing joint economic outcomes. We predict specifically that sleep deprivation should impair epistemic motivation. Epistemic motivation is the motivation to obtain an accurate and comprehensive understanding of an issue or a situation, and the willingness to exert cognitive effort to achieve this goal (e.g., De Dreu et al., 2008; Kruglanski & Webster, 1996). Epistemic motivation is conceptualized as a state variable and is therefore susceptible to situational factors like fatigue (e.g., De Dreu, 2003; Webster et al., 1996). Generally, when sleep deprived, individuals show a reduced willingness to engage in cognitively demanding tasks and are less motivated to systematically process complex information (e.g., Odle-Dusseau et al., 2010; see Engle-

Friedman, 2014, for a review). Although we are not aware of any direct empirical tests of the effects of sleep deprivation on epistemic motivation there is good reason to assume a negative impact. First, sleep deprivation has been found to curb motivation in general (Engle-Friedman, 2014). Second, for the specific case of epistemic motivation, it has been found that mental fatigue reduces epistemic motivation (Webster et al., 1996); and sleep deprivation is typically accompanied by mental fatigue (Durmer & Dinges, 2005).

Successful negotiations and especially fully integrative agreements require high levels of epistemic motivation (Brett & Thompson, 2016; De Dreu et al., 2008). Epistemic motivation contributes to joint outcomes in integrative negotiations, because negotiators have to be motivated to systematically exchange and process information that is relevant to priorities and preferences in a negotiation (for a related argument, see De Dreu et al., 2000, and Faber et al., 2017). In line with dual-process accounts, when epistemic motivation is low, however, information search is generally reduced and less systematic and the available information is processed more heuristically.

In line with this theoretical argument, negotiators with high epistemic motivation have been found to show a better understanding of the negotiation situation and the underlying conflict of interest, and they reached better joint outcomes (e.g., Ten Velden et al., 2010). Conversely, De Dreu et al. (1999) showed that low dispositional epistemic motivation leads to a heightened use of heuristics in negotiations.

In light of the eroding effects of sleep deprivation on the motivation to exchange and process complex information, we propose a negative effect of sleep deprivation on joint outcomes via reduced epistemic motivation:

*Proposition 1.2: The negative effect of sleep deprivation on joint economic outcomes should be partially mediated via epistemic motivation: Sleep deprivation is negatively related to negotiators' epistemic motivation, which reduces the systematic exchange and processing of information, which in turn decreases joint economic outcomes.*

### **2.3. Sleep Deprivation and Economic Outcomes in Distributive Negotiations**

In integrative negotiations, joint economic outcomes can be considered as an objective benchmark for success. As, by definition, joint economic outcomes are the combined individual outcomes of the negotiation partners, psychological processes negatively affecting integrative solutions also reduce individual outcomes. In distributive negotiations, however, the joint outcomes are fixed (by definition), and therefore individual economic outcomes are of central interest. We argue that sleep deprivation further affects individual outcomes in such purely distributive contexts, due to increased heuristic processing, as a consequence of decreased cognitive capacities and epistemic motivation.

When lacking the skill and will for systematic information processing, people tend to operate in System-1 and rely more on automatic processing, routines and heuristics. In line with this, it has been found that sleep-deprived individuals use more heuristic information processing (Ghumman & Barnes, 2013; McKenna et al., 2007). Heuristic information processing can, in turn, play out in negotiations by biasing the evaluation of offers or requests. With respect to negotiations, heuristic processing in terms of anchoring is of particular interest (Galinsky & Mussweiler, 2001, Gunia et al., 2013). Anchoring is defined as the assimilation of a judgement to a relevant or arbitrary value (anchor) that is externally provided prior to judgement (Tversky & Kahneman, 1974). Anchors have been found to have strong effects on judgement and decision making in diverse domains, such as probability estimates, legal judgements, purchasing decisions or forecasting (see Furnham & Boo, 2011, for an overview). In negotiations, first offers made by the negotiation partner can be powerful anchors. In three experiments, Galinsky and Mussweiler (2001) for instance found consistent evidence that first offers had an even stronger impact on final agreements than the subsequent concessions from both parties and that the negotiator who made the first offer obtained the better outcome (see also Moran & Ritov, 2002; Yukl, 1974, for related findings). This first-mover advantage is particularly pronounced in distributive negotiations, where the offer provides merely a numerical anchor without implying priority-related information (Loschelder et al., 2016).

As noted above, from a theoretical perspective, the role of anchoring in negotiations can be best understood through the lens of dual-process models (Kahneman, 2011). The presentation with an anchor (first offer) at least initially results in automatic processing of this anchor (System 1 - processing), using simple comparative strategies (“Is the offer too high?”) and activation or generation of anchor-consistent knowledge (“How is this offer justified?”; Mussweiler & Strack, 2000). Moreover, it signals a range of plausible agreements and sets the stage for the final agreement (Galinsky & Mussweiler, 2001).

Hence, by increasing susceptibility to anchoring, sleep deprivation should have negative effects on individual economic outcomes for the receiver of the first offer. In contrast, for the provider of the first offer, sleep deprivation may even increase individual economic outcomes. Because sleep deprivation reduces inhibition and self-regulatory capacities (Welsh et al., 2014), sleep deprived negotiators might be bolder in setting their own anchors. This in turn can increase their final individual economic outcome, particularly if the negotiation partner shows increased proneness to anchoring due to sleep deprivation.

In sum, we argue that sleep deprivation should increase the susceptibility to anchoring, by impairing cognitive capacities and epistemic motivation. Thus, when negotiating under sleep deprivation, first offers are likely to have an even stronger impact compared to negotiating under well-rested conditions. Thus, we propose:

*Proposition 2: Sleep deprivation should increase the proneness to anchoring, thereby increasing the first-mover advantage. Therefore, the negotiation partner making the first offer should realize higher individual economic outcomes, whereas the receiver of the first offer should realize lower individual economic outcomes.*

#### **2.4. Sleep Deprivation and Emotions in Negotiations**

Beyond cognitive functioning and motivation, emotions may play a crucial role in negotiations under sleep deprivation. In fact, the effects of sleep deprivation on mood seem to be even more pronounced as compared to the effects of sleep deprivation on cognitive performance (see Pilcher & Huffcutt, 1996, for a meta-analysis). In negotiations under sleep deprivation the role of

emotions should be two-fold with a need to differentiate between a) emotions as processes, and b) emotions as outcomes.

#### ***2.4.1. Emotions as Processes: Other-Related Emotions and Emotional Responsiveness***

There is a plethora of studies showing negative effects of sleep deprivation on socio-emotional processing, with sleep deprivation altering the likelihood and intensity of negative emotions and reducing emotional responsiveness (see Ben Simon et al., 2020, for a recent review). Sleep deprivation is also associated with increased emotional instability and irritability (Minkel et al., 2012).

For negotiations, the inter-individual functions of emotions are of particular interest, because they most likely have an impact on interactions during the negotiation. In other words, emotion expression and emotional responsiveness is altered as a consequence of sleep deprivation, which in turn affects the negotiation process and ultimately negotiation outcomes.

Particularly, sleeping poorly can induce feelings of anger (Short & Louca, 2015). In line with this, in an experimental study with a manipulation of sleep loss (restricted sleep over two days), Krizan and Hisler (2019) found that sleep loss can also intensify anger and prevent anger reduction over time. Moreover, sleep deprivation is related to reduced emotional intelligence, for example, expressed in reduced empathy for others (e.g., Killgore et al., 2008). Sleep-deprived individuals are less accurate at identifying emotions such as happiness or anger in other people's facial expressions (van der Helm et al., 2010). Sleep deprivation has also been found to influence emotional expressivity (i.e., fewer emotional words but a higher ratio of negative affective expressions are uttered, see Beattie et al., 2015, for a systematic review). In sum, as compared to well-rested individuals, sleep deprived individuals tend to show more negative other-related emotions, reduced accuracy in emotion perception and reduced emotional responsivity (cf. Ben-Simon et al., 2020).

In light of these findings, it seems likely that in negotiations under sleep deprivation negotiators would also be more likely to express negative other-related emotions, such as anger and would be less responsive to emotions expressed by the other party. Anger, accuracy of emotion perception, and responsiveness to emotions should affect socio-emotional outcomes of

negotiations, that is, social perceptions of the negotiation and the negotiation partner (see below). Moreover, as we will show in the next section, negative other-related emotions should also increase the likelihood of impasses.

#### **2.4.2. Emotions as Outcomes: Social Perceptions**

In addition to ‘hard’ outcomes (i.e., the agreement detailing, for instance, the division of resources or mutual obligations), ‘soft’ outcomes of negotiations, such as social-emotional consequences, should also be taken into account (Curhan, et al., 2006; Thompson, 1990). In a seminal paper, Thompson (1990) argues that to arrive at a more holistic understanding of negotiations, the exclusive focus on objective economic outcomes is detrimental, because it tends to overlook relevant outcomes of negotiations—especially social perceptions. These social perceptions include the evaluation of and satisfaction with the negotiation process, the agreement, the negotiation partner, and the self (cf. Curhan et al., 2006).

Curhan et al. (2006) emphasize the importance of better accounting for the affective evaluations of the final agreement, and obviously, the mood and satisfaction of the negotiators are important outcomes in their own right. In addition, these *post-negotiation* social perceptions can foreshadow future negotiations, determining the economic outcomes of the negotiations to come (even when controlling for the economic outcomes of the first negotiation; Curhan et al., 2010). In line with this, aversive feelings regarding the interaction and the negotiation partner can reduce the willingness to cooperate in future negotiations (Kopelman et al., 2006). Reduced willingness to cooperate may jeopardize establishing effective long-term negotiation relationships, such as vendor-buyer relationships, political coalitions or romantic relationships.

We argue that social perceptions and feelings regarding *the process* and *the negotiation partner* are most likely to be influenced by sleep deprivation: Due to reduced emotion expression and impaired responsiveness the subjective interaction quality is likely to be less satisfying and the negotiation partner should appear less likable and sociable. Moreover, amplified anger in sleep-deprived negotiators should on the one hand negatively bias the own perception of the interaction and the negotiation partner (cf. *feelings-as-information theory*; Schwarz, 2010). On the other hand, hardline bargaining

such as expressing anger when rejecting offers should also produce more negative social perceptions in the negotiation partner (Hüffmeier et al., 2014).

Taken together, with respect to emotions as processes and outcomes in negotiations, we state:

*Proposition 3: Sleep deprivation should result in more negative social perceptions, that is, feelings and evaluations regarding the interaction and the negotiation partner.*

More specifically, this effect is mediated by sleep deprivation-induced a) anger, and b) reduced emotional responsiveness.

## **2.5. Sleep Deprivation and Impasses**

We predict that sleep deprivation increases the risk of impasses through impaired cognitive flexibility and perspective taking as well as sleep deprivation-induced anger. Impasses emerge when the negotiating parties fail to reach a mutual agreement and, thus, the negotiation is terminated without the conflict of interest being solved (Tripp & Sondak, 1992). Knowledge about impasses is currently still limited (e.g., Cotter & Henley, 2017; Tuncel et al., 2016), but some factors have been discussed to help avoid impasses and deadlock negotiations. With respect to our model, it is interesting to note that the likelihood of impasses does not differ as a function of epistemic motivation (Ten Velden et al., 2010; van der Schalk et al., 2010). However, cognitive capacities may play a crucial role in whether or not an agreement is reached. In particular there are two relevant cognitive processes that have been found to contribute to the likelihood of impasses: cognitive flexibility in the bargaining process (Druckman & Mitchell 1995; Spector, 1995) and perspective taking (Galinsky et al., 2008; Trötschel et al., 2011). Cognitive inflexibility should lead to more rigid representations of the conflict of interests and reduced perspective taking should prevent the understanding of the negotiation partner's interests and therefore reduce the possibility of making mutually beneficial concessions. Because—as laid out earlier—cognitive flexibility and perspective taking are likely to be impaired by sleep deprivation, sleep deprivation should increase the danger of non-agreements.

Furthermore, it has been found that the likelihood of impasses increases due to negative other-directed emotions, particularly anger (Adam & Brett, 2018; Yip & Schweinsberg, 2017). Thus, as an additional mediation pathway,

sleep deprivation should increase the likelihood of impasses through sleep deprivation-induced and intensified anger (Krizan & Hisler, 2019; Short & Louca, 2015).

Taken together, our theoretical analyses suggest that in addition to a reduced quality of negotiation agreements and socio-emotional outcomes, sleep deprivation should also increase the likelihood that no agreement is reached at all. Hence, we state:

*Proposition 4: Sleep deprivation should increase the likelihood of impasses in negotiations.*

More specifically, this effect is mediated by a) cognitive flexibility, b) perspective taking, and c) anger.

## **2.6. Discussion**

In our theoretical framework we identified three focal mechanisms—cognitive capacities, epistemic motivation, and emotions—through which sleep deprivation should influence negotiation outcomes. Our theoretical analysis has revealed a coherent picture: Sleep deprivation should generate negative effects in negotiations. Specifically, we posit that it decreases joint economic outcomes (and thereby also individual joint outcomes), produces more negative social perceptions, and increases the danger of impasses.

### **2.6.1. Moderators and Compensation of Sleep Deprivation<sup>3</sup>**

Although in general we expect negative effects of sleep deprivation on joint economic outcomes, we acknowledge that the occurrence and extent of these negative effects might not be uniform and robust, but is also a function of specific characteristics of (i) the negotiation task, (ii) the involved individual negotiator(s), and (iii) the interaction between the negotiators. To be clear here, we do not expect any positive effects of sleep deprivation on negotiation outcomes, but identify conditions under which sleep deprivation is *less* likely to produce negative effects, and thus, could be compensated for.

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<sup>3</sup> Note that some of the variables conceptualized in our model as a moderator (e.g., task complexity) likely have a direct effect on our proposed mediators (e.g., epistemic motivation), but also on some of the outcomes (e.g., economic outcomes). Although we acknowledge such potential relationships, we refrain from including them in our model for reasons of parsimony, because these relationships should occur independently of sleep deprivation and thus do not inform about our key research question, that is, how negotiation outcomes are influenced by sleep deprivation.

The idea that the negative effects of sleep deprivation on joint negotiation outcomes can be compensated for by different mechanisms is also reflected in the first empirical manuscript on the topic [*Chapter 3*]. In two experiments, in which participants performed a dyadic integrative negotiation task either well-rested or after a night of total sleep deprivation, sleep-deprived negotiators did not achieve worse joint outcomes than well-rested negotiators. Moreover, in a third experiment, using a sleep restriction manipulation, sleep-deprived individuals also did not propose inferior agreements after observing a videotaped negotiation. However, in these studies, there was consistent indication of compensatory efforts by sleep-deprived negotiators. Furthermore, as a result of a further, qualitative interview study, experienced politicians reported their compensatory strategies to counteract negative effects of sleep deprivation in real-life political negotiations.

**Moderators and Potential for Compensation at the Task Level.** A task characteristic that potentially moderates the impact of sleep deprivation in negotiations is *task complexity*. With an increasing number of negotiable issues, the potential for integrative bargaining does expand (Geiger & Hüffmeier, 2020), but at the same time a higher number of negotiable issues means that the task becomes more complex and requires more cognitive effort (Geiger & Hüffmeier, 2020; van der Schalk et al., 2010). Generally, and perhaps somewhat contra-intuitively, for tasks outside the negotiation domain, it has been found that the impact of sleep deprivation is typically stronger and more stable in simple compared to more complex tasks (see Harrison & Horne, 2000; Horne, 2012, for a discussion). For example, rather basic cognitive functions (e.g., psychomotor vigilance) are more susceptible to sleep deprivation as compared to higher cognitive functions (e.g., short-term memory; Lim & Dinges, 2010).

One reason for this finding might be that the potential to compensate for deficits induced by sleep deprivation should increase as a function of complexity, as in highly complex tasks outcomes are determined multi-causally and different approaches can be applied to reach an outcome. In contrast, in tasks low in complexity, the potential for compensation is restricted, as outcomes are determined by fewer factors, and the variety in ways to approach the task is limited. Moreover, Harrison and Horne (2000) argue that higher task

complexity intrinsically motivates sleep-deprived individuals to show compensatory effort. With such increased efforts, sleep deprivation-related deficits can be counteracted and performance can be maintained over time (e.g., Horne & Pettitt, 1985; Hsieh et al., 2010).

A second characteristic of negotiations that should produce compensatory effort is the *(subjective) importance of the negotiation*. Given the nature of negotiations as a means to solve social conflicts, many negotiations are of high individual importance (e.g., union-employer negotiations). Thus, negotiators should be inclined to perform well and to accept additional effort to optimize negotiation outcomes. We suppose that particularly those negotiations that are carried out under sleep deprivation are typically high-stakes negotiations, with far-reaching consequences for either the negotiators and/or their constituents, further stakeholders, or even the broader public at large (think of, e.g., international political summits, union-employer negotiations, or negotiations during hostage-takings). Even under sleep deprivation, high subjective importance should translate into increased effort to meet the demands of the situation, allowing for compensating sleep deprivation-induced impairments (cf. Deliens et al., 2015, Faber et al., 2017).

Taken together, we argue that if task characteristics allow for and are likely to elicit compensatory effort (as in complex situations or in important negotiations) negative effects of sleep deprivation are likely to be alleviated by active compensatory efforts.

#### **Moderators and Potential for Compensation at the Individual Level.**

Between-person differences can influence if sleep deprivation unfolds its effects in a negotiation or could be compensated for. Generally, some people are more resilient to sleep deprivation than others. They are more effective in coping with sleep loss (Saksvik et al., 2011). The knowledge on the foundations of these between-person differences in terms of personality and cognitive styles is still sparse (see Horne, 2012, for a discussion), but accumulating evidence has emphasized the role of chronotype as a moderator. Chronotype describes between-person differences in the circadian 24-hour cycle of physiological and psychological functioning (e.g., Horne & Östberg, 1976; Monk et al., 1997). Chronotype is approximately normally distributed, but extreme morning types ('larks') and extreme evening types ('owls') do exist (Roenneberg et al., 2007).

These extreme types show specific wake-sleep patterns (larks: early to bed and early to rise; owls: late to bed and late to rise) and performance peaks over the course of the day (larks: morning; owls: late afternoon/evening). There is also evidence that evening types are better in adjusting to sleep loss and in compensating for the negative effects of sleep deprivation than morning types (Saksvik et al., 2011; Taillard et al., 2011). Hence, we predict that late types are better in compensating for sleep deprivation and should therefore perform better in negotiations under sleep deprivation compared to morning types.

Although there is still a lack of research regarding the role of personality traits in shaping the effects of sleep deprivation, there is preliminary evidence that *need for cognition* may serve as a buffer of negative effects of sleep deprivation. Need for cognition describes a trait characterized by high motivation and enjoyment when performing cognitive tasks (Cacioppo & Petty, 1982; Cacioppo et al., 1996). Kobbeltvedt et al. (2005) argue that individuals high in need for cognition should show more compensatory effort to counteract sleepiness and maintain cognitive performance when being sleep-deprived. In line with this prediction, they found that, when sleep-deprived, cadets scoring high in need for cognition performed better in planning a military operation than cadets low in need for cognition.

In the context of between-person differences, it has also been argued that experience matters when coping with sleep deprivation (Horne, 2012). Hence, in life domains in which high-stakes negotiations under sleep deprivation are common (e.g., in the political arena), the involved negotiators should be better able to compensate for the negative effects of sleep deprivation due to experience and habituation. Even a survival bias is possible: Individuals who are resilient to sleep loss are more likely to arrive at positions where they have to negotiate through the night on a regular basis (Häusser, 2017).

Taken together, individual negotiators can compensate for negative effects of sleep deprivation by taking measures to fight sleepiness or increase effort. Some individuals (i.e., late types, those scoring high in need for cognition, those who are highly experienced) should be more effective in doing so.

**Moderators and Potential for Compensation at the Inter-Individual Level.** As we discussed earlier, negotiations are interpersonal mixed-motive

situations, where the motivation of the individual negotiator is to optimize their individual outcome, while at the same time the negotiators have the collective goal to reach a mutual agreement. In this sense, negotiations show similarity with some tasks, which are often used in studies on group dynamics and performance. In negotiations, the insight that a partial compatibility of interests exists is the key to tapping into the integrative potential and to optimizing joint economic outcomes. Hüffmeier et al. (2019) argue that this task is of a eureka-type, which makes integrative negotiations similar to disjunctive group tasks (cf. Steiner, 1972). Particularly, Hüffmeier et al. (2019) show that an integrative solution in negotiations is sufficiently demonstrable and intuitively plausible for negotiators, as they immediately recognize that this solution would increase the achieved economic outcomes. Hence, due to the sufficient demonstrability (cf. Laughlin & Ellis, 1986) of integrative solutions, it can suffice if one negotiation partner identifies the partial compatibility of interest to unlock the integrative potential (see, however, Zerres et al., 2013).

For the case of negotiations under sleep deprivation, this would mean that compensation on the inter-individual level is possible: Due to the disjunctive nature of integrative negotiations, compensation on the inter-individual level can counteract negative effects of sleep deprivation. Research on group performance under fatigue has shown that groups engage in group monitoring (Frings, 2011), that is, the individual impairments of the group members are monitored by the group and accounted for when working together. Hence, in integrative negotiations, if at least one negotiation partner effectively copes with sleep deprivation, for example, due to compensatory effort or experience, the negative effects of sleep deprivation on joint economic outcomes can be diminished.

## **2.7. Practical Implications**

Our theoretical analysis reveals that sleep deprivation has the potential to negatively affect negotiation processes and outcomes in several ways. Although these negative effects can be compensated for, particularly by increased individual or collective effort, there is no good reason to assume that negotiations under sleep deprivation should produce any *better* outcomes as compared to negotiations under well-rested conditions. In other words, the best outcome that should emerge is that no bad consequences occur. That said, the

high prevalence of sleep-deprived negotiations in economy, politics, close relationships, or in the labor market appears somewhat disturbing.

Of course, there are situations that are highly critical in time, such as negotiations between conflict parties at the brink of an armed conflict or in hostage-taking situations (see Mertes et al., 2020). However, in other cases, the perceived need to “sit it out” all night and to arrive at an agreement no matter how long it takes is often self-inflicted. A clear-cut practical recommendation based on our analysis would be to refrain from negotiations under sleep deprivation whenever possible.

Our analysis highlights the crucial role of two psychological pathways, namely cognitive capacities and epistemic motivation for negotiations in general and for negotiations under sleep deprivation in particular. Hence, from a practical perspective, it seems to be wise to account for impairments of these two processes whenever our recommendation to refrain from negotiations under sleep deprivation cannot (or will not) be followed. Specifically, we advise creating conditions that allow for compensation of sleep deprivation induced impairments. It has been found that sleep deprived individuals are aware of their sleep deprived impairments (Baranski, 2007) and readily use decision aids to compensate for these impairments (Häusser et al., 2016).

For negotiations, that would mean measures must be taken that support the exchange and processing of information. For example, as cognitive capacities of the negotiators are likely to be decreased, the cognitive load produced by the negotiation task should be reduced. Several decision aids to reduce cognitive load in negotiations have been shown to be effective. For example, providing a negotiation structure with explicit phases of information accumulation and information assessment supports accurate judgements in negotiations (Arunachalam & Dilla, 1995). Additionally, graphical presentations of negotiation-relevant information can reduce cognitive load (see Gettinger & Koeszegi, 2014, for a review). Another effective approach to support the negotiation process is third party mediation as it should compensate for impaired cognitive capacities by promoting the flow of information and supporting uncovering underlying interests (Carnevale & Pruitt, 1992).

Moreover, specific measures can be taken to increase epistemic motivation. For example, introducing higher levels of accountability, reducing

environmental noise, or reducing time pressure have been found to increase epistemic motivation in social mixed-motive situations (see De Dreu et al., 2008, for an overview).

## **2.8. Concluding Remarks**

In an extensive theoretical analysis, we examined the potential effects of sleep deprivation on negotiation processes and outcomes. Based on our analysis, we conclude that sleep deprivation is likely to have negative effects on joint and individual economic outcomes, socio-emotional outcomes, and impasses. The driving forces behind most negative effects are impairments in cognitive capacities and epistemic motivation. These impairments in turn reduce or bias information processing and hamper effective information exchange necessary to arrive at optimal agreements. Although the expected negative effects are highly likely to occur, a compensation of these impairments on the task level, the individual level, and the inter-individual level is possible, and thereby negative effects may be reduced or even fully alleviated.

## Chapter 3: Empirical Examination of the Model

**Publication status:** The following Chapter 3 represents a manuscript with the title “*Sleep deprivation and negotiation*”.<sup>4</sup>

### 3.1. Introduction

Negotiations are a fundamental element of human social life—in private matters, in business, and politics (De Dreu & Gelfand, 2008). Whether the subject of a negotiation is how to distribute household chores, how to resolve conflicts in labor negotiations, or how to manage a global pandemic—at times, negotiations are prolonged late into the night. They continue until an agreement is finally reached or an impasse is inevitable, often far beyond the time the negotiators would usually go to sleep. There is robust evidence that sleep deprivation negatively affects cognitive performance and motivation of individuals (Lim & Dinges, 2010; Kruglanski & Webster, 1996) with more severe decrements evident with prolonged wakefulness (Lim & Dinges, 2010; Philibert, 2005). For example, sleep deprivation severely impairs working memory, and also more complex decision-making (cf. Alhola & Polo-Kantola, 2007; Harrison & Horne, 2000). But does a lack of sleep also negatively impact the quality of socially interactive decisions such as negotiation agreements? The key objective of this paper is to investigate whether sleep deprivation impairs the outcomes of negotiations or whether it is possible to overcome potential impairments and still arrive at satisfactory negotiation agreements.

There is growing theoretical interest in potential impairments due to sleep deprivation in social contexts (Barnes & Hollenbeck, 2009; Beattie et al., 2015; Faber et al., 2017; Gordon et al., 2017; 2021), and first empirical examinations of the influence of sleep on decision making in social contexts have been conducted (e.g., Anderson & Dickinson, 2010; Dickinson & McElroy, 2017). Still, this earlier research does not address the practically and theoretically highly relevant case of negotiations. Here, we deliver a first examination of how sleep deprivation affects negotiations. We use a multi-

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<sup>4</sup> Halfmann, E., Hüffmeier, J., Faber, N. S., & Häusser, A. (unpublished manuscript). Sleep deprivation and negotiation.

method approach combining experimental studies with qualitative data, focusing on the effects of insufficient sleep on joint economic outcomes in bilateral integrative negotiations. With that, our studies contribute to the literature in both fields, sleep research and negotiation research. Regarding sleep research, our research provides insights into the—yet understudied—social effects of sleep (Christian & Ellis, 2011; Faber et al., 2017), and, more broadly, contributes to the discussion around how individual-level impairments play out in social contexts (Faber et al., 2017; Faber & Häusser, 2022). Regarding negotiation research, we assess the effect of a highly prevalent context factor. Sleep deprivation has been dubbed a public health epidemic by the U.S Centers for Disease Control and Prevention (2015), and is even more likely to be present in high-stakes negotiations (e.g., political summits, labor negotiations, crisis situations). By addressing the effects of this contextual factor on negotiation outcomes, we gain further insight into the determinants of successful negotiation.

### **3.1.1. Integrative Negotiations**

Negotiations are social interactions in which two or more parties seek to find a mutual agreement concerning a (perceived) conflict of interests (Pruitt, 1983; Pruitt & Carnevale, 1993). A broad distinction is typically made between distributive and integrative negotiations (Walton & McKersie, 1965). In distributive negotiations, the parties have to allocate resources and one party's gain corresponds to an equivalent loss of the other party (i.e., zero-sum situations). In contrast, in integrative negotiations (i.e., variable-sum situations), the interests of both negotiating parties can be partly reconciled, and negotiators can systematically trade mutual concessions when the respective priorities concerning the negotiation issues differ between negotiation partners (i.e., *log-rolling*, Froman & Cohen, 1970; Thompson & Hastie, 1990) or they can even identify issues where the parties have identical preferences (Thompson & Hrebec, 1996). By recognizing the parties' different priorities regarding (some of) the negotiation issues and the even full compatibility regarding other issues and using this knowledge appropriately, negotiators can increase the *joint economic outcomes* (i.e., the mutual "payoff" of both sides resulting from the agreement) beyond mere compromises (i.e., using the so-called *integrative potential*, Walton & McKersie, 1965).

Most negotiations comprise at least some integrative potential (Raiffa, 1982; Thompson & Hastie, 1990). Joint economic outcomes are therefore an important indicator for the success of a negotiation, or more specifically, the overall quality of the negotiation agreement. To identify the integrative potential in a negotiation and to be able to engage in strategies such as log-rolling, a correct understanding of the interest structure of the negotiation partners is crucial, and effective information exchange and information processing are of utmost importance (Thompson, 1991; Zerres et al., 2013). For example, a valid representation of the interest structures (the partner's priorities and preferences) can be obtained when negotiators directly provide (or ask for) interest-related information to unlock the integrative potential (*interest-related information exchange*; Hüffmeier et al., 2019; Thompson, 1991) and are thereby able to optimize the joint outcomes. Beyond direct exchange of interest-related information, by using a heuristic *trial-and-error* approach negotiators can unsystematically exchange offers and counteroffers (Pruitt & Lewis, 1975). From these offers and counteroffers (and the negotiation partner's reactions to them) negotiators can infer the partner's priorities and preferences. For example, if a negotiator is very persistent with respect to a specific negotiation issue, the negotiation partner may infer that this specific issue is of high priority to them. Whether via the interest-related or the trial-and-error route, information exchange and processing are crucial to enable the systematic trade-off of low and high-value issues (Froman & Cohen, 1970) and the recognition of issue compatibility (Thompson & Hrebec, 1996). Thus, information exchange and processing are key to unlock the integrative potential and increase joint economic outcomes (Thompson, 1991; Zerres et al., 2013).

We predict that effective information exchange and processing of information in negotiations is jeopardized by sleep deprivation due to cognitive and motivational impairments among the negotiators. In turn, this should hinder the identification of the integrative potential and thereby reduce joint economic outcomes.

### **3.1.2. Sleep Deprivation and Negotiation**

Sleep deprivation refers to a state of insufficient sleep, in which individuals are usually awake for more than 24 hours. However, periods of chronically restricted sleep over several days—which can occur for example in

situations of collective bargaining or political negotiations— also produce cumulative deficits comparable to those of total sleep deprivation (Van Dongen et al., 2003). Sleep deprivation has been found to impair diverse domains of cognitive functioning (for a review, see Alhola & Polo-Kantola, 2007) and motivation (for a review, see Engle-Friedman, 2014) and both factors are highly relevant for negotiation outcomes (De Dreu et al., 2000; Neale & Bazerman, 1992).

In the domain of cognitive functioning, there is consistent empirical evidence that sleep deprivation impairs vigilance, attention, and working memory capacity (Harrison & Horne, 2000; Lim & Dinges, 2010). Moreover, the ability to incorporate new information into an existing mental representation of a situation (*information updating*, cf. Harrison & Horne, 1999, 2000), to abandon suboptimal strategies (*cognitive flexibility*, cf. Luchins, 1942; Whitney et al., 2015), and to generate new ideas for problem-solving are impaired by sleep deprivation (Frings, 2011; Horne, 1988). Negotiations are cognitively demanding tasks involving the processing of large amounts of verbal and non-verbal information (Bazerman et al., 1999; De Dreu et al., 2006; Neale & Bazerman, 1991). Therefore, sufficient cognitive capacities are essential for the systematic exchange and processing of information, and these capacities are positively related to better negotiation outcomes (Fulmer & Barry, 2004; Sharma et al., 2013). Additionally, a common misconception of negotiators leads them to overestimate the conflict of interest and thereby overlook the integrative potential. Negotiators often assume that interests are incompatible, and also that negotiations are—mostly—zero-sum situations (*fixed-pie perception*, cf. De Dreu & Carnevale, 2003; Thompson & Hastie, 1990). Impaired information updating and increased cognitive inflexibility due to sleep deprivation may contribute to the persistence of such dysfunctional mental representations.

Taken together, when cognitive functions are impaired due to sleep deprivation, sleep-deprived negotiators should be less effective in exchanging and processing information and in drawing valid inferences from the obtained information, less likely to obtain valid representations of the negotiation partners' interests, and ultimately to unlock the integrative potential.

As laid out in dual-process models (e.g., Petty & Wegener, 1999), systematic processing of information requires the skill (cognitive resources) and the will (motivation) to do so. Hence, in addition to sufficient cognitive resources, negotiators' motivation should also play a crucial role in reaching successful agreements (in terms of maximizing joint economic outcomes). It has been found that sleep deprivation generally reduces the willingness to process complex information (Engle-Friedman, 2014; Odle-Dusseau et al., 2010). In particular, sleep deprivation could impair negotiators' *epistemic motivation* (see Webster et al., 1996, for a study on the effects of tiredness on epistemic motivation). Epistemic motivation means the motivation to obtain an accurate and comprehensive understanding of a situation and also the willingness to exert effort to gain such insights (De Dreu et al., 2008). As argued above, even if the cognitive resources might suffice for the systematic exchange and processing of information, motivation is still required to do so. Earlier research consistently demonstrated that successful and efficient negotiations and especially the unlocking of the full integrative potential require high levels of epistemic motivation (Brett & Thompson, 2016; De Dreu et al., 2008). More specifically, negotiators with high epistemic motivation reach higher joint economic outcomes (Ten Velden et al., 2010), while low epistemic motivation results in an increased use of sub-optimal heuristics in negotiations (De Dreu et al., 1999). If sleep deprivation decreases epistemic motivation in negotiations, negotiators should be less motivated to exchange and process information to arrive at an extensive and valid mental representation of the conflict of interests, which in turn should prevent them from exploiting the full integrative potential of a negotiation and, thus, leave them with inferior joint economic outcomes.

Thus, we put forward the following hypothesis: Sleep-deprived, as compared to well-rested negotiation dyads, will achieve lower joint economic outcomes in integrative negotiations.

Although the prediction of negative effects of sleep deprivation on joint economic outcomes is straightforward given the robust evidence for individual-level cognitive and motivational impairments (with consequences for individual performance), individual-level impairments do not necessarily translate into similar performance decrements in social contexts (see Faber et al., 2017, and

Faber & Häusser, 2022, for a discussion). In social contexts, an impaired individual might be inclined to invest additional effort to compensate for their impairment in order to meet the demands of the social situation (e.g., to fulfill expectations of others or general social norms, to build up a desirable reputation towards others, etc.). Moreover, social contexts allow for mutual compensation, with one interaction partner compensating for individual deficits of another (which naturally is not the case in individual performance). Given that negotiations are a powerful social context in terms of social demands and social influences, at least some efforts to compensate for sleep-deprivation-induced impairments may occur. For example, sleep-deprived negotiators might invest compensatory effort to meet the social demands of the negotiation (e.g., arriving at an individually and collectively satisfying agreement). Or negotiation partners might support each other with information updating. However, whether such compensation strategies, if they occur, would be able to trump the profound impairing effects sleep deprivation exerts on individual-level cognition, is an open question. Hence, if the results of our experimental studies should suggest a rejection of our hypothesis, we will put a special emphasis on compensation as the explanation.

To test our hypothesis, we conducted three experimental studies, two in the laboratory and one online, and pre-registered the second and third of these studies. In the first two experiments, dyads of sleep-deprived versus well-rested participants conducted an integrative negotiation. In Study 2, we replicated Study 1, while increasing statistical power with a larger sample, using a stronger manipulation of sleep deprivation, a more complex negotiation task, and measures of compensatory effort. Both studies revealed null effects and Study 2 provided evidence that these might be attributable to compensatory efforts. To test whether the lack of medium-sized effects was alternatively attributable to the activating experimental setting in the laboratory, we conducted an online experiment (Study 3) where participants passively observed a video-taped negotiation and were asked to propose an agreement. Again, we found no effect of sleep deprivation on the quality of proposed agreements and further support for compensatory effort. Considering the lack of support for our research hypothesis, and the possibility of compensatory effort, we aimed at learning about lay person's expectations about negotiating sleep-deprived in an

online survey (Study 4). If lay beliefs would result in expecting a negative impact of sleep deprivation this anticipation should trigger compensatory efforts. In an additional qualitative study (Study 5), we conducted semi-structured interviews to gain insights into strategies for compensation with politicians from different political levels like head of state, federal ministers, and mayors who are experienced with negotiating under sleep deprivation.

### **3.2. Study 1**

Study 1 provides a first-time test of the effects of sleep deprivation in negotiations by testing the impact of one night of total sleep deprivation on joint economic outcomes in an integrative negotiation.

#### **3.2.1. Method Study 1**

##### ***Transparency and Openness***<sup>5</sup>

In all studies we report how we determined our sample sizes, all data exclusions, and all manipulations. The exclusion of measurements is reported. Data were analyzed using IBM SPSS for Windows, version 24.0.–27.0. (2016, 2017, 2019, 2020). We provide the data and study materials on OSF upon publication. Three of the studies were pre-registered on OSF:

Study 2:

[https://osf.io/x8mgj/?view\\_only=271656baf6f647c0a49d78e1fc4a9cbf](https://osf.io/x8mgj/?view_only=271656baf6f647c0a49d78e1fc4a9cbf)

Study 3:

[https://osf.io/u8paj/?view\\_only=480750a3a1034fe9a9b07ac0deb01f52](https://osf.io/u8paj/?view_only=480750a3a1034fe9a9b07ac0deb01f52)

Study 4:

[https://osf.io/9d68m/?view\\_only=4ed71a53cbb344759b628245354c2fa](https://osf.io/9d68m/?view_only=4ed71a53cbb344759b628245354c2fa)

2.

##### ***Participants and Design***

Ninety-six participants took part in the study. We only included participants who did not (i) work night shifts, (ii) suffer from chronic sleep disorders or depression, (iii) use sleep-inducing medication, or (iv) were not pregnant. Because some participants did not comply with the experimental protocol (e.g., no caffeine intake or no day-time napping), we had to exclude eight dyads resulting in a final sample of  $N = 80$  participants (40 dyads,

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<sup>5</sup> Please note that this section applies to all of the reported studies.

$M_{\text{age}} = 22.15$  years,  $SD_{\text{age}} = 3.09$ ; 18-31 years; 75% women). The theoretical foundations and empirical findings our research question is based on (i.e., individual-level effects of sleep deprivation), suggested that we should find at least medium effects for this type of manipulation on negotiation outcomes. Therefore, for this first test, the sample size was calculated to be sufficient to detect a large effect ( $d = .8$  for the critical test of the difference in joint economic outcomes between experimental conditions) with  $\alpha = .05$  and a  $1 - \beta = .8$  (G\*Power, Faul et al., 2007). We manipulated how the participants spent the night before testing by randomly assigning them to one of two *sleep status* conditions (sleep-deprived [ $n = 40$ ] versus well-rested participants [ $n = 40$ ]). All participants were recruited via email and were undergraduate students. To control for potential gender effects (Mazei et al., 2015; Stuhlmacher & Walters, 1999), we paired participants randomly in same-sex dyads. The study was conducted in accordance with the Declaration of Helsinki and approved by the local ethics board. Participants gave written informed consent, were fully debriefed, and received course credit for participation.

### **Procedure**

On the morning of testing, participants filled in questionnaires upon arrival indicating whether they complied with our instructions, and their subjective tiredness. Afterwards, participants were seated in a lecture room where a maximum of six randomly paired dyads negotiated simultaneously. Folding screens separated dyads providing a secluded work environment. The negotiators sat face-to-face at a table with a shoulder-high paper screen between them shielding individual negotiation material from each other's view. Participants had ten minutes to read instructions and take notes and 20 min to find an agreement for all of the four issues of the negotiation task. All negotiations were videotaped.

**Sleep Deprivation.** We used a sleep manipulation similar to Barnes and colleagues (2015). Participants in the well-rested condition were instructed to spend a night of normal sleep (at least 6 hours) at home. Participants in the sleep-deprived condition spent the night at home staying awake. They received an hourly email between 11 PM and 8 AM containing a link with to a short questionnaire, which they had to answer within 15 min to remain eligible for the

study. Participants were instructed to refrain from consuming caffeine and other psycho-stimulants. In both conditions, testing started at 9 AM.

**Negotiation Task.** We adapted a negotiation task from Thompson and Hastie (1990). Participants were either assigned to the role of a buyer or a seller in a car sale scenario. They had to find an agreement concerning four issues with five options each (see *Appendix*, Table S1; e.g., interest rate for financing, ranging from 2% to 10%). Participants received a payoff schedule specific to their role. The values for each option within the issues differed between them based on the assigned points. The task contained two distributive issues, for which one negotiating party's win was equivalent to the other party's loss (i.e., zero-sum issues). The other two were pair-wise integrative issues, which allowed for log-rolling. That is, one negotiating party's win was higher than the other party's loss for one of the two issues and vice versa for the other issue. The joint economic outcomes of an agreement could vary between 8000—the worst solution—and 12,800 points—for a fully integrative potential.

### **Measures**

**Manipulation Check.** To ensure the effectiveness of the sleep deprivation procedure, we asked participants to indicate their subjective tiredness on a 10-point scale, from '1 = not at all tired' to '10 = very tired' prior to the negotiation.

**Joint Economic Outcomes (Dependent Variable).** Based on the individual pay-off schedules, the joint economic outcomes were calculated as the sum of both parties' individual outcomes for the final agreement.<sup>6</sup>

**Exploratory Measures.** To shed light on the processes behind the potential effects of sleep deprivation, we also used a two-item scale of Energetic Arousal from the Multidimensional Mood Questionnaire (*MDMQ*, Wilhelm & Schoebi, 2007). Energetic arousal was measured with two bipolar items on a 7-point scale, from '0 = very tired' to '6 = very awake' and '0 = full of energy' to '6 = without energy' (reverse coded). Energetic Arousal was measured before ( $r = .717$ ,  $p < .001$ ) and after ( $r = .604$ ,  $p < .001$ ) the negotiation.

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<sup>6</sup> In Study 1, 2, and 3 we collected further data for constructs that had previously been associated with negotiation for exploratory or educational purposes. These are beyond the scope of the present paper.

### 3.2.2. Results Study 1

#### ***Induction of Sleep Deprivation***

Sleep-deprived participants ( $M = 7.41$ ;  $SD = 1.89$ ) stated that they were significantly more tired than well-rested participants ( $M = 4.80$ ;  $SD = 1.62$ ),  $t(77) = 6.60$ ,  $p < .001$  (one-tailed),  $d = 1.49$  prior to the negotiation, indicating a successful manipulation.

#### ***Joint Economic Outcome***

To test our hypothesis, we analyzed differences in joint economic outcomes between sleep-deprived and well-rested negotiators using an independent t-test. Results show that well-rested dyads ( $M = 11,480$ ;  $SD = 883.5$ ) did not realize higher joint economic outcomes as compared to sleep-deprived dyads ( $M = 11,780$ ;  $SD = 756.4$ ),  $t(38) = -1.153$ ,  $p = .128$  (one-tailed),  $d = -.37$ . Thus, our hypothesis was not supported by our analyses.

The average joint economic outcomes in both groups were significantly higher compared to the mere compromise agreement of 10,400 points, with  $t(19) = 5.47$ ,  $p < .001$ ,  $d = 1.22$ , for the well-rested dyads and  $t(19) = 8.16$ ,  $p < .001$ ,  $d = 1.82$ , for the sleep-deprived dyads. This indicates that in both conditions the integrative potential was realized to some degree. An additional t-test revealed that the joint economic outcomes of well-rested dyads,  $t(19) = -6.68$ ,  $p < .001$ ,  $d = -1.49$ , and the sleep-deprived dyads,  $t(19) = -6.03$ ,  $p < .001$ ,  $d = -1.95$ , were significantly below the maximum joint economic outcome of 12,800 points excluding the possibility of a ceiling effect as an alternative explanation for our null finding.

#### ***Exploratory Measures***

Regarding Energetic Arousal, we first conducted a repeated-measures ANOVA with condition as a between-subjects factor (well-rested vs. sleep-deprived negotiators) and Energetic Arousal as a within-subjects factor (before vs. after negotiation), and found a significant interaction,  $F(1,76) = 6.39$ ,  $p = .014$ ,  $\eta_p^2 = .08$ . Dependent t-tests of the simple effects verified that Energetic Arousal only increased for the sleep-deprived negotiators,  $t(37) = -4.14$ ,  $p < .001$ ,  $d = -.67$ , but not for well-rested negotiators,  $t(39) = -1.70$ ,  $p = .097$ ,  $d = -.27$ .

### 3.2.3. Discussion Study 1

Study 1 provides a first-time test of the role of sleep deprivation in negotiations and revealed evidence speaking against a large negative effect of sleep deprivation on joint economic outcomes (our hypothesis was not supported). However, this was the very first test of an effect of sleep deprivation, thus, the finding needs further examination. To allow for more reliable conclusions, we conducted a second experiment with several crucial changes. We first increased the sample size of Study 2 as compared to Study 1. Second, although we used a procedure to induce sleep deprivation in Study 1 that has been successfully used before (Barnes et al., 2015), we used a stronger manipulation in Study 2 allowing for full control of compliance with the experimental protocol. Third, we wanted to extend our findings to a more complex negotiation task. Pilcher and Huffcutt (1996) found in a meta-analysis greater effects of sleep deprivation on complex task performance as compared to performance in simple tasks. The negotiation task we used in Study 1, which is often used in negotiation research is—with four issues only—comparatively simple.

Finally, one possible explanation for the null effect in Study 1 is that sleep-deprived dyads were able to compensate for the deficits inflicted by sleep deprivation. This also coincides with the rationale of previous research that psycho-physiological impairments can be compensated for in social contexts (Faber & Häusser, 2022; Faber et al., 2017). When fatigued, individuals are typically still able to reflect on their behavior and are able to identify poor performance and lapses in attention (Baranski, 2007; Dorrian et al., 2000), which could lead them to put in additional effort and to adopt strategies to counteract impairments (Engle-Friedman, 2014; Rogers et al., 2003). For example, it has been demonstrated that sleep-deprived individuals exhibited increased effort when performing cognitive tasks (Ode-Dusseau et al., 2010; Pilcher & Walters, 1997). In Study 1, this assumption is indirectly supported by the fact that sleep-deprived participants showed an increase in Energetic Arousal after the negotiation as compared to before, which was not observed in the control group.

In Study 2, we accounted for the possibility that sleep-deprived, as compared to well-rested negotiation dyads, might not achieve lower joint

economic outcomes in integrative negotiations due to increased compensatory effort. We included a measure of compensatory effort replacing the more indirect measure of energetic arousal used in Study 1.

### **3.3. Study 2**

In Study 2, we increased the statistical power ( $N = 174$ ) to allow for detecting at least medium-sized effects. Moreover, by exposing participants to sleep deprivation in our laboratory, we exerted full control over compliance with the experimental protocol, preventing participants from napping and from consuming caffeine and other stimulants. Additionally, we used another—more complex—negotiation task (see Hüffmeier et al., 2019, Negotiation 3). Finally, we included a measure of compensatory effort to clarify a potential null finding.

#### **3.3.1. Method Study 2**

##### ***Participants and Design***

One-hundred-and-eighty-two participants took part in the preregistered<sup>7</sup> study. Only participants who did not meet our exclusion criteria for participation were included. The exclusion criteria were: Chronic sleeping problems or psychological disorders, regular intake of sleep-inducing drugs/medicine, parents of small child(ren), pregnancy, regular nightshifts, age below 18 or above 40, non-German native speaker, heavy smoker, regular caffeine consumption of more than 2 cups of caffeine a day, psychology students, jet-lag of min. one hour (due to travel) in the last 7 days, journey to the lab would take more than 45 minutes. We had to exclude 4 dyads for not being fluent in German ( $n = 2$ ) and due to errors that occurred during the negotiation (e.g., violating instructions,  $n = 2$ ).

Our final sample consisted of 174 participants (87 dyads,  $M_{age} = 23.73$  years,  $SD_{age} = 3.27$ ; 18-39 years; 60.9 % women). Ninety-five percent were students (33.9 % science, 18.4 % pedagogy, 13.2 % social science, 10.3 % medicine, etc.). As said before, we expect to find at least medium effects for this type of manipulation. The sample size was calculated to be sufficient to detect medium effects ( $d = 0.5$ ) for the critical test of the difference in joint economic outcomes between the experimental conditions with  $\alpha = .05$  and

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<sup>7</sup> [https://osf.io/x8mgj/?view\\_only=271656baf6f647c0a49d78e1fc4a9cbf](https://osf.io/x8mgj/?view_only=271656baf6f647c0a49d78e1fc4a9cbf)

$1-\beta = .8$  (G\*Power, Faul et al., 2007). As in Study 1, we used a one-factorial experimental design with the between factor *sleep status* (sleep-deprived [ $n = 88$ ] versus well-rested participants [ $n = 86$ ]). To control for potential gender effects (Mazei et al., 2015; Stuhlmacher & Walters, 1999) we used same-sex dyads and held the percentage of female and male dyads in each condition approximately equal. Participants were randomly assigned to the experimental conditions and negotiation dyads. The study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics board. Participants gave written informed consent, were fully debriefed, and received €30 for participation plus €50 in the experimental condition.

### **Procedure**

Four days before testing participants were informed about the protocol that applied to their condition and how to handle a sleep diary and activity monitors. Participants spent the night as instructed (see below). Testing began at 10 AM the next day. All testing rooms were completely shut off from any daylight. Participants were seated at separate tables with privacy screens on both sides. First, they watched a 30 min documentary about underwater sea life on 17-inch laptops to calm potential physical or psychological arousal accompanying commuting and the start of the testing. Afterwards, they were asked to indicate their current tiredness. Next, participants were assigned to their dyads and roles. Each dyad negotiated in a separate room. Both negotiators sat face-to-face at a table with a shoulder-high paper screen between them. Participants had 15 minutes to read the instructions and 30 min to agree on all issues. Negotiations were videotaped. Finally, participants reported their subjective tiredness for a second time.

**Sleep Deprivation.** To ensure total sleep deprivation of at least 26 hours we used an experimental procedure similar to Häusser et al. (2016, see also Harrison & Horne, 1999). Participants in the sleep-deprived condition were instructed to get up at 8 AM the day before testing and come to the laboratory at 10 PM. They spent the night in the lab at private tables without sleeping and were supervised throughout the whole period by two research assistants. Participants were not allowed to interact or to consume caffeine or other stimulants, but they were free to spend the time at their own discretion, e.g., watching movies, or reading. Two short walks (2 AM and 6 AM) were made as

a group during the night. Non-caffeinated beverages and snacks were available ad-lib, and breakfast was served at 8:30 AM the next day. Testing began at 10 AM. Participants in the control condition were instructed to spend a night of normal sleep at home, get up at 8 AM, and arrive at the laboratory at 10 AM the next morning.

**Negotiation Task.** The integrative negotiation task was adopted from Hüffmeier et al. (2019, Negotiation 3; see also Moran et al., 2008) and simulates a negotiation on a residential community development project between a city councilor and a real estate developer. This negotiation was different from the task in Study 1 in terms of complexity and structure. Participants had to find an agreement for six issues (e.g., duration of the contract) and to stipulate the terms in a contract. Outcomes were framed as expenses and gains for both parties. To achieve the optimal outcome in the task, the negotiating parties had to engage in three different value-creating strategies beyond log-rolling (the only integrative strategy required in Study 1). These strategies included identifying different expectations about a future event (i.e., crafting a contingent contract), recognizing of different time-related preferences and therefore identifying a related trade-off option, and adding an optional issue to the negotiation. More precisely, the negotiation consisted of one distributive issue, two log-rolling issues, one contingent contract issue, one issue for which both negotiators had different time preferences, and one compatible issue (see *Appendix*, Table S2). Additionally, the negotiation included a seventh issue that was not part of the agenda but that could be added to create more value. The joint economic outcome could vary between € -450,000 (least optimal solution) and € 150,000 (full realization of the integrative potential).

### **Measures**

**Manipulation and Compliance Check.** Four days prior to the experimental session all participants were equipped with activity monitors (ActiGraph® wGT3X-BT), which are attached to the wrist and a sleep diary. Both served to check for adherence to the experimental protocol, and to record sleep data. Using validated algorithms (Sadeh et al., 1994; Tryon, 2004), the recorded activity patterns can be translated into indicators of sleep duration. Subjective tiredness was measured as in Study 1. We measured subjective tiredness a second time after the negotiation to test trajectories of tiredness

during the experimental session. In addition, after the negotiation task, we asked participants how much their ability to perform was negatively affected by tiredness using a 7-point scale from 'not at all' to 'very much'.

**Joint Economic Outcomes (Dependent Variable).** Based on the individual pay-off schedules, the joint economic outcomes were calculated as the sum of both parties' individual outcomes in Euro for the final agreement.

**Compensatory Effort.** We measured the individual effort to compensate for sleep deprivation with two items, with a 7-point scale from 'not at all' to 'very much': (1) "How hard did you try to fight tiredness and stay awake during the task?" (2) "How hard did you try to stay focused during the task?" ( $r = 0.584, p < .001$ ).

### 3.3.2. Results Study 2

#### ***Induction of Sleep Deprivation***

Data of activity monitors (ActiGraph® wGT3X-BT monitor) were used to compute average sleep duration for three days before testing. On average, participants slept 7 hours and 3 minutes ( $SD = 70.56$  min) each night. Participants in the control group were sufficiently well-rested with 6 hours and 46 min ( $SD = 85.88$  min) of average sleep on the night before the testing. Subjective tiredness prior to the negotiation was higher for sleep-deprived individuals ( $M = 7.28, SD = 2.15$ ) as compared to well-rested ones ( $M = 4.00, SD = 1.79$ ),  $t(171) = 10.91, p < .001$  (one-tailed),  $d = 1.66$ . A mixed ANOVA with sleep status (sleep-deprived vs. well-rested participants) as between-subject factors and subjective tiredness (pre-negotiation vs. post-negotiation) as a within-subjects factor revealed a significant main effect for sleep status: Well-rested participants reported lower tiredness ( $M = 3.77, SD = .21$ ) than sleep-deprived participants ( $M = 6.98, SD = .20$ ),  $F(1,171) = 124.59, p < .001, \eta_p^2 = .42$ . Moreover, a significant main effect of time of measurement indicated that overall tiredness was higher before ( $M = 5.64, SD = .15$ ) as compared to after ( $M = 5.12, SD = .18$ ) the negotiation,  $F(1,171) = 11.13, p = .001, \eta_p^2 = .06$ . The tiredness by sleep status interaction was not significant,  $F(1,171) = .23, p = 0.631, \eta_p^2 = .001$ . The subjective degree of impairment due to tiredness was also higher for sleep-deprived individuals ( $M = 5.23, SD = 1.34$ ) than for well-rested ones ( $M = 2.19, SD = 1.35$ ),  $t(172) = 14.93, p < .001, d = 2.26$ . In

conclusion, actigraphy data and self-reported tiredness confirm the effectiveness of our experimental manipulation.

### ***Joint Economic Outcome***

All dyads reached an overall agreement. For the partial impasses of two dyads (i.e., they did not find an agreement for one issue), we imputed the worst value obtained in the sample for the respective issue. We used an independent t-test to compare the joint economic outcomes between both conditions. The variance in the sleep-deprived condition was significantly higher, as Levene's test for equal variances revealed,  $F(1,85) = 4.53$ ,  $p = .036$ . Well-rested dyads ( $M = -31,325.58$ ;  $SD = 78,373.87$ ) did not achieve significantly higher joint economic outcomes as compared to sleep-deprived dyads ( $M = -38,863.64$ ;  $SD = 112,770.94$ ),  $t(76,80) = .36$ ,  $p = .359$  (one-tailed),  $d = .08$ . An additional t-test revealed that the joint economic outcomes of well-rested dyads ( $t(42) = -15.17$ ,  $p < .001$ ,  $d = -2.31$ ) as well as the sleep-deprived dyads ( $t(43) = -11.11$ ,  $p < .001$ ,  $d = -1.68$ ) were significantly below the maximum joint economic outcome of 150,000 points, ruling out a possible ceiling effect.

### ***Compensation***

We conducted additional analyses focusing on compensatory effort. Overall, sleep-deprived dyads finished their negotiation faster ( $M = 20.61$  min;  $SD = 5.83$ ) as compared to well-rested dyads ( $M = 24.02$  min;  $SD = 5.76$ ),  $t(85) = 2.74$ ,  $p = .007$ ,  $d = .59$ , which could be seen as an indicator of more focused discussions and, hence, increased effort. An independent t-Test further revealed that sleep deprived participants reported increased compensatory effort in terms of fighting tiredness, trying to stay awake and concentrated to a higher degree ( $M = 4.81$ ,  $SD = 1.53$ ) as compared to well-rested participants ( $M = 3.02$ ,  $SD = 1.59$ ),  $t(172) = -7.55$ ,  $p < .001$ ,  $d = -1.15$ .

### **3.3.3. Discussion Study 2**

Study 2 replicates the finding of Study 1 that sleep deprivation does not impair joint economic outcomes in integrative negotiations to any significant extent (that is medium-sized effects). In both studies, we consistently found no support for our hypothesis. Because our manipulations have been successful regarding strong effects on tiredness and perceived impairments, the absence of a medium effect of sleep deprivation on joint economic outcomes could be

related to successful efforts to compensate for tiredness. This is also indicated in a self-report measure of compensatory effort.

There is, however, an alternative explanation for the observed findings: Sleep-deprived participants might have been activated by the interesting and highly interactive task of a face-to-face negotiation (cf. Thompson & Leonardelli, 2004). An indicator for such activation might be that subjective tiredness was higher before as compared to after the negotiation in Study 2 (in both conditions). To assess whether the results of Study 1 and 2 may have been due to activating effects of the experimental setting, we conducted Study 3. Study 3 was an online study, in which each participant alone passively observed a video-taped negotiation rather than participating in a negotiation. This less involving, non-interactive task that was conducted at home provides important insights into whether the null effects (meaning lack of medium-sized effects) in Study 1 and Study 2 are likely to be due to active compensatory effort or due to more passive activation resulting from the participation in a negotiation as part of a laboratory experiment. If the latter is the case, sleep-deprived participants should propose less integrative agreements than control participants. If the null effects in Studies 1 and 2 are due to active compensatory effort, a null effect is again likely to occur. In addition, we used a different approach to sleep-deprive the participants to further generalize our findings.

### **3.4. Study 3**

Instead of total sleep deprivation as in the prior studies, we induced sleep loss by reducing sleep to 50% of the participant's average time in bed in the two nights before the study (Swann et al., 2006). To reduce involvement, participants watched a video of an integrative negotiation, and were asked to propose the optimal agreement for both negotiation parties.

#### **3.4.1. Method Study 3**

##### ***Participants and Design***

Three hundred eighty-eight participants took part in the screening and were eligible to participate in our preregistered<sup>8</sup> study (for our exclusion criteria, see Study 2). After a 7-day sleep protocol, in which 246 persons participated,

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<sup>8</sup> [https://osf.io/u8paj/?view\\_only=480750a3a1034fe9a9b07ac0deb01f52](https://osf.io/u8paj/?view_only=480750a3a1034fe9a9b07ac0deb01f52)

we excluded 22 persons from further participation, whose average night sleep was less than seven or more than nine hours. From the remaining sample, we randomly selected participants and invited them to take part in the main study. From the 156 persons, who completed the main study, we excluded 12 for deviating more than 30 min on average from their scheduled bedtimes ( $n = 4$ ) or for more than 20 min daytime napping ( $n = 8$ ). The final sample consisted of 144 undergraduate students ( $M_{\text{age}} = 22.85$  years,  $SD_{\text{age}} = 2.85$ ; 18-36 years; 83.3% women). The sample size was calculated to be sufficient to detect small to medium effects ( $d = 0.4$ ) for the critical test of the difference in the deviance from the optimal agreement for the negotiation (our DV) between the experimental conditions with  $\alpha = .05$  and  $1 - \beta = .8$  (G\*Power, Faul et al., 2007). We used a one-factorial experimental design with the between factor *sleep status* (sleep-restricted [ $n = 67$ ] versus well-rested participants [ $n = 77$ ]). The study was conducted in accordance with the Declaration of Helsinki and was approved by the local ethics board prior to data collection. Participants provided a written informed consent and received €20 for participation plus an additional €20 in the sleep-restricted condition (or course credit).

### **Procedure**

Participants were recruited via email and instructed on how to use the online sleep diary for baseline assessment. Within two weeks after finishing the sleep diary, participants were randomly selected and randomly assigned to either the control or the experimental group. Participants spent the two nights before the testing as instructed (see below). On testing day, participants were not allowed to consume any caffeinated beverages or other stimulants after 1 PM. Testing started at 7 PM. First, participants were asked to indicate their current tiredness. Next, they were instructed to read the information material about the negotiation. Afterwards, they watched a 15-min video of a negotiation, in which two negotiators discussed all negotiation issues but the video stopped before they agreed on a settlement. Participants received a table displaying the negotiation issues and the related negotiation options and were asked to choose the optimal agreement for each issue, that is, the option yielding the highest joint outcome. Finally, they were asked to indicate their subjective tiredness for a second time and whether (and how) they made efforts to compensate for tiredness and to perform well.

**Sleep Deprivation.** To restrict sleep to 50% of participants' habitual sleep duration for two nights, we used a similar experimental procedure as Swann and colleagues (2006). For the baseline assessment, all participants recorded their exact going to bed, sleep onset, wake-up times, and daytime napping (duration in min) for seven consecutive nights. Participants in the well-rested condition were informed about their individual (average from baseline assessment) going to bed and wake-up time. For two consecutive nights preceding the testing, they were instructed to adhere to these times and to record it in a sleep diary. Participants in the sleep restriction condition were required to reduce sleep to 50% of their average time in bed on the two nights before the study. Sleep time was calculated as 25% later than their habitual going to bed time and wake-up time was 25% earlier than habitual time, as calculated from the baseline assessment. Participants were sent text messages 30 min before their individual going to bed time and at wake-up time and had to answer these messages.

**Negotiation Video.** The negotiation task from the video was adopted from Thompson and colleagues (1996) and showed a negotiation on the construction of a thermal cracking system in Oman (cf. Hüffmeier et al., 2019, Negotiation 1) between two parties. The trained negotiators in the video were instructed to fully exchange all relevant information, that is, their exact preferred option for each issue as well as their priorities between issues. Two versions of the video were pretested with pilot participants ( $N = 60$ ,  $M = 24.50$  years,  $SD = 4.09$ , 70% woman) and the video for which these participants were better in identifying the correct interests of the two negotiators was selected. The video ended before the negotiators agreed on a final contract. The negotiation consisted of two distributive issues, four log-rolling issues, and two compatible issues with five options each (see *Appendix*, Table S3).

### **Measures**

**Manipulation and Compliance Check.** As in Study 2 we measured subjective tiredness once before and once after the task and asked the participants how much their ability to perform the task was negatively affected by tiredness (see Study 2).

**Joint Economic Outcome.** Participants were asked to choose the one out of the five options for each negotiation issue that they deemed optimal for

maximizing the joint economic outcomes of the two negotiators. We calculated the absolute difference between the selected option and the optimal option yielding the best joint outcomes for each negotiation issue. For example, if a participant selected option 3 for Issue 2, but the optimal was option 5 (see Table S3), the absolute difference score for this issue is 2. The possible range for integrative and compatible issues was 0-4. The range for distributive issues was 0-2, because distributive issues are fixed-sum and deviations from the middle option do not alter joint outcomes, but still reduce the fairness of the agreement (and were therefore deemed to be suboptimal). The sum score of all difference scores between the proposed and the optimal options for each issue constitute our dependent variable (see Kappes et al., 2020, for similar procedures). The range for the sum score was 0-28 with 0 indicating the optimal solution (no differences between proposed and optimal options).

**Compensatory Effort.** Effort to stay focused and to fight tiredness was measured with the same scale as in Study 2 ( $r = 0.301$ ,  $p < .001$ ). Additionally, we asked the sleep-deprived participants to write down in an open format what they deemed was helpful in their participation in the study to stay focused, perform well in the task, and cope with tiredness.

### 3.4.2. Results Study 3

#### ***Induction of Sleep Deprivation***

The experimental manipulation resulted in an average sleep duration of 4 hours and 1 minute ( $SD = 26.27$ ) for sleep-restricted participants and 8 hours and 1 minute ( $SD = 20.57$ ) for well-rested participants in the two nights prior to the experiment. Subjective tiredness prior to the negotiation was higher for sleep-restricted participants ( $M = 6.73$ ,  $SD = 20.06$ ) as compared to well-rested ones ( $M = 4.05$ ,  $SD = 2.10$ ),  $t(142) = 7.71$ ,  $p < .001$  (one-tailed),  $d = 1.29$ . A mixed ANOVA with sleep status (sleep-restricted vs. well-rested) as a between-subjects factor and subjective tiredness (pre-negotiation vs. post-negotiation) as a within-subjects factor revealed a significant main effect for sleep status: Well-rested participants reported lower tiredness ( $M = 4.02$ ,  $SD = .23$ ) than sleep-restricted participants ( $M = 6.70$ ,  $SD = .24$ ),  $F(1,142) = 65.49$ ,  $p < .001$ ,  $\eta_p^2 = .32$ . No main effect for time of measurement was found,  $F(1,142) = 0.21$ ,  $p = .648$ ,  $\eta_p^2 = .001$ , and the tiredness by sleep status interaction was not significant,  $F(1,142) = .00$ ,  $p = .985$ ,  $\eta_p^2 = .000$ . These results suggest that, as

intended, the participants were not activated by their participation in the study (deviating from Study 2).

The subjectively perceived degree of impairment due to tiredness was also higher for sleep-restricted individuals ( $M = 3.31$ ,  $SD = 1.80$ ) than for well-rested ones ( $M = 2.09$ ,  $SD = 1.38$ ),  $t(124.82) = 4.61$ ,  $p < .001$ ,  $d = 0.78$ .

### ***Joint Economic Outcome***

The sum score of all differences between the proposed and the optimal options for each issue constituted our dependent variable (range 0-28), with lower values indicating more optimal propositions. Well-rested participants did not achieve a significantly lower difference score ( $M = 4.79$ ,  $SD = 2.82$ ) as compared to the sleep-restricted participants ( $M = 4.54$ ,  $SD = 2.81$ ),  $t(142) = -.541$ ,  $p = .589$ ,  $d = -.09$ . The scores in both groups were significantly higher compared to the optimal score of zero, with  $t(76) = 14.91$ ,  $p < .001$ ,  $d = 1.70$ , for the well-rested participants and  $t(66) = 13.20$ ,  $p < .001$ ,  $d = 1.61$ , for the sleep-restricted participants, indicating the absence of a floor effect.

### ***Compensation***

An independent *t*-Test revealed that sleep deprived participants reported more compensatory effort ( $M = 4.95$ ,  $SD = 1.18$ ) as compared to well-rested participants ( $M = 3.80$ ,  $SD = 1.23$ ),  $t(142) = -5.73$ ,  $p < .001$ ,  $d = -.96$ .

For exploratory purposes, we descriptively summarized sleep-deprived participants' strategies to compensate for tiredness and to perform well that they provided in a free text format. Seventy-five percent of sleep-restricted participants reported that using auxiliary tools—specifically taking notes—helped to suppress tiredness and to stay focused. They mentioned further strategies to perform well despite their tiredness: Concentrating very hard (29.9%), avoiding distractions (26.9%), active listening (10.5%), trying to understand both perspectives (10.5%), and self-monitoring as a strategy to intervene when attention slips (9.0%). During the two days of sleep restriction, 71.6% of participants distracted themselves from the tiredness by constantly staying active (i.e., sport, working, housekeeping, meeting friends). In contrast, only 16.4% tried to counteract tiredness with relaxing activities (such as watching TV and reducing demanding tasks). Other strategies were getting fresh air (29.9%) or eating/ drinking water (22.4%).

### 3.4.3. Discussion Study 3

The complementary methodical approach in Study 3 suggests that the results of Study 1 and 2 are likely not due to activating effects of the engaging and interactive face-to-face negotiations. The non-significant main effect of the tiredness measurements before and after the negotiation could be interpreted as support for this interpretation.

Although the experimental setting in Study 3 was less activating, as compared to Study 1 and 2, we still found a null effect regarding the quality of the proposed agreement. Hence, this effect is unlikely to be due to task-related activation, lending further support to our interpretation of the findings to rather result from compensatory effort. In line with this—and similar to Study 2—participants in the sleep-restriction condition reported higher compensatory effort, as compared to participants in the well-rested condition. We also found first anecdotal evidence for specific strategies that sleep-deprived participants used for compensation.

### 3.4.4. Bayesian Analysis Across Studies

We conducted additional Bayesian analyses for the experimental studies. The Bayes factor (JASP 0.13.1., JASP Team, 2020) for Study 1 suggests that these data are 6.16 ( $BF_{01}$ ) times more likely to be observed under the null hypothesis relative to our hypothesis. The Bayes factors for Study 2 and 3 also suggest that the data are in favor of the null hypothesis (Study 2:  $BF_{01} = 3.33$ , Study 3:  $BF_{01} = 8.05$ ). We conducted a Bayesian meta-analysis across the samples of Study 1, 2, and 3 (total  $N = 271$ ; JASP 0.13.1., JASP Team, 2020) which again supported the null hypothesis,  $d = -.08$  (95% CI, -0.37 to 0.18),  $BF_{01} = 5.84$ .

In three empirical studies, ranging from at-home sleep restriction to one night of total sleep deprivation in our laboratory, we found cumulative evidence in favor of the null hypothesis opposing our prediction that sleep deprivation leads to suboptimal negotiation agreements. Nevertheless, it seems that business or political negotiations under sleep deprivation are regularly a matter of discussion or even frowned upon by the public and media (cf. Weaver, 2015). This may indicate that the idea that sleep deprivation has a negative impact on negotiation outcomes might be deeply entrenched in lay conceptions. To empirically assess this impression, we conducted a study examining

laypeople's beliefs about negotiations under sleep deprivation. This study taps into an important precondition for our observed effects: If lay beliefs would imply negative effects of sleep deprivation in negotiations, this anticipation would also further inform about the potential for compensatory effort. In fact, the belief that sleep deprivation is a danger to negotiation outcomes is a precondition for negotiators to invest additional effort in order to maintain agreement quality.

### **3.5. Study 4**

In a preregistered<sup>9</sup> online study, we described Study 2 to laypeople. Participants learned about the experimental procedure and were provided with all negotiation material and the average joint economic outcomes that were achieved by the well-rested dyads. Participants were then asked to estimate the joint economic outcomes achieved by the sleep-deprived dyads (cf. Häusser et al., 2019, for a similar procedure).

#### **3.5.1. Method Study 4**

##### ***Participants and Design***

The online study was conducted via Prolific with  $N = 152$  participants ( $M_{age} = 29.51$ ,  $SD_{age} = 9.68$ ; 53.9% woman, 2% diverse). The sample size was calculated to be sufficient to detect small effects ( $d = 0.25$ ) for the critical test of the expected difference in joint economic outcomes between the experimental conditions, with  $\alpha = .05$  and  $1 - \beta = .9$  (G\*Power, 59). The study was conducted in accordance with the Declaration of Helsinki. Participants provided informed consent.

##### ***Procedure***

Participants read an accurate description of the manipulation of the sleep status manipulation and negotiation procedures of Study 2 and were given a shortened version of the negotiation material. Additionally, participants were informed about the underlying integrative potential, the optimal solutions for each negotiation issue, and the possible range of the joint economic outcome. Participants were informed about the average joint economic outcome that was achieved by the well-rested dyads as reference score, rounded to the tens digit (€ -31,330). They were then asked to estimate the joint economic outcomes

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<sup>9</sup> [https://osf.io/9d68m/?view\\_only=4ed71a53cbb344759b628245354c2fa2](https://osf.io/9d68m/?view_only=4ed71a53cbb344759b628245354c2fa2)

that were achieved in the sleep-deprived condition. Finally, they were asked to answer general questions regarding the assumptions on negotiations under sleep deprivation.

### **Measures**

**Joint Economic Outcomes.** Participants were asked to estimate the joint economic outcomes that were achieved in the sleep-deprived condition in full euro amounts in a possible range of € -450,000 to € 150,000.

**Expected Effects of Sleep Deprivation in Negotiations.** We asked the participants to estimate the quality of results of real negotiations, which take place under sleep deprivation, as compared to negotiations that do not take place under sleep deprivation using a 5-point scale from 1 = 'much worse' to 5 = 'much better'. Additionally, participants were asked on a 5-point scale from 'much worse' to 'much better' how they would expect to perform themselves in negotiations when being sleep-deprived as compared to well-rested.

#### **3.5.2. Results Study 4**

With a one-sample *t*-test, we tested whether the estimated joint economic outcomes in the sleep-deprived condition were significantly different from the control condition, that is a joint outcome of € -31,330. The average estimate for the sleep-deprivation condition was -120,463.27 (*SD* = 106,598.04), which is significantly lower than the value provided from the well-rested control group,  $t(151) = -10.32$ ,  $p < .001$ ,  $d = -.84$ . Moreover, participants expected the results of real negotiations under sleep deprivation to be worse than of well-rested negotiations ( $M = 1.99$ ,  $SD = 1.01$ ) which is significantly different from the center of scale,  $t(151) = -12.37$ ,  $p < .001$ ,  $d = -1.00$ ; and they also expected themselves to perform worse in such a situation ( $M = 1.65$ ,  $SD = .78$ ) which is significantly different from the center of scale,  $t(151) = -21.24$ ,  $p < .001$ ,  $d = -1.72$ .

#### **3.5.3. Discussion Study 4**

With the survey from Study 4 we aimed to compare lay person's beliefs on the result of Study 2 with its actual results. We demonstrate that layperson's expectations fall in line with our predictions based on our theoretical arguments and earlier empirical research (expectation of at least medium-sized effects). Hence, the lack of medium-sized effects in our experimental study are surprising from a scientific as well as a lay-theoretical viewpoint. Moreover, the

common expectation that sleep deprivation should have detrimental effects on performance is an important precondition to motivate compensatory effort.

However, we assume that in the lay conceptions of what happens in negotiations under sleep deprivation, compensatory effort and also social requirements of the negotiation situation were not taken into account sufficiently, which may have resulted in the overestimation of the negative effects of sleep deprivation on joint economic outcomes. To better understand the role of compensatory strategies in negotiations under sleep deprivation, we conducted a fifth study using a qualitative approach in a sample of professionals who are experienced with negotiating under sleep deprivation.

### **3.6. Study 5**

Study 5 was a qualitative study employing semi-structured interviews with politicians who are experienced in negotiating while being sleep-deprived. It was our goal to learn which specific measures they use to compensate for sleep deprivation-induced impairments when negotiating, and whether these measures apply to the individual or the negotiators' interaction (inter-individual level).

#### **3.6.1. Method Study 5**

##### ***Sampling Procedure and Characteristics***

We conducted semi-structured interviews with German politicians experienced with negotiating under sleep deprivation. Political negotiations typically deal with coalition building or policymaking and are regularly conducted under acute sleep deprivation and fatigue due to time pressure and busy daily schedules. We aimed to interview at least 20 politicians who fulfilled the sampling criteria of at least one major negotiation under sleep deprivation throughout their political careers. Overall, we conducted interviews with 22 politicians (five women,  $M_{age} = 55.6$  years,  $SD_{age} = 11.3$ , from 37 to 79 years) from different political levels (four members of the federal parliament, including ministers; 15 members of state parliaments, including heads of state and state ministers; three communal politicians, including a mayor). Interviews took on average 20.5 minutes (min: 10 min, max: 30 min). Respondents' professional experience in political positions ranged from 3 to 44 years ( $Mdn = 23$ ). All interviews were audio-recorded and conducted in German via telephone or face-to-face.

### ***Interview Guide and Procedure***

Two trained interviewers followed an interview manual comprising open-ended questions. The manual was pretested in two interviews with individuals who were highly experienced with sleep deprivation (a physician and a politician) and it was slightly modified afterwards. We chose semi-structured interviews so that we could ask targeted questions but also allow respondents to mention topics that we did not previously consider with the aim to obtain as much critical information as possible. The interview started with information about the goals of the interview, asking for informed consent and informing about data protection and privacy. Afterwards, interviewees were provided with a definition of negotiation to ensure a common understanding of critical information. Based on the Critical Incident Technique (Flanagan, 1954), we asked interviewees to remember and describe a typical negotiation under sleep deprivation in their careers. We then asked the following open-ended questions: “How and to what extent did sleep deprivation impair the negotiation process and the negotiators?” Central for our scope of interest was the question: “How did you deal with this situation and circumstances?”, and we asked for specific compensatory strategies on the individual and inter-individual level to obtain more information: (a) “How did *you* behave? What helped or did not help *you personally*?” (b) “How did the *group* behave? How did people deal with each other during the negotiation?” Before finishing the interviews, the interviewees were asked whether the interviewed person wanted to add something. All interviews were anonymized and transcribed.

### ***Qualitative Content Analysis and Interpretation***

We applied the Qualitative Content Analyses (QCA) approach by Mayring (2014). Central to the QCA is the development of a category system on the basis of the information provided by the interviewees. Two independent coders analyzed the interviews systematically, following the procedural rules of the content analysis approach. As a starting point, the material was divided into content analytical units, focusing on text passages dealing with strategies politicians use to compensate for sleep deficits and impairments during negotiation, with the aim to extract a catalog of measures and techniques. The content was analyzed separately for individual and inter-individual compensation. The basic principle of the analytical steps is that relevant text

passages were paraphrased and generalized to a higher level of abstraction, and further reduced and combined until a comprehensive category system remained as a result (see Mayring, 2014, for a detailed practical guideline). Next, the first author took the category systems of both coders, and compared and combined them into one categorical system of compensatory strategies for the individual and the inter-individual level. The categories from the independent coders were conceptually identical.

### **3.6.2. Results Study 5**

All interviewees reported that they made efforts to compensate for motivational, cognitive, and physiological impairments when the context allowed for it. A set of distinctive categories of cognitive and behavioral strategies to compensate for impairments due to sleep deprivation emerged from our data (see *Appendix Table S4*, for categories and exemplary quotes). Our analyses revealed three main categories, with several subcategories: (1.) preconditions for compensation, (2.) compensatory strategies at the individual level, and (3.) compensatory strategies at the inter-individual level.

#### **1. Preconditions for Compensation**

The first category includes prearrangements that open up opportunities to deal with impairments during the negotiation. Politicians proposed the following factors which we summarized in sub-categories: (1) environmental factors like lightning or the provision of catering, (2) negotiation characteristics comprising (a) the possibility to adjourn and (b) setting an agenda of negotiation points in advance, (3) individual factors comprising (a) a thorough professional preparation of documents and line of arguments and (b) negotiating in the area of your own expertise or of high subjective importance. As politician 001 describes it: “There are topics that you can discuss at night and you won’t get tired (...) if it is an emotional topic, or one that particularly interests you, then you won’t get tired so quickly either.” As a third individual factor, resting prior to the negotiation was mentioned, as well as (4) the use of advisor systems or an external team as support.

#### **2. Individual-Level Compensation**

The second category includes instantaneous strategies each negotiator can rely on individually to handle increased tiredness during the negotiation: (1) being conscious about nutrition, (2) cardiovascular activation like getting fresh

air or breathing exercises, (3) taking a break to nap, (4) self-monitoring performance to be able to intervene, as politician 003 states: “(...) it is important to have a good self-assessment. To be able to assess for yourself how far you are still able to think reasonably clearly, to act clearly and to express yourself clearly.” And last, (5) an active participation in the negotiation. Politician 007 described it precisely: “As long as you actively think and actively engage, the effects of exhaustion and tiredness, of lack of concentration, rushes in much later for you than for those who mostly do not interact but rather only are present.”

### **3. Inter-Individual Compensation**

The third main category is on the inter-individual level and describes strategies that can buffer tiredness by interacting with colleagues or negotiators of the other party. Politicians described the following strategies: (1) a change of negotiation subject to overcome dead points, (2) appointment of a leader who enforces negotiation rules and breaks, (3) monitoring of in-group behavior and providing mutual motivational and professional support, and (4) taking breaks to reflect on the strategy for one’s own negotiation team or to distract oneself from the negotiation. As politician 014 describes: “It is very important to reflect, because you have to hold your own negotiating delegation together. Breaks are important for this. (...) [It means that] you reflect on arguments that have come from the opposing side of the negotiation that you reflect on your own position and see where there are opportunities to move. And maybe also save you from rash approaches.”

#### **3.6.3. Discussion Study 5**

Our results provide novel insights into which compensatory efforts are commonly used and are considered subjectively effective by experienced negotiators. Interestingly, their reported strategies in parts overlap with the anecdotal findings from Study 3 where sleep-deprived participants mentioned similar strategies such as self-monitoring and physical activity prior to the negotiation. As is evident from the qualitative analysis, in real-life negotiations, compensation for sleep deprivation is highly prevalent and manifold and our study is the first comprehensive analysis of such compensation strategies. Three main categories emerged from our data: Preconditions for compensation, individual-level compensation, and inter-individual level

compensation. The first category dealt with strategies such as ensuring good air quality, comfortable room temperature, and organizational factors, such as the possibility of adjournment. Thermal comfort and light settings have indeed been found to affect tiredness and work performance (Azmoon et al., 2013; Zhang et al., 2010). The second category contains individual-level compensation strategies. Politicians reported physical activity as a compensation strategy. Exercising has been found to buffer fatiguing effects of sleep deprivation at least for a short period of time (Scott et al., 2006; Taheri & Irandoust, 2020). Napping, whether in advance or in breaks, can have a beneficial effect on sleep-deprived participants (Lumley et al., 1986; Waterhouse et al., 2007). Politicians indicated the importance of self-monitoring in order to regulate and intervene when facing increasing tiredness. Participants under sleep deprivation have been found to be able to self-monitor declining cognitive performance when cognitively active (Baranski et al., 1994; Baranski & Pigeau, 1997).

The third category contained inter-individual level compensation strategies. A widely mentioned strategy is the use of breaks. In line with previous research based on the group-monitoring hypothesis (Abrams et al., 2006), it has been found that teams as compared to individuals were relatively unaffected by impairing factors such as sleep deprivation (Faber et al., 2017; Frings, 2011) and members benefit from increased motivation and compensating dynamics within the team. The beneficial effect of distraction breaks on negotiation processes and agreement quality has been confirmed before in non-sleep-deprived negotiators (Harinck & De Dreu, 2008; Olekalns & Smith, 2005).

In summary, politicians reported manifold compensatory strategies to alleviate the effects of sleep negotiation in real-life negotiations.

### **3.7. Overall Discussion**

Negotiations ranging from private matters via labor negotiations to issues of international security often extend into the night. Do sleep-deprived negotiators reach worse outcomes? Both theoretical considerations and—as we show—lay conceptions (Study 4) point in this direction. Yet, this question so far remained uninvestigated. In three experiments, we provided first-time empirical tests of the effects of sleep deprivation on joint economic negotiation

outcomes. Against the prediction that individual impairments of cognitive capacities and motivation due to sleep deprivation carry over to the quality of negotiation agreements in interactive (Study 1 and 2) and observed negotiation tasks (Study 3), we consistently found no medium-sized effect of sleep deprivation on joint economic outcomes. Overall, there is cumulative evidence—as shown by the Bayesian meta-analyses—that our data are in favor of the null hypothesis relative to our hypothesis to a moderate to large degree (Aczel et al., 2018; Lee & Wagenmakers, 2013)—which speaks against strong and robust effects of sleep deprivation on negotiation outcomes.

So where does this leave us? Do the findings mean that the theoretical argument, building on individual-level impairments, for a negative effect of sleep deprivation as well as lay conceptions are simply wrong? Does it follow that it actually does not matter whether important negotiations are conducted by day or night? While our findings provide robust evidence that there is no effect of significance of sleep deprivation on the quality of joint economic outcomes this does not mean that sleep deprivation is irrelevant for negotiations. We found evidence for compensatory effort and specific compensation strategies. Hence, although on the surface, sleep deprivation might not affect the negotiation outcomes to a greater extent, we deem it likely that it alters the *process* through which these outcomes were obtained.

More specifically, our experimental findings suggest that the well-established individual-level psychological impairments due to sleep deprivation could be compensated for in negotiations. We found that sleep-deprived individuals reported that they tried to stay focused and maintain performance, hence they coped with sleep deprivation by actively engaging in compensatory effort. Moreover, using in-depth interviews (Study 5) with politicians highly experienced with negotiating under sleep deprivation, we obtained first insights into specific compensation strategies and their prevalence in real negotiation settings. For example, politicians reported to self-monitor tiredness, or to use breaks to reflect on the negotiation process.

Hence, our results indicate that the effect of sleep deprivation and sleep restriction on negotiation outcomes is more complex than our hypothesis suggested. We based our predictions on well-established negative effects of sleep deprivation on individual cognitive functioning (see Lim & Dinges, 2010,

for a meta-analysis) and motivation (see Engle-Friedman, 2014, for a review). However, these findings do not translate into an inferior quality of agreements in interactive negotiation tasks and an observation task. That also means that we cannot simply take the findings on how the performance of individuals in various domains of human functioning is impaired by sleep loss and transfer them to dyadic negotiations or other complex social situations (Faber & Häusser, 2022; Faber et al., 2017). A social decision-making or performance situation is by far more complex and rich, as compared to individual decision-making or simple performance situations. The social situation implies specific situational demands (for example the demand to communicate or to interact, to adhere to social norms, to balance self-regarding versus other-regarding motives). These social demands or requirements are likely to modulate the impact of individual-level impairments, such as sleep deprivation.

We cannot exclude that there are small effects but can conclude, that there is no effect of theoretical or practical value, in relation to the strength of the manipulation and the reliability of the outcome measure. Given the robust evidence with medium to large-sized effects for negative effects of sleep deprivation on motivation and cognitive capacities, and the research emphasizing the role of motivation and cognitive capacities on negotiation outcomes we do not expect a less than medium-sized effect. The ecological relevance of very small effects of sleep deprivation in negotiations would probably be only marginal, given that negotiation outcomes are multi-determined in real-world contexts. Moreover, the data of Study 4 suggest that laypeople expect, that large effects should unfold following sleep deprivation, showing that these data are not only counterintuitive to experts but also to lay people.

Our studies show that a supposedly strong contextual factor in negotiations seems to have no effects to any significant extent on agreements—by showing and replicating this unexpected finding we contribute to future theorizing in negotiation and sleep research. Performance deficits due to sleep deprivation seem to be task-dependent and could trigger an increased allocation of task-related effort as an adaptive decision process (see Massar et al., 2019a, for an overview). The task could have been complex or interesting enough to facilitate the decision to allocate additional compensatory effort to

counteract performance deficits. The results of Study 3—in which individuals observed a negotiation and proposed an agreement on their own— and qualitative findings of Study 5 support the idea of a voluntary increase in effort and concentration. Besides potentially increased individual effort, also interactive compensation strategies could unfold. Even more than other potential effects of sleep deprivation on social decisions, the process, and outcomes of negotiations are fundamentally relational (see, for example, the *Relational Process Modell of Negotiation* by Elfenbein, 2021). As is evident from Study 5, group dynamics such as mutual motivation could probably help to buffer the negative effects of sleep deprivation.

### **3.7.1. Limitations and Implications for Future Research**

A limitation relates to the possibility that participants might have been more aware of their sleep-deprived status in the laboratory environment as compared to natural environments (cf. Kühnen, 2010) and might have experienced the negotiation as highly activating (Thompson & Leonardelli, 2004). However, it is unlikely that the latter alternative explanation can explain our findings, since we replicated the null finding in Study 3 while using a less activating online setting where participants did not negotiate, but only made a suggestion for an agreement.

Moreover, in our research, we used single-round negotiations of limited duration. If compensatory effort is responsible for the lack of medium effects (which we deem the most plausible interpretation), it would be interesting to test the limits of compensatory effort. Because exerting compensatory effort is demanding, at some point a breakdown is to be expected with negative consequences for joint economic outcomes (but potentially also for socio-economic outcomes, e.g., feelings about the negotiator relationship or the negotiation process, see Curhan et al., 2006; Thompson, 1990). Future research could explore the impact of sleep deprivation in settings with prolonged negotiations instead of performing a single-round negotiation after one night of total sleep deprivation. Participants could either negotiate through the night (e.g., marathon negotiations) or several days in a row while being partially sleep-deprived. Examining marathon negotiations—potentially monotonous in the long run—can help to identify the tipping point, when sleep-deprived participants can no longer compensate for impairments.

### 3.7.2. Practical Implications

Frequent nighttime negotiations, as occurring in politics, are usually viewed critically by the media and the general public (cf. Weaver, 2015). Somewhat surprisingly, from an applied perspective, the results of our mixed-method analyses indicate that negotiating under sleep deprivation does not necessarily lead to worse results. Individuals in experimental negotiations, as well as politicians in 'real' negotiations might be able to compensate for the negative effects of sleep loss on motivation and cognitive functioning with increased effort and different compensatory strategies thereby maintaining agreement quality.

While it is a task for future research to explore whether these strategies are truly successful, participants from Study 3 and 5 mentioned several strategies that could be applied under sleep deprivation to successfully reach high-quality agreements: Action could be taken in advance of a negotiation, by agenda-setting, by creating a negotiation environment suitable to decrease tiredness, by individual preparation of the negotiation case, or by using advisor systems. During a negotiation, compensation strategies could be applied on the individual level as well as on the inter-individual level. On the individual level, effective strategies are active participation, self-monitoring, and psycho-physiological self-care (e.g., nutrition, physical activity, and resting). On the inter-individual level negotiators could engage in group-monitoring, change between negotiation issues if deadlocks occur, appoint a leader, and use breaks in an adaptive way to reflect the negotiation process, but also to detach from the negotiation.

However, even if negative effects might be completely compensated for by increased effort and the implementation of the specific compensation strategies, such compensation is costly and cannot be maintained over a long period of time. For the individual, a prolonged increased effort may result in exhaustion (Hockey, 1997; 2011), which in turn jeopardizes individual well-being and health. Thus, although the negotiation outcomes may be not significantly affected by sleep loss, the negotiators are most likely negatively affected. Moreover, the negotiation process might be less efficient (while being still equally effective), because the implementation of several compensation strategies (e.g., breaks, use of advisor strategies, change of negotiation issues)

tends to prolong the negotiation. This could be costly, if timely agreements are of utmost importance (e.g., crisis negotiations or wage bargaining including strikes). In addition, the results of the interview study suggest, that outcome quality could depend on whether opportunities for compensation are provided or whether negotiators are appropriately trained or experienced.

### **3.7.3. Conclusion**

Our mixed-method approach provides first-time insights into negotiations under sleep deprivation. The results of three experimental studies, laypeople's beliefs and the expert interviews suggest that sleep deprivation does not impair negotiators' joint economic outcomes as we (and laypeople) expected. Instead, we suggest, that compensatory effort might occur and suppress the emergence of negative consequences of negotiation outcomes.

## **Chapter 4: General Discussion**

### **4.1. Summary of Research Goals and Results**

In a society that is increasingly sleep deprived (cf. Khubchandani & Price, 2020; US Centers for Disease Control and Prevention, 2015), high stakes negotiations in business and policy settings are often prolonged late into the night. This dissertation project addresses the research question of whether negotiations under sleep deprivation will reach worse outcomes as compared to well-rested negotiators. As laid out in a comprehensive model (Chapter 2), theoretical considerations [and lay conceptions (Chapter 3, Study 4)] would clearly expect a negative effect of sleep deprivation on negotiation outcomes in general, and on joint economic outcomes in integrative negotiations in specific. These expectations were subjected to an initial empirical test (Chapter 3). The initial (underpowered) null finding of Study 1 was replicated in Study 2 with a larger sample and a stronger manipulation of sleep deprivation. The findings were further generalized to an observation of a negotiation (Study 3) to test whether the findings were alternatively attributable to the activating experimental setting in the laboratory. An additional study on lay conceptions (Study 4) also delivers a potential explanation for negotiators to invest additional effort: Because lay conceptions propose a substantial detrimental effect of SD in negotiations, this expectation might represent a precondition leading negotiators to invest effort to maintain agreement quality. The results of a meta-analysis suggest that individuals rather account for a general expectation of a poorer performance after sleep loss than correctly estimate their (potentially impaired) performance (Boardman et al., 2021). From the interviews of Study 5, a set of compensatory strategies that negotiators use to cope with the negative effects of sleep deprivation was derived.

### **4.2. Theoretical Interpretation of the Findings**

The central finding of my dissertation project is that the negative effects of sleep deprivation are less robust and uniform than was expected by the theoretical model (Chapter 2). Nevertheless, the model was a valuable scientific “anchor” from which the steps to empirically test the prediction were carefully chosen. The empirical studies were sufficiently powered to detect medium effects (on average), three of which were preregistered and made use of

established study designs. After the first surprising result of a lack of substantial (that is, large sized) effects, it was not concluded that the effect simply does not exist or is too small to be theoretically or practically relevant, and that previous considerations should be overthrown. Instead, potentially limiting factors (e.g., arousal; see Chapter 2) were addressed in follow-up studies and excluded step by step. The findings were complemented by in-depth qualitative analyses of interviews with experts and a survey on lay conceptions. With the multi-study and mixed-method approach, it was possible to grasp the bigger picture and complexity of underlying processes shaping negotiation performance under sleep deprivation. As indicated by the findings, especially task-related, individual, and inter-individual factors that allow for compensatory effort may help to theoretically explain the findings, provide valuable insight into the effectiveness of sleep manipulation in negotiation settings, and could guide future directions of research.

Nonsignificant results in psychological research are often misinterpreted and seen as support for the null hypothesis (see Aczel et al., 2018 for an overview). I used Bayes analyses to examine the degree to which the nonsignificant results provide support for the null hypothesis. The Bayes factors in three studies—as additionally shown with a Bayesian meta-analysis across the empirical studies 1, 2, and 3 [ $d = -.08$  (95% CI, -0.37 to 0.18),  $BF_{01} = 5.84$ ]—indicate cumulative (moderate) evidence in favor of the null hypothesis (Jeffreys, 1961; Lee & Wagenmakers, 2013). Nevertheless, the theoretical underpinnings and empirical findings on which the research question is based suggest that at least a medium effect should be found. Given the robust evidence of the impairing effects of sleep loss on motivation and cognitive functioning on the one hand and the relevance of these factors for integrative negotiation outcomes on the other, the lack of substantial effects is surprising in the context of prior expectations. It seems therefore very unlikely that the effect simply does not exist.

There are potential explanations for why the null hypothesis is not rejected: (a) The power may have been insufficient, (b) the study design was not suited to detect the true effect, (c) or the true effect was concealed or counteracted by compensatory effort and strategies. These explanations are briefly discussed in the following.

(a) Post-hoc power analyses are deemed to be misleading (Zhang et al., 2019), but the present sample sizes were chosen after a priori power analyses as described in Chapter 2. Study 1 should be considered a first-time test, and the study was (for resource reasons) powered to detect large effects. Study 2's sample size is adequate to detect medium to large effects with a power of .8 and makes use of a stronger manipulation. The other studies' sample sizes are well powered and suffice to detect small to medium effects. Consistently across all studies, the hypothesized (medium to large sized) effect could not be found. It cannot be excluded that there are small effects (see also Discussion of Chapter 2). However, the effect sizes consistently point to the absence of a substantial detrimental effect of sleep deprivation on negotiation outcomes and provide cumulative evidence in favor of the null-hypothesis (as shown by the Bayesian meta-analysis), and indicate a reliable estimate even in the absence of a large sample.

(b) One can question whether the study designs were suited to detect the hypothesized effect, as the most pronounced effects of sleep deprivation are found after severe forms of total sleep deprivation (Harrison & Horne, 2000) and rather on speed than accuracy measures of performance (Koslowsky & Babkoff, 1992; Hockey et al., 1998). Our sleep deprivation of  $\leq 26$  hours could have been too short to produce detectable performance decrements. This limitation can be leveraged by the fact that three different manipulations of sleep deprivation were used which have previously been proven to impair individual and social performances. Minor changes actually improved control over the experimental protocol. All studies showed consistent null findings. Additionally, regardless of the fact that there is room for divergence between sleep manipulations and tiredness (e.g., circadian effects, see Section 4.2.2.), all of the participants reported being more tired after sleep loss compared to the well-rested control group, indicating an effective manipulation of sleep.

Overall, one cannot completely rule out the possible explanation of the null effects by insufficient power. However, the theoretical foundations and empirical findings the research question is based on (i.e., individual-level effects of sleep deprivation), suggested that at least medium effects should be found. The null findings could alternatively be interpreted as an indication of an

effective counteracting of impairments in the negotiation, and it is likely that the null effect occurred due to compensatory effort.

(c) The comprehensive theoretical model of Chapter 2 focuses on identifying individual factors (such as motivation and cognitive functioning) to approach the link between sleep loss and negotiation outcomes but may have underestimated the importance of conditions under which compensatory effort buffers or counteracts the impairing effects of sleep deprivation. The discussed moderators (discussion of Chapter 2) on the task, the individual and inter-individual level may have been more influential than assumed and—most importantly—were not sufficiently controlled for in the experimental studies. In the following, potential variables that may have influenced or buffered the hypothesized effect of sleep deprivation on integrative negotiation outcomes are discussed for the three levels.

#### **4.2.1. The Task Level**

As mentioned before (Section 1.2.4. and discussion in Chapter 2), task characteristics are known to moderate the impact of sleep deprivation. Due to heightened interest and compensatory effort, complex tasks are deemed to be unaffected by short-term sleep deprivation (Harrison & Horne, 2000). Nevertheless, three different negotiation tasks that vary in complexity (not just in number of negotiable issues) were used to test the model and showed comparable results regarding manipulation checks, effort, dependent measures, and effect sizes. Putting task complexity aside, as laid out in Chapter 1.2.4. and argued in the discussion of Study 2 (Chapter 3), it is possible that negotiation tasks—in general—are novel and interesting and could therefore trigger intrinsic motivation and arousal that consequently eases the allocation of task-related effort to meet the situational demands under sleep deprivation. This is backed by a heightened subjective effort indicated by the sleep-deprived participants compared to the well-rested ones (Study 2 and 3). The aim of study 3 was to examine whether the finding of the first two studies is attributable to heightened arousal due to the interesting and novel task. The degree of arousal of the task was limited to a minimum resulting in less activation of the participants (as shown via tiredness measures pre and post negotiation). The finding was replicated and withstood the critical test. A decline in arousal as an effect of sleep deprivation (Kjellberg, 1977), can be understood as a trigger of

compensatory effort (Massar et al., 2019a). While arousal was reduced in Study 3, the interestingness and novelty of the task were still not controlled for. Additionally, not all task characteristics that bear the potential to stimulate and ease compensation were inhibited. For example, 75 % of participants stated that taking notes helped them to suppress tiredness and stay focused. We therefore cannot fully exclude the possibility that taking extensive notes as preparation and during the task helped as an auxiliary tool to prevent performance decrements (compare Häusser et al., 2016). Future research could not only control for perceived complexity, novelty, or interestingness but also for “hidden” stimulating and auxiliary tools and possibilities to strategically ease cognitive demands that are embedded within the task, aiming to understand techniques that facilitate the allocation of effort and maintenance of performance.

A clearer differentiation of seeking (bottom-up) stimulation at the task level on the one hand and (top-down) compensatory effort at the individual level when stimulation is not available as described by Fisher et al. (2008) would be helpful to fully understand the underlying processes. Furthermore, in the studies, only self-reports of effort were used. Subjective and objective measures of effort are not necessarily parallel constructs and should be distinguished in future research (Mathew et al., 2021). Following the biopsychosocial model of *Challenge and Threat* states (Blascovich & Tomaka, 1996; see also Hase et al. 2019 and Uphill et al. 2019 for reviews) negotiations could be understood as situations that require adequate and motivated performance, and are *challenging*. The unconscious evaluation of the challenge state—that is, whether individual coping resources match the situational demands—results in physiological responses (e.g., cardiovascular patterns) which in turn could be objectively measured (Blascovich et al., 1999). As another example, increased pupil size has already been used as an indicator of task-related cognitive effort (cf. Massar et al., 2019b; Sullan et al., 2021; see review by Van der Wel & Van Steenbergen, 2018).

In line with the *Compensatory Control Model*, even if the allocation of effort protects individuals' performance while sleep-deprived, other subsidiary aspects of task performance may be distorted, for example, negotiators may choose strategies that ease the exchange and processing of information or

narrow their attention on primary task goals (Hockey, 1997; Hockey et al., 1998). Whether narrowed task priorities influence performance stability while negotiating under sleep deprivation has to be further evaluated in future studies. However, allocating effort comes at the expense of physiological and behavioral costs such that performance goals will be reduced over time (Hockey, 1997; Massar et al., 2019b). And however interesting the task, it might lose its novelty over time or if performed repeatedly, which will leave participants more vulnerable to sleep loss (Harrison & Horne, 2000). Compensatory effort is thereby only a temporary fix against performance decrements, depending on various task factors.

#### **4.2.2. The Individual Level**

Dual-process models typically account for individual factors that determine the likelihood of effortful elaboration (cf. Petty & Wegener, 1999; Petty et al., 2003). Some individuals simply do not enjoy engaging in effortful thought and thus tend to conserve mental resources and therefore should be less likely to exert additional effort to meet the cognitive demands of a situation. People who derive more pleasure from thinking, who have a high *Need for Cognition* (see Cacioppo & Petty, 1982; or Cacioppo et al., 1996 for a review), are more willing to exert effort because of their intrinsic enjoyment. Additionally, they do so without a need to be correct or necessarily high importance of the issue (cf. Cacioppo et al., 1996; Petty & Briñol, 2012). Therefore, effort expenditure has a strong voluntary component based on personal motivation (see also Earle et al., 2015 for a similar rationale).

In a similar vein, one of the findings of the qualitative study in Chapter 3 was that the personal relevance of the topic being negotiated (subjectively) seemed to help overcome impairments caused by sleep loss. As one of the determinants of elaboration likelihood, the personal relevance of a message has been found to trigger a high thought process and a thorough evaluation of information (Petty et al., 1981). Individual expertise could also influence the allocation of effort. Individuals tend to assess information in relation to knowledge that they already possess (Petty & Briñol, 2012).

Additionally, subjective tiredness can vary individually depending on the time of the day. Future research could be inclined to control for different chronotypes, and, for example, exclude extreme morning and evening types

from the sample after adequate measurements (cf. *Morningness-Eveningness Questionnaire* by Horne & Östberg, 1976; or the *Munich ChronoType Questionnaire*, Roenneberg et al., 2003).

An additional contextual factor that could influence individual behavior in negotiations under sleep deprivation is how the negotiation is integrated into the daily schedule. Real negotiations are often embedded in already demanding workdays or extended over several days without the negotiators knowing when an agreement will be reached (or an impasse will occur). People may enter a negotiation or a new round of negotiations already exhausted and with no opportunity to rest afterward. Following the *Effort-Recovery Model* (Meijman & Mulder, 1998), short-term effects of stressors are reversible and recovery sets in as soon as an individual is no longer exposed to these stressors. However, if recovery does not occur, stress reactions accumulate into chronic impairments that are reversible only to a limited extent. Regular recovery from work-related stressors can thus be seen as an individual resilience factor in the stress process, restoring well-being and performance (Meijman & Mulder, 1998). In the experiments of this dissertation, sleep deprivation was only a short-term stressor, and individuals knew how long they were going to be exposed to sleep deprivation, how long the task would take, and that they would have the opportunity to rest afterward. Anticipation of rest or further stress (compare Casper & Sonnentag, 2020; Seibel et al., 2022) could also be relevant in the context of sleep deprivation and influence the conservation of mental resources and the allocation of compensatory effort (cf. Haslam, 1983).

#### **4.2.3. The Inter-Individual Level**

The present findings suggest that one cannot rely solely on findings on how individuals perform under sleep deprivation to understand the link between sleep loss and negotiation outcomes. Group monitoring and inter-individual compensatory effort might help to overcome impairments inflicted by sleep loss (e.g., Faber et al., 2017). Therefore, social processes among the negotiators as a group have to be taken into account. Negotiations are interpersonal mixed-motive situations, where individuals have to optimize their outcomes while following the collective goal to reach a mutual agreement, which is similar to some types of group decision making. As laid out in the theoretical model

(Chapter 2) and Section 1.2.4. interdependent behavior—including group dynamics—may compensate for the impairing effects of sleep deprivation on the individual and the inter-individual level. By that, relevant processes necessary to tap into the integrative potential may be protected. Integrative negotiations could be understood as disjunctive group tasks (Steiner, 1972) since the integrative potential in negotiations is demonstrable (Hüffmeier et al., 2019). It was found that only one competent negotiator who identifies the partial compatibility of interests (by individually asking interest-related questions) suffices to unlock the integrative potential and thereby optimize joint economic outcomes (Hüffmeier et al., 2019). Consequently, one negotiator at the negotiation table that is able to withstand the negative effects of sleep deprivation (for example, due to resilience or effective allocation of effort) could compensate for performance losses and protect the performance in the negotiation task. While assuming homogeneous effects, it remains unclear— theoretically and empirically—whether the impairing of sleep deprivation and counteracting effects of compensatory effort develop their effectiveness at the level of the individual, the dyad, or both. As pointed out in previous research the composition of the negotiation dyad matters (Ten Velden et al., 2010): For example, the presence of one negotiator with high epistemic motivation is sufficient to engage in effective—in terms of mutually beneficial outcomes— information exchange. Nevertheless, unilateral knowledge about a possible integrative solution has been found to benefit joint negotiation performance, but it turned out to be role (and therefore task) dependent (Zerres et al., 2013). It might be useful to take group dynamics or the perception of the task as a group performance under consideration. To further the understanding of mutually beneficial process gains (and losses) in the process of negotiating sleep-deprived, it seems logical to question the a priori assumption of a homogeneous dyad, and look more closely at the composition of the dyads regarding subjective impairments and mutually compensational effort. The results of Study 5 suggest specific interactions within one negotiating party (e.g., motivational support, taking turns) or across all negotiators (e.g., appointing a leader, informal exchange/joking) which could be helpful to overcome impending performance decrements. The potential to engage in inter-individual

compensatory strategies in the face of sleep loss to protect mutual performance goals is novel and has not been sufficiently scientifically explored.

### **4.3. Future Directions**

The addressed potential explanations for the findings of the previous section result in the following summarized implications for future research. Future research should address the research question of which factors influence the maintenance or collapse of compensatory efforts in negotiations under sleep deprivation. More precisely: One could explore the impact of sleep deprivation on processes and outcomes in *prolonged* negotiations. This can be done by creating tasks with more issues than usually used, or letting negotiators perform several tasks in a row throughout the night. This is ecologically more valid and, moreover, prolonged negotiations might in the long run help to identify the tipping point when compensatory effort collapses, and performance decrements inevitably occur.

Future research should account for individual and task-related moderators and measure self-reported involvement, chronotype, perceived interestingness, or complexity of the task, to be able to control for effects that facilitate (or hamper) compensatory effort and therefore influence the strength of the effect of sleep deprivation. Individual compensatory effort should be measured with a more distinct and objective measure (e.g., cardiovascular patterns, Gendolla et al., 2012; pupil size, Van der Wel & van Steenbergen, 2018) to fully understand to what extent one (successfully) allocated effort to meet the task demands.

Future research should also address the question of which inter-individual strategies negotiators use to compensate for each other to a mutual benefit. This could be done by in-depth video analyses of the negotiation processes. Generally, there should be more focus on the composition of the dyad regarding individual impairments and effort.<sup>10</sup>

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<sup>10</sup> To test whether one less impaired individual or one that shows a high degree of compensatory effort suffices to secure the required exchange and processing of information and thereby optimize the joint economic outcome, several possibilities exist. The straightforward approach would use dyadic composition as a three-level independent variable, for example, with the levels of mixed effort (high and low levels), both low, and both high levels of effort as used to test the effect of the composition of epistemic motivation in dyads (cf. Ten Velden et al., 2010).

Another—hitherto unmentioned—approach could focus on group negotiations, that is, one party of two or more persons negotiating against another party of two or more persons. Real world negotiations—especially in the context of high stakes negotiations—are rarely 1:1 negotiations. While some research has looked at the impact of TSD on decision-making in teams (Baranski et al., 2007; Barnes & Hollenbeck, 2009) not much is known about the underlying processes of team negotiations. It has been argued that team negotiations do not necessarily carry advantages in negotiations (Hüffmeier et al., 2019). Nevertheless, teams can be useful in negotiation under sleep loss. Unshared knowledge, different competencies, and individual differences in compensatory effort, reliance, and chronotype may help individuals to maintain performance by taking turns, as mentioned by politicians in the interview Study 5. The anecdotal evidence from experts' experiences is backed by the findings that turn-taking has a beneficial effect on creativity and perspective-taking in dyadic group tasks (Lu et al., 2020).

Apart from all this, the empirical analyses of this dissertation neglected socio-emotional outcomes of negotiations (see Chapter 2). Future research could therefore address the question of whether sleep deprivation affects the evaluation of the negotiation process, the negotiation partner(s), and the satisfaction with the economic outcome—despite the present results.

#### **4.4. Practical Implications**

In the face of the finding that sleep deprivation may not impair negotiation performance as straightforwardly as expected, several practical implications may follow.

Before negotiators in business and politics shrug and carry on as before because the empirical studies show no substantial negative effects of sleep deprivation on the outcome quality in integrative negotiation, it is important to realize: The best thing that can happen is that sleep deprivation has no negative effects. It still has no *positive* effects on either the negotiation process or negotiation outcomes. Relying on the individual and inter-individual abilities to compensate for the negative effects of sleep loss in the negotiation situation while not knowing *how* it unfolds and *when* compensatory efforts collapse due to exhaustion is a dangerous gamble.

Putting aside the lack of detrimental effects on economic negotiation outcomes, the model (Chapter 2) clearly predicts that sleep deprivation should affect other negotiation outcomes. Additionally, there remains the risk that sleep deprivation will be abused to shape the negotiation environment: (a) Extending negotiations until late at night can be understood as a form of power play. Being exposed to sleep deprivation remains unpleasant and mood is negatively affected, that is, sleep-deprived individuals tend to feel more strained, depressed, more stressed, experience more anxiety and anger, as well as report lower vigor and positive affect (Schwarz et al., 2018; Short & Louca., 2015). The effects of sleep deprivation on mood are even more pronounced than the effects on cognitive capacities (see Pilcher & Huffcutt, 1996 for a meta-analysis). Prolonging negotiations could therefore be used as discouragement tactics and to exercise power over the other negotiation party. (b) Prolonged negotiation can also be used as a tool for signaling effort to public and media. *Costly Signaling Theory* in social contexts (cf. Smith and Bliege Bird, 2005) proposes that seemingly arbitrary behavior conveys information on qualities that are probably not directly observable by others. The *arbitrary behavior* (prolonged negotiations that are usually seen critically in lay conceptions and usually result in impaired performance) could therefore be understood as a signal of the *sender* (e.g., politicians) to the *observer* (media and public) to provide information on a non-observable *quality*, that is, being highly committed to negotiate the optimal solution for party members and the electorate and to prove resistance to premature yielding.

Besides the tactical use of prolonged negotiation late into the night as power play or to signal effort, dismissing sleep deprivation as something that has no serious effects is negligent and dangerous on many levels of organizational behavior. Due to the hierarchical influence of leadership on subordinates, when sleep is devalued by the leader by directly or indirectly promoting that one should sacrifice sleep quantity and quality for work, it has been found to have harmful effects on employees' sleep quality (Barnes et al., 2020). Additionally, to name some examples, impaired sleep leads to productivity slumps, and increases the risk of absenteeism, accidents on the job, and significant economic costs (e.g., see Barnes & Watson, 2019; Hafner et al., 2017 for overviews). Social processes suffer, as sleep-deprived

coworkers show less social support and the leadership-subordinate relationship is negatively affected (for an overview, see Gordon et al., 2021). Furthermore, sleep loss generally has been found to decrease prosocial behavior, trigger workplace conflict, enhance feelings of loneliness, and decrease work motivation (for an overview see Ben-Simon et al., 2020). Also, sleep restriction has been found to increase stress and aggression (Demichelis et al., 2022).

#### **4.5. Concluding Remarks**

In my dissertation, I developed a theoretical model of the various effects of sleep deprivation on negotiation outcomes. The model was subjected to an initial empirical test, with the surprising—from the point of view of convincing theoretical predictions and lay-conceptions—result that the analyses found no substantial impairment of joint economic outcomes in integrative negotiations after sleep manipulations. There is some indication that compensatory effort is likely to occur and might diminish the emergence of negative effects of sleep deprivation on negotiation outcomes. As a result of qualitative interviews, experienced negotiators share many strategic tips that are considered helpful under sleep deprivation. The mixed-method approach provides a first insight into negotiation under sleep deprivation. Taken together, it is unlikely that the proposed effect simply does not exist. Future research should consider controlling for possibilities to allocate compensatory effort on the task, individual and inter-individual level that shape negotiation processes under sleep deprivation. Because one thing remains untouched: Sleep is good for business—even in political negotiations.

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## Appendix: Supplement Information

**Table S1**

*Summary Chart for the Negotiation Task of Study 1*

Issue	Option	Buyer payoff	Seller payoff	Joint outcome	Type of issue
<b>Interest</b>	2%	1600	0	1600	Log-Rolling
	4%	1200	1000	2200	
	6%	800	2000	2800	
	8%	400	3000	3400	
	<b>10%</b>	<b>0</b>	<b>4000</b>	<b>4000</b>	
<b>Stereo system</b>	Type A	0	2400	2400	Distributive
	Type B	600	1800	2400	
	<b>Type C</b>	<b>1200</b>	<b>1200</b>	<b>2400</b>	
	Type D	1800	600	2400	
	Type E	2400	0	2400	
<b>Warranty</b>	6 month	0	1600	1600	Log-Rolling
	12 month	1000	1200	2200	
	18 month	2000	800	2800	
	24 month	3000	400	3400	
	<b>30 month</b>	<b>4000</b>	<b>0</b>	<b>4000</b>	
<b>Delivery</b>	1 week	2400	0	2400	Distributive
	2 weeks	1800	600	2400	
	<b>3 weeks</b>	<b>1200</b>	<b>1200</b>	<b>2400</b>	
	4 weeks	600	1800	2400	
	5 weeks	0	2400	2400	

*Note.* This table shows the payoff schedule for each role and the joint economic outcome by issues and options. The joint economic outcome is determined by summing the number of points (individual outcomes) of both negotiators. The total joint economic outcome (dependent variable) is calculated as the sum of the joint outcomes of each option they agreed upon. Bold options indicate the optimal solution.

**Table S2**

Summary Chart for the Negotiation Task of Study 2

Issue	Option	Real estate developer	City council	Joint Outcome	Type of issue
<b>a) Amount of city council financing</b>	Non	0 €	0 €	0 €	Distributive
	<b>Small</b>	<b>250.000 €</b>	<b>-250.000 €</b>	<b>0 €</b>	
	Large	500.000 €	-500.000 €	0 €	
<b>b) Developing of a park</b>	<b>Real estate developer</b>	<b>-100.000 €</b>	<b>0 €</b>	<b>-100.000 €</b>	Log-Rolling
	Real estate developer and city council	-50.000 €	-100.000 €	-150.000 €	
	City council	0 €	-200.000 €	-200.000 €	
<b>c) Sewage tank</b>		Role specific expectation			Contingent Contract
		Price decreases	Price increases		
	Buy now	-400.000 €	-400.000 €		
	<b>Wait</b>	<b>-350.000 €</b>	-450.000 €		
<b>d) Developing of a parking lot</b>	Real estate developer	-200.000 €	0 €	-200.000 €	Log-Rolling
	Real estate developer and city council	-100.000 €	-50.000 €	-150.000 €	
	<b>City council</b>	<b>0 €</b>	<b>-100.000 €</b>	<b>-100.000 €</b>	
<b>e) Dividing incomes from a sports club</b>	Income to divide each year: € 250.000				
	Tax year 1	0%	40%		Time related trade of
	Tax year 2	40%	40%		
	Tax year 3	40%	40%		
<b>f) Duration of contract</b>	8 years	0 €	-50.000 €	-50.000 €	Compatible
	9 years	25.000 €	-25.000 €	0 €	
	<b>10 years</b>	<b>50.000 €</b>	<b>0 €</b>	<b>50.000 €</b>	
<b>g) Property</b>	<b>Included</b>			<b>100.000 €</b>	Additional issue
	not included			0 €	

Note. This table shows the payoff schedule for each role and the joint economic outcome by issues and options. The joint economic outcome is determined by summing the number of points (individual outcomes) of both negotiators. The total joint economic outcome (dependent variable) is calculated as the sum of the joint outcomes of each option they agreed upon. Bold options indicate the optimal solution (except for Issue e).

**Table S3: Summary Chart for the Negotiation Task of Study 3**

Issue	#	Option	Seller (Pollmann GmbH)	Buyer (Petro Star Inc.)	Type of issue
Price	1	7.500.000 €	0	<b>2400</b>	distributive
	2	7.600.000 €	600	1800	
	<b>3</b>	<b>7.700.000 €</b>	1200	1200	
	4	7.800.000 €	1800	600	
	5	7.900.000 €	<b>2400</b>	0	
Payment conditions	1	0 / 0 / 100 (% at time of contract / on delivery / after acceptance)	0	<b>800</b>	integrative
	2	0 / 50 / 50	800	600	
	3	10 / 30 / 60	1600	400	
	4	10 / 40 / 50	2400	200	
	<b>5</b>	<b>30 / 30 / 40</b>	<b>3200</b>	0	
Date of delivery	<b>1</b>	<b>October 15</b>	0	<b>4000</b>	integrative
	2	October 29	400	3000	
	3	November 12	800	2000	
	4	November 26	1200	1000	
	5	December 10	<b>1600</b>	0	
Number of companies from Oman participating in the installation of pumps	1	0%	0	0	compatible
	2	25%	300	300	
	3	50%	600	600	
	4	75%	900	900	
	<b>5</b>	<b>100%</b>	<b>1200</b>	<b>1200</b>	
Transfer of risk and shipping costs	1	Pollmann takes over risk and costs up to the construction site (CIP Yibal)	-6000	<b>0</b>	distributive
	2	Transfer at the port of destination in Oman (CIF Mina al-Fahal)	-4500	-1500	
	<b>3</b>	<b>Transfer at the port of exchange in Alexandria (CFR Mina al-Fahal)</b>	-3000	-3000	
	4	Transfer when loading onto the ship in Genoa (FOB Genoa)	-1500	-4500	
	5	PetroStar takes over risk and costs ex Pollmann plant in Germany (EXW)	<b>0</b>	-6000	
Included inspections	1	4 inspections included	0	<b>1600</b>	integrative
	2	3 inspections included	1000	1200	
	3	2 inspections included	2000	800	
	4	1 inspections included	3000	400	
	<b>5</b>	<b>No inspections included</b>	<b>4000</b>	0	
Maintenance agreement	<b>1</b>	<b>24 month</b>	0	<b>3200</b>	integrative
	2	18 month	200	2400	
	3	12 month	400	1600	
	4	6 month	600	800	
	5	No maintenance included	<b>800</b>	0	
Supplier of connection pipes	1	Tuyanterie Francois Marchand SA (France)	-2400	-2400	compatible
	2	Smithson Pipe Systems Inc. (USA)	-1800	-1800	
	3	Tubos Rocco Roletti SA (Italy)	-1200	-1200	
	4	Rohrsysteme Vulkan GmbH (Germany)	-600	-600	
	<b>5</b>	<b>MacCogan Pipes PLC (UK)</b>	<b>0</b>	<b>0</b>	

Note. This table shows the payoff schedule for each role by issues and options. The joint outcome (DV) is determined by summing the differences between the proposed option (1-5) and the optimal option for all issues. Bold options indicate the optimal solution.

**Table S4**

*Qualitative Results of Study 5: Categories of Compensation*

<b>Categories</b>		<b>Description</b>	<b>Exemplary quote</b>
<b>Preconditions of compensation</b>			
<b>External factors</b>	<i>Environment</i>	Lightning, air quality, temperature, catering, retreats	An important point is that the negotiation situation is properly set up. From the space which you are in (...), the temperature, the air quality (...), the catering situation, whether there are beverages or food (...).the environment, you cannot change it in the negotiation situation, but you can, if you are interested in success, set it up in advance.
	<i>Adjournment</i>	Possibility to adjourn	Or it makes sense to adjourn again and say (...) "Come on, let's sleep on it another night or half a night and sit back down together again in a day or two"
		<i>Agenda</i>	Setting a negotiation agenda
<b>Individual factors</b>	<i>Professional preparation</i>	Professional preparation of documents and line of argument	(...) it is always part of it, that you prepare (...) the content of such negotiations very, very well. So that you (...) if you know that it will take a long time and be difficult, that you simply have good documents and (...) that you have prepared possible compromising formulations and such things well (...).

	<i>Subjective importance/expertise</i>	Familiar, urgent, or interesting negotiation topics, focusing on one's area of expertise, splitting responsibilities	[Whether sleep deprivation leads to restrictions is] of course still a question of the topic. There are topics that you can discuss at nights, at midnight, and you won't get tired (...) if it is an emotional topic, or one that particularly interests you, then you won't get tired so quickly either.
	<i>Physical and mental preparation</i>	General physical fitness, mental balance, resting and napping in advance	Don't eat heavy and much before, maybe take a short five or ten minute walk before. (...) also to calm the brain a bit, so as to arrive fresh into the negotiation. That is a very important point.
<b>Inter-individual factors</b>	<i>Advisor systems</i>	External team can provide expertise and support on demand	I can of course then organize a support group outside of the negotiation room. One that supports me on that matter (...). With that, you can take burden off yourself during the situation when it gets late and tiring (...). Because you cannot integrate them directly into the negotiation, but they can do a lot of the groundwork.
<b>Individual level of compensation</b>			
	<b>Conscious nutrition</b>	Consuming water, psycho-stimulants (e.g., coffee), sweets; abstinence from alcohol, large amounts of coffee, heavy meals	So, in my opinion, being conscious about what you eat is very helpful. (...) And then personally I always drink a lot of water and try to eat relatively little because that naturally contributes to fatigue coming from the stomach.
	<b>Cardiovascular activation</b>	Stretching, standing up, change of sitting position, fresh air, cold water on the face, chewing gum, breathing exercise	As far as the situation allows for it, simply get up, briefly go out, go back in, so that (...) by this activity (...) the body is reactivated.
	<b>Resting</b>	Napping/ resting in breaks	Otherwise, (...) you just have to see whether you maybe need to be radical and say: "So, I now need 5 minutes. I'm sorry, I've just reached a low point. Can we take a break?"

**Self-monitoring**

Tracking and assessment of own performance to be able to intervene and to suppress impairments

(...) it is important to have a good self-assessment. To be able to assess for yourself how far you are still able to think reasonably clearly, to act clearly and to express yourself clearly.

**Active participation**

Following the negotiation, active participation, taking leadership

As long as you actively think and actively engage, the effects of exhaustion and tiredness, of lack of concentration, rushes in much later for you than for those who mostly do not interact but rather only are present.

**Inter-individual Level****Change of negotiation subject**

Negotiation of non-controversial or easy issues to break a deadlock and to invigorate the negotiation dynamics

To say "We're not getting any further here." On the one hand, it tires out and above all, it may harden the fronts for the other points. So, you then first take something that is less controversial or not really entirely relevant. To calm down, you just work on another point.

**Appointing a leader**

A leader to suggest breaks, admonish in cases of negligence, enforce negotiation rules and moderate conflicts

(That) depends very much on the negotiator, to what extent he [she] sets the direction or brings it together or gives a friendly warning: "So, please concentrate again now, we'll be finished soon!"

**Group monitoring and support***Motivational*

Mutual goal for agreement, willingness to compromise, encouragement, openly addressing tiredness

And I have colleagues with whom I'll talk about the situation, i.e. articulate and name what currently is going on: "Are you also so tired?" "Oh, I can't go on." (...) And it is sort of a good outlet when you say this to someone and they confirm that: "It really has been very long now."

<i>Professional</i>	Taking turns and help each other out to enable short breaks	"[I] have colleagues there with whom I have already often been through something like this before, so that everyone can already tell when the other has reached a low point. And then [someone else] quite simply takes over, (...) so that they can catch their breath for a few minutes. (...) Sometimes in such a way that the others don't even notice. You know, you can definitely get it under control. This interaction in a homogeneous group.
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<b>Breaks</b>	<i>Breaks for reflection</i>	strengthen in-group dynamics, allow for constructive summary of what has been negotiated so far and for planning further strategies, prevent premature concessions	It is very important to reflect, because you have to hold your own negotiating delegation together. Breaks are important for this. (...) Although a break here does not mean that you go to sleep somewhere, but that you reflect on arguments that have come from the opposing side of the negotiation that you reflect on your own position and see where there are opportunities to move. And maybe also save you from rash approaches.
	<i>Breaks for distraction</i>	Informal exchange, small talk, joking within the negotiation context	(...) You can tell when the group, no matter how heterogeneous its views are, works well together on a human level, that they really motivate each other to carry on. And if it comes to something private, or an experience that may have, yes, amused you that day. A story. (...) That brings a personal closeness and wakes you up.

*Note.* Qualitative Results of Study 5: Categories of compensatory strategies with exemplary quotes of politicians.