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# **The Effect of a Daily Diary Intervention on Subjective Sleep Quality During the Covid-19 Pandemic: Does Positive Reappraisal Make a Difference?**

## **Master Thesis**

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### **Zusammenfassung**

Die weltweite Covid-19 Pandemie hatte katastrophale Auswirkungen auf die mentale Gesundheit der Bevölkerung. Erste Forschungsergebnisse zeigen einen Anstieg von Angsterkrankungen, Depressionen, und Stress, sowie eine deutliche Verschlechterung der subjektiven Schlafqualität. Studien legen außerdem einen starken Zusammenhang zwischen Stress und subjektiver Schlafqualität nahe, mediiert durch negativen Affekt. In der vorliegenden Arbeit wurde untersucht, in welchem Ausmaß die subjektive Schlafqualität während der Covid-19 Pandemie beeinträchtigt war. Das Ziel war, herauszufinden, ob durch eine Positive Reappraisal Intervention negativer Affekt reduziert und die subjektive Schlafqualität verbessert werden kann. Hierfür wurde eine Tagebuchstudie durchgeführt, mit täglicher Untersuchung von negativem Effekt, Pre-Sleep Arousal und subjektiver Schlafqualität, mithilfe der Inventare PANAS, PSAS, und einer kurzen Schlafqualitätsskala. Die Zusammenhänge zwischen der täglichen Veränderung des negativen Affekts, dem Pre-Sleep Arousal und der subjektiven Schlafqualität wurden mittels Multilevel Model analysiert. Die Ergebnisse zeigen einen signifikanten Rückgang der subjektiven Schlafqualität während der Covid-19 Pandemie. Während der Tagebuchphase zeigte sich zudem, dass hoher negativer Affekt und hohes Pre-Sleep Arousal am Tag signifikant mit schlechterer subjektiver Schlafqualität zusammenhängen. Pre-Sleep Arousal erwies sich hierbei als besonders aussagekräftiger Prädiktor. Die Positive Reappraisal Intervention konnte jedoch keine signifikante Verbesserung der subjektiven Schlafqualität oder des negativen Affekts erzielen. Mögliche Gründe und Erklärungen werden erläutert, sowie Implikationen für künftige Forschung diskutiert.

### **Abstract**

The worldwide Covid-19 pandemic had devastating effects on the mental health of the population. Initial research shows increased symptoms of anxiety, depression, and stress, and a considerable deterioration of subjective sleep quality. Findings also suggest a strong link between stress and subjective sleep quality, mediated by negative affect. The present study examined to which extent subjective sleep quality was affected during the Covid-19 pandemic. The goal was to assess whether negative affect can be reduced, and subjective sleep quality improved with a positive reappraisal intervention. A daily diary study was conducted, surveying negative affect, pre-sleep arousal and subjective sleep quality employing PANAS, PSAS, and a brief scale to assess subjective sleep quality. The relationship between daily changes in negative affect, pre-sleep arousal, and subjective sleep quality was analyzed with a multilevel modeling approach. Results show a significant decline of subjective sleep quality during the Covid-19 pandemic. Analyses of the daily diary data further revealed that high negative affect and pre-sleep arousal during the day significantly predict a decline in subjective sleep quality. Pre-sleep arousal proved to be a particularly strong predictor. However, the positive reappraisal intervention did neither yield a significant improvement in subjective sleep quality, nor a significant decline in negative affect. Possible reasons and explanations as well as implications for future research are being discussed.

## Introduction

“Süßer Schlaf! Du kommst wie ein reines Glück, ungebeten, unerfleht am willigsten.“ – Goethe. (“Sweet sleep! You come as a pure joy most willingly unsought, not implored.” – translated by Keith Anderson). This quote by German poet Johann Wolfgang von Goethe accurately describes the mysterious and sensitive nature of sleep. Sleep is vital for our health, our psychological and physical wellbeing. And yet, its manifestation is quite different from other health related behaviors. While we can decide to eat healthier, to exercise more, and to stop smoking or drinking alcohol, we cannot force ourselves to sleep more or better. Sleep is a very sensitive matter that is affected by numerous factors. Some of these factors are of technical nature and easier manipulable, such as blue light in screens that disturbs the production of melatonin, a hormone released by the pineal gland that is associated with controlling the wake-sleep rhythm. Others are individual and subject to personal experience and learnings, such as different chronotypes and biological clocks. Yet others are more elusive and difficult to manipulate. One of the most prominent of those factors is perceived stress and the resulting negative emotions that emerge from a stressed mind.

The worldwide spread of the Covid-19 pandemic in 2020 and all its implications was arguably a universal stressor for almost the entire world’s population, regarding how public health emergencies of national and international concern, such as epidemics and pandemics, have always been a source for increased stress, worrying and deteriorating mental health. For example, studies conducted after the Ebola outbreak in West Africa in 2014 found increased levels of anxiety and depressive disorders in both survivors of the illness (Ji et al.,

2017) and individuals who were not infected themselves (Shultz, Baingana, & Neria, 2015). Contributing factors were exposure to trauma such as witnessing and caring for infected individuals, fear of death, but also secondary effects such as resource insecurity. A study that examined the psychological aftermaths of the SARS pandemic of 2002/2003 furthermore showed that isolation as a protective measure and stigmatization of infected people can have severe impacts on the mental health of large proportions of the population (Mak, Chu, Pan, Yiu, & Chan, 2009).

While the Covid-19 pandemic thus was not the first crisis of this nature, its impact rose to new dimensions in that it affected almost the entire world for an extended period. This pandemic was an unprecedented situation from virtually all standpoints of human life: It severely affected the world economy, strained the health sector, basically commandeered political decision making, put enormous pressure on society and individuals and drastically changed the way we lived our daily lives. Accordingly, the present study was conducted under exceptional historical circumstances, roughly four months after the first confirmed case of Covid-19 in Germany in January of 2020 and two months after the initial implementation of measures against the spread of Covid-19 in March of 2020. These initial measures included the shut-down of schools, kindergartens, universities, restaurants, shops, and most sites of public life, as well as the implementation of social distancing regulations, hygiene measures, and contact restrictions. During the conduction of this study, these measures were still in place in all states in Germany except from Hamburg, North Rhine-Westphalia, and Saxony-Anhalt. A cumulative 186,461 confirmed cases of Covid-19 infections, and 8,791 Covid-19 related deaths were reported in Germany upon the final

survey day of the present study (Robert-Koch-Institut, 2020).

Even though the measures against the spread of Covid-19 have proven to be effective in the past, they constitute enormous restrictions for people's lives and have the potential to affect the mental health of an entire generation. Regarding the universality of this pandemic, it is imperative to study its ramifications and repercussions on mental health. While most studies that examined the deterioration of mental health during the Covid-19 pandemic so far have focused on depression and anxiety disorders, subjective sleep quality has not been explored to the same extent. The goal of the present study was hence to examine how the pandemic has affected negative affect, stress, and in turn people's subjective sleep quality. For that purpose, a study was conducted that subjected participants to a daily diary intervention involving a positive reappraisal intervention. The main focus of this thesis is to assess whether diary keeping in general and positive reappraisal in particular is a suitable tool to reduce negative affect and improve subjective sleep quality, especially in times of crisis.

### **Theoretical Background**

This section will provide definitions of the constructs relevant for this study, as well as illustrate prior research conducted on the interrelations of perceived stress, emotional state and subjective sleep quality. It will also briefly summarize the current state of research on how the Covid-19 pandemic has affected particularly perceived stress and sleep quality. The research purpose of the present thesis, as well as the derived hypotheses that were examined in this study will conclude this section.



### **Defining Stress**

Despite being a widely used term in both colloquial and scientific language, a universally recognized definition of stress has not been established so far. Due to the complexity and multifacetedness, the scientific community approached the phenomenon from different angles and perspectives, ranging from materials engineering and physics to philosophy.

One of the first to coin the modern concept of stress was Hans Selye. His first definition of stress as “the non-specific response of the body to any demand for change” (Selye, 1936, p.32) constitutes a physical approach, implying that stress is the quality of a material to regain its original size and form after the application of external force. Selye’s description of stress furthermore differentiates between stimulus and reaction and calls the stimuli stressors.

A modern, psychological definition of stress was postulated by Heinrichs, Stächele and Domes (2015): Stress results from threatening a person’s physical and/or psychological integrity, which causes an adaptive physiological, behavioral, emotional, and cognitive response. The evaluation of the stressor’s threat level is crucial, independent from whether the situation is objectively threatening or subjectively interpreted as such. Thus, according to Heinrichs et al. (2015), stress happens on four levels: On the physiological level, the body reacts by activating the hypothalamic-pituitary-adrenal axis and releasing various hormones and neurotransmitters that momentarily put the body on alert. The behavioral component is reflected by a person’s behavior and their feelings are expressed on the emotional level. On the cognitive level, the stressor is assessed and processed mentally. The connection

between the situational requirements and the acting person is, however, in no way subject to a rigid stimulus-response pattern. Instead, person and environment are connected in a complex system of interrelations. Plus, according to concurrent findings from research on stress over the past decades, the harmful effects of stress do not primarily seem to depend on intensity and duration of a stressor, but on the employed coping strategy. This insight emphasizes the importance of the subjective evaluation of a stressor in Heinrich et al.'s (2015) definition.

### ***Transactional Model of Stress and Coping***

A very influential model allocating major importance to the cognitive evaluation of stress is the *Transactional Model of Stress and Coping* (Lazarus & Folkman, 1984). According to this model, the emotional response to a stressor is the result of a two-step process of appraisal in a given situation. In a process called *primary appraisal*, a person evaluates the situation as irrelevant, potentially dangerous, or positive. In the case of the situation being viewed as potentially dangerous, the second step of the process, the *secondary appraisal*, is engaged. Now, available resources to deal with the threat are evaluated, for example personal skills, prior experiences, actual material resources, but also social support. If the appraisal process does not yield sufficient available resources, a stress reaction is triggered. Next, depending on personality characteristics and the specific situation, a coping strategy to meet the stress reaction is selected. By Lazarus and Folkman's (1984) definition, coping is not necessarily equated with successfully overcoming the stressful situation, but rather describes the attempt to deal with the stressor in a certain way. For example, aggression,

flight, or denial are legitimate coping strategies. According to Lazarus and Folkman (1984), coping can be *problem-focused* or *emotion-focused*. Problem-focused coping targets the stressor itself and centers around a person's ability to change the situation and thus disperse the stressor, whereas emotion-focused coping is directed at altering one's relationship with the stressor, for example through emotion regulation. To illustrate the different approaches, imagine someone with a fear of arachnids finding themselves in a room with a big, hairy spider. A person selecting a problem-focused approach might leave the room, whereas an emotion-focused approach might be to acknowledge that the spider is harmless and fear therefore unnecessary.

In an additional step, the so-called *reappraisal*, the success of the coping strategy is evaluated and ideally adapted to be applicable to future situations. This way, a well dealt with stressor might henceforth be perceived as a challenge, whereas an inadequately managed situation might pose a threat. Essentially, the appraisal processes in the Transactional Model of Stress and Coping are iterative feedback loops. The evaluation of a stressor is, hence, a lifelong and dynamic developmental process.

### **Perceived Stress during the Covid-19 Pandemic**

In a society already heavily shaped by a high stress level, a worldwide pandemic poses a special threat to mental health. Besides the obvious concerns for one's own health and the wellbeing of loved ones, people face additional stressors such as financial worries accompanying an economic shutdown, job uncertainty and work-related changes, and general uncertainty about the future, confronted with an unprecedented situation. Across the societal spectrum, the Covid-19 pandemic has shattered previous structures of work-life

balance. Homeschooling challenges established notions of compatibility of family and career and puts an enormous amount of pressure on families. Couples are afflicted with the challenges of home office and curfews in small apartments, and on the other side of the spectrum, single people suffer from loneliness and lack of physical contact through social distancing.

More than two years after the onset of the pandemic in Germany, the negative effects of lockdowns, social distancing and other protective measures on mental health have been the subject of a large body of studies. But even during the first months of the pandemic, several surveys and studies found that the pandemic and the associated uncertainty led to increased stress, anxiety, and depressive symptoms among the general population. For instance, compelling evidence was provided by the NAKO health study, Germany's largest research project examining the health of the German population. It is a long running cohort study that has tested roughly 200,000 people on a regular basis since 2014 (Schipf et al., 2020). A subsample of nearly 114,000 people gave information about their mental health in the timeframe between end of April 2020 and end of May 2020 to assess the initial impact of the Covid-19 pandemic and the resulting protective measures implemented by the authorities. According to this study, perceived stress was increased among all age groups (Peters, Rospleszcz, Greiser, Dallavalle, & Berger, 2020). For participants younger than 60, the rate of moderate to severe symptoms of depression also increased from 6.4% prior to the pandemic to 8.8% during the pandemic, anxiety-related symptoms rose from 4.3% to 5.7%.

Based on the Transactional Model of Stress and Coping (Lazarus & Folkman, 1984), perceived stress during the pandemic might mainly be increased for people who, first, evaluate their current situation as dangerous, for example because of job loss or the threat thereof, and secondly, who do not feel like they have the necessary resources available to cope with the current situation. In an unprecedented situation like the Covid-19 pandemic, these factors are likely to apply to a larger number of people than usually.

### **Sleep and the Consequences of Chronic Sleep Loss**

The importance of sleep becomes clear when we consider the sheer amount of time humans spend asleep. Most people sleep for up to a third of their lifetime, so it is safe to say that sleep must be a very important feature, otherwise it would be one of evolution's biggest mistakes. This fact makes it even more surprising that astoundingly little is known about why humans need to sleep, how they fall asleep, how they wake up and what happens during sleep. The first electroencephalograph (EEG) to measure electrical activity in the brain during sleep was employed in 1937 (Loomis, Harvey, & Hobart, 1937), rendering sleep research a fairly young scientific subject. In 1957, Dement and Kleitman defined the stages of sleep that to this date form the basis for a deeper understanding of sleep physiology (Dement & Kleitman, 1957). Today, there is consensus among scientists about how sleep regulates basic biological and psychological regeneration and how essential healthy sleep is for virtually all aspects of human life. Without sleep, almost all living beings cannot function over an extended period of time and complete sleep deprivation leads to the organism's death within a few weeks.

On an individual level, sleep deprivation is associated with detrimental consequences for physical and mental health. After only a few days, the function of the immune system is compromised (Birbaumer & Schmidt, 2010), quality of life declines significantly due to excessive daytime sleepiness, and memory and concentration are impaired (Dinges, Rogers, & Baynard, 2005). Further, depressed mood, anxiety symptoms, and alcohol abuse have been associated with chronic sleep loss (Altevogt & Colten, 2006). Meanwhile, the public health costs of insomnia and poor sleep are enormous: sleep disorders have been associated with higher risk of heart diseases, diabetes, obesity, and strokes, leading to higher costs for treatment and medication. In addition, individuals suffering from insomnia are less productive, more prone to accidents and injuries, and are thus putting a high burden on society and the economy (Stoller, 1994). Stoller estimates the total annual cost of insomnia at \$92.5 to \$107.5 billion in the United States of America alone. Sleep deprivation can also have catastrophic and immediate consequences: disasters like the nuclear power plant meltdown in Chernobyl or the oil spill caused by the Exxon Valdez have at least partially been blamed on impaired performances attributed to fatigue and sleep-loss (Altevogt & Colten, 2006). These devastating effects of sleep deprivation on individuals and society as a whole highlight the importance of a healthy sleep routine and a positive subjective sleep quality.

Subjective sleep quality in this context reflects more than just quantitative indicators of sleep, such as time spent asleep. According to Morin et al. (2003), subjective sleep quality is the perception of feeling refreshed when waking up and the perceived sleep soundness. A systematic review that compared people who report healthy sleep with people who suffer

from insomnia shows that the perception of feeling refreshed when waking up is the most important indicator for people to evaluate their subjective sleep quality (Harvey, Stinson, Whitaker, Moskovitz, & Virk, 2008).

Recent statistics support the concern that sleep disorders have become a widespread problem in German society: Figures published by the German Federal Bureau of Statistics (Destatis) show that in 2019, 101,400 patients were hospitalized with a diagnosed sleep disorder (Statistisches Bundesamt, 2021). This includes trouble falling or remaining asleep, imbalances in the circadian rhythm, sleep apnea, but also excessive sleepiness and narcolepsy. The German Health Interview and Examination Survey for Adults (DEGS1) found that during the survey period from 2008 to 2011, one third of the participants reported potentially clinically relevant sleep problems (Schlack, Hapke, Maske, Busch, & Cohrs, 2013). A survey conducted by the Techniker Krankenkasse in 2017 yielded similar results: two thirds of the participants reported no sleep-related problems, whereas one third evaluated their sleep quality as mediocre or bad (Techniker Krankenkasse, 2017).

### **Impaired Sleep Quality during the Covid-19 Pandemic**

As the prior section has established, sleep disorders have become more prevalent in recent years and have thus been an enormous burden for individuals and societies alike, even prior to the Covid-19 crisis. A worldwide pandemic now certainly has the potential to affect the subjective sleep quality of millions of people, even for members of the general public who do not usually suffer from insomnia. Indeed, numerous polls and surveys have already confirmed that the first year of the Covid-19 pandemic had catastrophic effects on

the psychological wellbeing and sleep quality of people all around the world (e.g., YouGov, 2020; Hetkamp et al., 2020). An initial poll by the Techniker Krankenkasse surveying a representative sample of 1000 people found that one in ten participants reported reduced sleep quality during the Covid-19 pandemic (Techniker Krankenkasse, 2020). A representative survey by the Kaufmännische Krankenkasse (KKH) which was completed several months later even found that one in five respondents reported sleep problems due to the pandemic (Kaufmännische Krankenkasse, 2021). Potential reasons are changes in people's daily routines and sleep habits, caused by relocating their work environment to their homes. Other factors are the lack of recreational activities such as sports and hobbies, and the drastic reduction of social contacts (Altena et al., 2020). This increase in sleep problems highlights the importance of research and the development of coping strategies for individuals to combat the rise of sleep disorders during health crises such as the Covid-19 pandemic.

### **Perceived Stress and Impaired Sleep Quality**

So far, this thesis has presented an overview over the theoretical constructs and practical implications of stress and sleep and how they have been affected by the Covid-19 pandemic. The following section describes how the two concepts are associated, details the current state of research on the topic and explores potential mediators.

One of the main problems individuals with insomnia report is trouble falling asleep. Years of sleep research indicate that the transition from waking to sleeping state is not a dichotomous matter but rather a phase that involves a series of changes (Ogilvie, 2001). For



healthy sleepers that includes among others slowing of the heart rate, lower body and higher skin temperature, and a decline in cortical activity. Especially the latter is of high significance regarding the development of sleep disturbances as it can be influenced for example by the perceived stress a person experiences upon falling asleep.

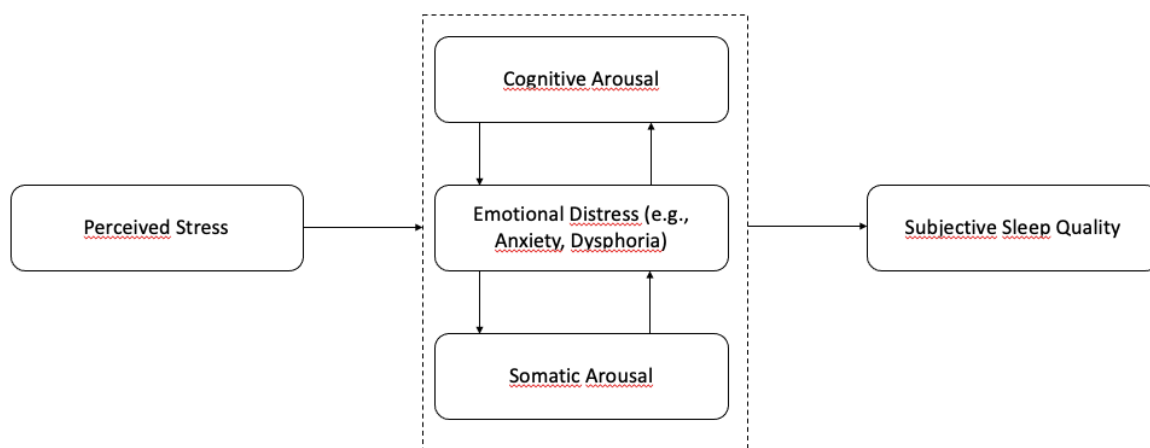
Numerous studies exploring the relationship between stress and sleep indicate that perceived stress upon falling asleep is a major predictor of subjective sleep quality (Winzeler et al., 2014; Åkerstedt et al., 2012). The reported stressors are very diverse, ranging from stressful life events to financial strain. However, Åkerstedt et al. (2012) found that a stressful workday does not necessarily result in poorer sleep that subsequent night, indicating that the mere demands a job for example requires cannot explain the relationship between stress and poor sleep. Instead, their results suggest that the connection between stress and impaired sleep may be caused by an anticipation of stress the upcoming day and a preoccupation with stress-related problems. A study conducted by Morin et al. (2003) found similar results: no significant difference in the frequency of minor daily stressors was reported between poor and good sleepers, however, the perceived impact and intensity of those stressors was rated higher by participants suffering from poor sleep. This leads to the assumption that the link between stress and sleep might be rooted in cognition, emphasizing the question which processes are involved in and influencing the relationship between stress and sleep.

Individuals suffering from insomnia describe increased psychophysiological arousal that delays the onset of sleep. This arousal can be divided into two subcategories: somatic arousal, which includes physiological features such as heart rate, skin conductance, and skin

temperature, and cognitive arousal, which is a state characterized by experiencing intrusive and uncontrollable cognitions (Nicassio, Mendlowitz, Fussell, & Petras, 1985). This so-called *pre-sleep arousal* is assumed to mediate the relationship between perceived stress and impaired subjective sleep quality. Morin et al. (2003) found a significant correlation between high daytime stress and poor nighttime sleep, mediated primarily by bedtime arousal (illustrated in figure 1). Higher stress during the day was associated with higher cognitive and somatic arousal which in turn was associated with impaired subjective sleep quality. Importantly, partialing out pre-sleep arousal erased the significant relationship between stress and sleep, clearly pointing to the importance of pre-sleep arousal as a crucial factor in stress and sleep research. Morin et al.'s (2003) findings additionally suggest another mediator, coping skills and appraisal processes, which will be discussed in more detail in the section on positive reappraisal.

### Figure 1

*Mediation Model of the Effects of Perceived Stress on Subjective Sleep Quality According to Morin et al. (2003)*



### **Emotion Regulation and Sleep Quality**

According to several studies, pre-sleep arousal might be the result of an inadequate ability to control one's emotions (e.g., Baglioni, Spiegelhalder, Lombardo, & Riemann, 2010). Consequently, a major factor to look at when trying to differentiate between poor and good sleepers is the ability to regulate emotion in a healthy way. Emotion regulation describes the process of monitoring, evaluating, and influencing emotional reactions (Gross, 1999). Specifically, the inadequate regulation of negative affect is listed as one of the dominating factors in several theoretical models trying to explain the development of sleep disturbances (e.g., Espie, 2002). One of those models is the widely recognized cognitive model of insomnia by Harvey (2002). Originally it has been developed to explain the maintenance of DSM IV defined insomnia, however, given that sleep disturbances and impairment of subjective sleep quality are central criteria for the diagnosis of insomnia, it is considered valid to draw conclusions from the model for a subclinical sample. The model states that individuals who suffer from insomnia experience intense intrusive thoughts and excessive worries upon trying to fall asleep. These thoughts primarily revolve around not getting enough sleep and lead to worries about health, daytime functioning, and impaired performance the next day. As a result, the individual spirals into an anxious state characterized by autonomous and cognitive arousal and emotional distress. This condition prevents the individual from calming down sufficiently to be able to go to sleep, which in return confirms their worries and results in an overestimation of the feared sleep deficit. In a kind of self-fulfilling prophecy, this sequence of triggers leads to an actual detrimental sleep deficit.

The cognitive model of insomnia thus emphasizes that a failure to effectively regulate one's emotions upon falling asleep can bring about a downward spiral, resulting in chronic self-maintaining sleep loss. One implication of this model is that treatment of insomnia should focus on reducing negative affect. Results from Görlich (2021) lead to a similar conclusion: she found that negative affect partially mediates the relationship between perceived stress and subjective sleep quality during the Covid-19 pandemic. Derived from that, she suggests the development of interventions promoting effective emotion regulation to reduce negative affect.

### **Positive Reappraisal**

Effective emotion regulation entails the flexible employment of various coping strategies, such as behavioral avoidance, acceptance, or distraction. However, one emotion regulation technique that has proven to be especially effective with regard to coping with negative emotions in the context of stress is *cognitive restructuring*, or *cognitive reappraisal* (Johnson et al., 2016; Troy, Wilhelm, Shallcross, & Mauss, 2010; Webb, Miles, & Sheeran, 2012). Munk et al. (2020) specifically point to the crucial role of the individual coping strategy with regard to a successful adjustment to the current pandemic. According to their results, coping strategies such as cognitive reappraisal and, specifically, focusing on positive situational aspects as coping style is clearly associated with lower risk for depression and anxiety disorders during the Covid-19 pandemic.

This so-called *positive reappraisal* is a variation of cognitive reappraisal by which thoughts about negative events and emotions are actively reframed as benign, positive, or

even beneficial (Folkman, 1997). This technique, sometimes also conceptualized as *benefit-finding*, entails the identification of benefit from adversity, that is, finding positive meaning from a negative experience. These potentially positive aspects are highly individual but often involve feelings of gratitude and appreciation of life, a shift in priorities and a new focus on things that are personally important, a more deliberate and purposeful approach to life, experiences of love and support from others, or personal growth and even pride over having been able to manage a stressful situation and employ or acquire new personal skills. Individuals who employ a positive reappraisal coping strategy are thus more likely to successfully adapt to stressful life events. For example, positive reappraisal and benefit finding has been shown to be very beneficial for people who experienced severe illnesses, such as breast-cancer (Sears, Stanton, & Danoff-Burg, 2003), and has also proven to be effective in reducing stress and improving parameters associated with mental health (Helgeson, Reynolds, & Tomich, 2006).

Individuals who successfully employ positive reappraisal as a coping strategy change the meaning of a demanding situation in a way that also changes the individual's emotional reaction to said situation (Gross, 2008). This feature renders positive reappraisal an ideal technique to reduce negative affect. The deliberate promotion of positive reappraisal hence has the potential to reduce cognitive arousal in the pre-sleep phase and is thus a promising candidate in the quest to enhance subjective sleep quality. For instance, Åkerstedt points out that stress only leads to impaired sleep in instances where the stressor is evaluated as stressful (Åkerstedt, Kecklund, & Axelsson, 2007). Morin et al. (2003) came to a similar conclusion in that poor and good sleepers experience the same number of daily stressors,

except poor sleepers evaluate them as more stressful than good sleepers. These results suggest that appraisal processes play a major role in the genesis of sleep disturbances and are thus a promising leverage point for interventions focusing on sleep quality. The cognitive process of positive reappraisal can be prompted in various ways, for example in a guided dialogue in a therapeutic setting, but also through targeted questions and prompts in a writing intervention. In fact, findings from Pogrebtsova et al. (2018) suggest that employing positive reappraisal in the form of a writing intervention can buffer negative affect.

### **Writing Interventions**

Expressive writing as a form of intervention has first been studied by Pennebaker (1997). He argues that the mere act of disclosure has beneficial effects on emotional and physical wellbeing. This circumstance has been used by virtually all forms of psychotherapy by relying on patients to first acknowledge a problem and then discuss it. Pennebaker outlines that although the experience of disclosing deeply emotional experiences may be painful during the process of writing, it is associated with a significant reduction in self-reported distress in the long run. These findings have been corroborated by a meta-analysis by Smyth (1998).

Especially for studies associated with insomnia and sleep problems, expressive writing has become an interesting intervention option. As detailed above in the section about sleep, patients reporting difficulties falling asleep, often complain about intrusive thoughts and worries. One explanation for this elevated cognitive arousal is an insufficient processing of stressors and emotional experiences throughout the day. In a pilot study,

Harvey and Farrell (2003) demonstrated that a Pennebaker-like writing intervention can facilitate this emotional processing and improve sleep. Participants who wrote about worries and concerns reported shorter sleep onset latency compared to participants who did not participate in any writing task.

### **Daily Diary Studies**

Aside from the established psychological benefits of diary keeping, interventions that involve diary data are a popular tool in social sciences because they constitute a type of intensive repeated measures. This quality is beneficial to the design of experiments on many levels. The human memory is susceptible to all kinds of biases, such as *recency*, or *salience* (e.g., Reis & Gable, 2000). Recent or salient events come to mind more swiftly upon a corresponding prompt. As a result, participants frequently report their most recent behavior, thoughts, or experience instead of a more accurate average over time. Plus, memory is a constructive process. When humans remember, they create memories as much as they recall memories. The more time passes between the event and the corresponding description, the more additional factors influence the recall (Nezlek, 2012). Retrospective self-reports have thus long been criticized as unreliable (Schwarz, 2007). Assessing data on a day-to-day basis avoids memory biases as best as possible. As opposed to the artificial context of laboratory studies that are common in psychological research, data produced in a diary study portray participants' everyday reality and thus display better external validity, with the additional benefit that the effect of the observer on the participants is minimized.

Daily diary studies can also reduce bias caused by social desirability. One factor is the

anonymous nature of providing data from the familiarity of one's home, but another crucial element is the specific design inherent to daily measures: It is likely that participants having to report socially undesirable behavior do so more frequently, when the described behavior is displayed only for a short period of time. This makes it easier for participants to excuse the undesired behavior as only temporary and not inherent to their personality (Schwarz, 2007).

For the specific research purpose of this study, assessing data on a daily level was deemed the ideal method because of its quality of intensive repeated measures. This provides a very accurate account of the development of sleep quality over the course of a week as opposed to a pre-post comparison with two surveys only.

The decision to use daily diary measures to examine the research questions in the present thesis was furthermore based on practical considerations. First and foremost, the possibility to complete all required diary entries individually and from home is a suitable format during a pandemic since it does not require participants to visit a lab or be otherwise exposed to potentially dangerous contacts. Second, to note one's thoughts and experiences in a physical pen and paper format from one's home, no particular skills or prior knowledge are needed. Regarding the broad sample surveyed in the study, this was a crucial requirement.

### **Research Purpose of the Present Thesis**

So far, the connections between negative affect, pre-sleep arousal, and subjective sleep quality have mainly been examined in cross-sectional studies. The daily diary approach



presented in the present study allows for more detailed conclusions about how negative affect and pre-sleep arousal affect subjective sleep quality over the course of the study and whether the outcomes can be influenced with an intervention.

An important aspect of the present study concerns the exceptional circumstances under which this study was conducted, that is, the worldwide Covid-19 pandemic. A study conducted by Görlich (2021) found that perceived stress during the Covid-19 pandemic has a significant effect on negative affect. Further, negative affect significantly influences subjective sleep quality. Görlich's results also suggest that negative affect is a significant mediator of the relationship between perceived stress and subjective sleep quality. Based on those findings, one focus of the present study is to assess whether individual participants actually report lower subjective sleep quality on days on which they experience higher negative affect and higher pre-sleep arousal respectively. Moreover, the present study introduces a daily diary writing intervention to determine whether subjective sleep quality can be improved by reducing negative affect and pre-sleep arousal. Finally, the objective of this study is to test whether positive reappraisal as a specific style of writing intervention is particularly effective. For this purpose, the established benefits of positive reappraisal and expressive writing are combined to assess whether a positive reappraisal intervention is a suitable method to reduce negative affect and pre-sleep arousal and in turn improve sleep quality in times of crisis.

**Hypotheses of the Present Thesis**

Hypothesis 1: Consistent with the results of numerous studies examining mental health during the Covid-19 pandemic, we expect mean perceived stress and mean negative affect of our sample to be higher than that of the general population prior to the pandemic. Similarly, we expect that subjective sleep quality during the Covid-19 pandemic was impaired compared to before the pandemic.

Hypothesis 2: We expect both the experimental and the active control group to report improved subjective sleep quality over the course of the intervention.

Hypothesis 3: We expect negative affect to decrease in both the experimental and the active control group over the course of the intervention.

Hypothesis 4: We expect participants in the positive reappraisal intervention group to benefit more from the intervention than the active control group. Accordingly, we hypothesize that participants in the positive reappraisal group report better subjective sleep quality than the active control group.

Hypothesis 5a: Over the course of the intervention, we expect participants to report lower subjective sleep quality on days when negative affect is high.

Hypothesis 5b: Over the course of the intervention, we expect participants to report lower subjective sleep quality on days when pre-sleep arousal is high.

## Methods

The present study was part of a larger research project examining protective and risk factors and potential measures for improving subjective sleep quality during the Covid-19 pandemic. All participants completed a cross-sectional survey focusing on protective and risk factors for subjective sleep quality. Details and results of the evaluation of this survey are outlined in Görlich (2021) and will only be described briefly in the upcoming sections. A subset of the participants then completed a ten-day diary intervention which the present thesis will focus on.

### Recruiting and Sample

For the cross-sectional study, a total of 183 participants were recruited via mailing lists and video postings in online lectures at the Department of Psychology at Heidelberg University. However, a university sample in psychological research typically predominantly consists of young female students age 18 to 25. In order to ensure a more balanced gender ratio and to enrich the sample with participants from the working population older than 25 years, a substantial number of participants was further recruited personally and through social media.

Exclusion criteria were if the participants' German skills were not sufficient to understand the instructions; furthermore, if their response patterns indicated that they did not read the instructions carefully, for example because of repeated contradictions or an unlikely fast completion time of the survey. Moreover, participants who indicated that they consumed sleeping pills on a regular basis were excluded, as well as participants who

suffered from a physical or mental illness that, according to their own assessment, affects their sleep, or if they had been diagnosed with a sleeping disorder. It is likely that for subjects suffering from the aforementioned illnesses, results concerning subjective sleep quality would be confounded (e.g., Schandry, 2011; Schlack et al., 2013) compared to a healthy sample that was aimed to be examined in the present study. The final sample of the cross-sectional survey consisted of 178 participants.

After completing the cross-sectional survey, 99 people agreed to further participate in the diary study. To provide enough data for a reliable analysis, at least one survey during the baseline phase had to be completed, at least four evening and four morning surveys during the diary phase, as well as the subsequent post intervention survey. Considering these criteria, a total of 36 participants had to be excluded because they did not provide sufficient data.

The final sample for the diary study consisted of 63 participants with an average age of 33.16 ranging from 20 to 65 ( $SD_{age} = 12.51$ ). 69.8% identified as female. Five people reported that German was not their native language but that they spoke German for at least nine years so that sufficient language proficiency can be assumed. 61.9% reported holding a university degree, 26.9% had completed high school (Abitur), 3.1% earned the qualification to attend a technical university (Fachhochschulreife), 6.3% reported having a secondary school diploma (Realschulabschluss), and 1.5% completed lower secondary school (Hauptschulabschluss). At the time of the study, 34.9% of the participants reported working a full-time job, 9.5% a part-time job, 6.3% a mini-job, 1.5% worked short-time (Kurzarbeit), another 1.5% were on maternity leave, while 22.2% were non-working (retired,

unemployed, homekeeper etc.), and 23.8% were students with student jobs. A little more than half of the participants reported that their job was being affected by the pandemic (52.3%). Six people considered themselves members of a risk group for severe Covid-19 cases. 14 participants reported living with children, nine participants had children age six or younger. 29 participants were eventually assigned to the experimental group, 34 participants were assigned to the active control group. A detailed description of the sociodemographic composition of the sample is outlined in table 1.

**Table 1***Sociodemographic Composition of the Sample (N = 63)*

Variable	<i>M</i>	<i>SD</i>	<i>N</i>	%
Age (in years)	33.16	12.51		
Gender				
Female			44	69.8
Male			18	28.6
Diverse			0	0
Not specified			1	1.6
German as a native language				
Yes			58	92.1
No			5	7.9
Education level				
University degree			39	61.9
High school degree (Abitur)			17	26.9
Technical university qualification (Fachhochschulreife)			2	3.2
Grammar school (Oberschule)			0	0
Secondary school diploma (Realschulabschluss)			4	6.4
Lower secondary school diploma (Hauptschulabschluss)			1	1.6
Other			0	0
Occupation				
Full-time			22	34.9

Part-time	6	9.5
Mini-job	4	6.4
Short-time	1	1.6
Maternity leave	1	1.6
Not working	14	22.2
Student with job	15	23.8
Employment		
Apprenticeship	4	6.4
Student	28	44.4
Employee	17	27
Civil servant	4	6.4
Self-employed	5	7.9
Unemployed	2	3.1
Other	3	4.8

### Study Design

As mentioned above, the present study was conducted in the context of a two-part project consisting of a cross-sectional survey and a subsequent diary intervention. After completing the cross-sectional survey, participants had the option to sign up for the diary part of the study by registering their Email address, which was stored independent from their data. Participants were then randomly assigned to the positive reappraisal intervention group or the active control group. Both groups received daily notifications to remind them of completing the diary entry and the subsequent survey. The diary entry was completed privately, non-electronically and did not have to be submitted to the researchers. Accordingly, there are no records of the entries. Data collection during the first three days served as a baseline to ensure that a possible effect could indeed be ascribed to the intervention and not solely be attributed to the passing of time. Subsequent to the diary phase, participants completed a post-intervention survey.

### **Study Procedure**

The complete data collection phase took place between May 24<sup>th</sup>, 2020 and June 15<sup>th</sup>, 2020, with the cross-sectional survey being online between May 24<sup>th</sup> and May 31<sup>st</sup>, daily diary study data being collected between June 1<sup>st</sup> and June 11<sup>th</sup>, and the post-intervention survey being online between June 11<sup>th</sup> and June 15<sup>th</sup>. All surveys were administered online via the platform SoSci Survey and could be completed on a personal computer or smartphone at home. Prior to beginning the cross-sectional survey, participants were informed that their participation was voluntary and that they could abort the survey at any time without declaring reasons or having to fear disadvantages. Participants declared their consent by clicking the “next” button. The subset of participants that took part in the subsequent diary study was asked to generate a pseudonymized code in order to assign the daily and nightly diary data to the according cross-sectional and post-intervention survey data. Psychology students had the option to be rewarded with partial credit toward their degree, beyond that, participation was not compensated. Completing the cross-sectional survey took approximately 20 minutes. During the diary phase, completing the entry and the following survey took about 5 minutes each night and every morning. Completing the post-intervention survey took 10-15 minutes.

During the first three days of the diary phase (baseline phase), participants did not yet receive any diary writing instructions. They did, however, receive daily reminder Emails to complete the evening and morning surveys by clicking on a link that led them to the according questionnaire on SoSci Survey. In order to assign the data correctly, participants had to enter their personal code prior to filling out all surveys. The subsequent seven days,

participants received daily diary writing instructions according to their respective group and were asked to complete evening and morning surveys.

One day after completing the last morning survey, participants received an Email with a link and the instruction to participate in the post-intervention survey.

### **Study Material Cross-Sectional Survey**

The following section contains a description of the variables, instruments and questionnaires that participants indicated and completed in the cross-sectional survey.

#### ***Sociodemographic and Control Variables***

Participants indicated their gender, age, and native language or German skills respectively. Further, they stated their level of education, occupation and current employment, and additionally whether and how their current job situation was affected by the Covid-19 pandemic, with the latter question offering to answer in a free response format.

Several control variables that are suspected to have a potential effect on sleep quality and perceived stress were included, such as the current living situation and the number and age of children in the participants' household. Participants also indicated their daily media consumption, divided into consumption of *news* (e.g., TV news, radio news, news websites etc.), and *social media* (e.g., Facebook, Instagram, WhatsApp etc.).

To assess the gravity of a potential Covid-19 infection and the therefore potentially intensified effect on perceived stress for a particular individual, the question "*Do you identify as a member of a group that has an increased risk for a severe case of Covid-19?*"



was included. Further, participants were asked to state whether they consumed sleeping pills on a regular basis, whether they suffered from a physical or mental illness that, according to their own assessment, affects their sleep, and whether they had been diagnosed with a sleeping disorder.

### ***Variables Assessing Sleep***

To examine whether the Covid-19 pandemic had an effect on people's sleeping habits, participants were first asked to indicate whether they had perceived any changes in their sleeping habits, such as duration of sleep or sleep quality. Subsequently they were asked for an open description of the alteration (*"How have your sleeping habits changed?"*) and for their personal assessment of the cause for those alterations (*"To what do you ascribe those changes in your sleeping habits?"*). To determine the quantitative nature of those changes, participants then answered questions about sleep duration and subjective sleep quality.

**Sleep Duration.** To assess whether a quantitative change concerning sleep duration had occurred in the context of the Covid-19 pandemic, participants were asked for their average sleep duration per night prior to the pandemic and during the pandemic. The original item from the *Pittsburgh Sleep Quality Index* (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989; Riemann & Backhaus, 1996) asks for the average sleep duration during the past month, however, for consistency purposes throughout the study, the item was modified slightly to assess the average sleep duration during the past two weeks. Participants were explicitly made aware that they were supposed to state the effective sleep

duration, which does not necessarily correspond to the hours spent in bed. Participants were further informed of the option to use decimals to state sleep duration.

**Subjective Sleep Quality.** To measure subjective sleep quality, a three-item short scale was used ( $\alpha = .74$ ) that has shown to be effective in Flock and Zintel (2019) and Steenbock (2018). Similar to sleep duration, subjective sleep quality prior to and during the pandemic was assessed with two separate sets of questions.

The first item of the short scale is based on a widely used item to assess subjective sleep quality in the German version of the PSQI (Riemann & Backhaus, 1996) and reads *“Overall, how would you rate the quality of your sleep prior to the Covid-19 pandemic [within the last two weeks]?”* Participants give their rating on a four-point answer scale with the options *“Very bad”, “Quite bad”, “Quite good”, and “Very good”*. The second item reflects the subjectivity in the perception of sleep and reads *“Subjectively, how well did you sleep prior to the Covid-19 pandemic [within the last two weeks]?”* Answers are given by positioning a slider on a scale ranging from 0 – *“Very bad”* to 100 – *“Very good”* in whole numbers. The feeling of waking up well-rested is another factor that constitutes subjective sleep quality and was considered with the third item *“In general, how rested did you feel upon waking up prior to the Covid-19 pandemic [within the last two weeks]?”* Again, participants give their answer by positioning a slider ranging from 0 – *“Not at all rested”* to 100 *“Completely rested”* in whole numbers. Based on all three items, one global value for subjective sleep quality is calculated.

The short scale considers both an overall assessment and the subjective quality of sleep and feeling rested. Moreover, it has proven to be an effective measure to assess

subjective sleep quality reliably and with high validity (Flock & Zintel, 2019; Steenbock, 2018), but at the same time with relatively little effort, which was a decisive factor considering that participants had to provide subjective sleep quality data every day for ten consecutive days during the diary phase.

### ***Perceived Stress***

To measure perceived stress, the German short version of the *Perceived Stress Scale* (PSS-10; Klein et al., 2016) was administered. This widely used scale measures to which extent participants find their lives unpredictable, uncontrollable, and overloaded. The two subscales “*Perceived helplessness*” and “*Perceived self-efficacy*” are based on the *Transactional Model of Stress and Coping* (Lazarus & Folkman, 1984) in that perceived helplessness captures a person’s emotional reaction to a given stressor, whereas the items ascribed to perceived self-efficacy represent their available resources and coping mechanisms to deal with stressful situations.

Instructions for the PSS-10 read “*The following questions concern your thoughts and feelings over the last two weeks. Please state for each question how often you have thought or felt accordingly*”. Overall, the PSS-10 consists of ten items that are answered on a five-point scale ranging from 1 – “*Never*” to 5 – “*Very often*”. To calculate the cumulative value, items of the self-efficacy scale are inverted. The higher the resulting cumulative value, the higher the perceived stress of the participant.

Use of the PSS-10 offered several advantages for the present study: It is a time efficient questionnaire with high reliability ( $\alpha = .84$ ) and high validity (Klein et al., 2016).

Furthermore, it has been tested on a large representative German sample. It is hence possible to draw initial conclusions from comparing results of the present study with existing reference values to understand whether and how the Covid-19 pandemic affects the perceived stress of the population in general.

### ***Emotional State***

The German version of the *Positive and Negative Affect Schedule* (PANAS) was used to assess emotional state (Breyer & Bluemke, 2016). The questionnaire consists of 20 adjectives describing various positive and negative emotional conditions. Ten of those adjectives are ascribed to the dimension *Positive Affect* (PA), with high values reflecting an energetic and enthusiastic state such as *“Inspired”* or *“Determined”*. Another ten adjectives describe the dimension *Negative Affect* (NA) that subsumes a variety of negative emotions such as feeling *“Distressed”* or *“Afraid”*. For the present study, the instruction was adapted to match the time frame assessed in other questionnaires and read *“Please state how you have felt during the last two weeks”*. Further, this adapted instruction ensured that participants indicated not their overall emotional situation, but their emotional state specifically during the Covid-19 pandemic. Answers are given by stating the intensity of the particular emotion on a five-point scale ranging from 1 – *“not at all”* to 5 – *“extremely”*. Separate global values for PA and NA are calculated by averaging over the single scores of each dimension. The PANAS scale features high reliability (PA:  $\alpha = .86$ ; NA:  $\alpha = .86$ ) and validity and also offers reference values for comparisons with the general population.

### **Resilience**

Resilience was considered a personality trait in the present study and measured with the *Resilience Scale* (RS-11; Schumacher, Leppert, Gunzelmann, Strauß, & Brähler, 2005), a short version of the German translation of the Resilience Scale developed by Wagnild and Young (1993). The RS-11 is a very reliable ( $\alpha = .92$ ) questionnaire with high validity that operationalizes resilience as a trait that protects people in light of demanding situations and straining experiences. It consists of 11 items, nine of which are taken from the original subscale *Personal Competence* and two from the subscale *Acceptance of Self and Life*. Participants are instructed to state how much the items (for example “*I feel that I can handle many things at a time*”) apply to them in general, that is how well their thinking and acting is described by the statements. Answers are given on a seven-point scale ranging from 1 – “*I do not agree*” to 7 – “*I completely agree*”.

Factor analyses found high correlations between the two subscales (e.g., Schumacher et al., 2005) so that one global resilience value is calculated by summing up the individual scores for the two subscales.

### **Posttraumatic Growth**

Posttraumatic Growth was measured with the *PPR* (Maercker & Langner, 2001), the German version of the *Post-traumatic growth inventory* (PTGI), originally postulated by Tedeschi and Calhoun (1996). The PPR is a reliable instrument ( $\alpha = .90$ ) that consists of 21 items, allocated to the five subscales “*Relating to Others*”, “*New Possibilities*”, “*Personal Strength*”, “*Spiritual Change*”, and “*Appreciation of Life*”. To fit the research purpose of the

present study and to adapt the questionnaire to possible changes that have occurred due to the Covid-19 pandemic, instructions were altered slightly and read “*The following questions are designed to capture whether certain things in your life have changed due to the current situation (the Covid-19 pandemic). Please indicate for every statement to what extent it applies to you*”. Answers are given on a three-point scale with the options “*Not at all*”, “*Slightly*”, and “*Very*”. To evaluate the PPR, a sum score for each subscale is calculated. It is also possible to calculate a global value by adding up all individual scores.

### ***Additional Questionnaires***

The cross-sectional survey was designed to also provide data for an additional study with alternative research objectives (Görlich, 2021). Therefore, questionnaires were administered concerning life satisfaction (*Satisfaction with Life Scale* SWLS; Diener, Emmons, Larsen, & Griffin, 1985), rumination (*Response Styles Questionnaire* RSQ-10D; Huffziger & Kühner, 2012), self-efficacy (*Skala zur Allgemeinen Selbstwirksamkeitserwartung*; Jerusalem and Schwarzer, 2014), dispositional optimism (*Life-Orientation-Test* LOT-R; Glaesmer, Hoyer, Klotsche, & Herzberg, 2008), Big Five personality traits (*BFI-10*; Rammstedt, Kemper, Klein, Beierlein, & Kovaleva, 2012), and self-concept (*Bem Sex Role Inventory* BSRI; Zimmermann, Sieverding, & Müller, 2011). Properties and results of these questionnaires will not be discussed in detail in this thesis because their objectives are not relevant for the research question in the present study.

**Study Material Diary Phase**

During the ten-day diary phase of the study, participants received Email notifications twice a day to remind them to complete their diary entry and to fill out surveys examining emotional state, cognitive pre-sleep arousal, sleep duration and subjective sleep quality. The composition of the Emails as well as the administered questionnaires will be described in detail in the upcoming section. For the full material, including German versions of all Email reminders, see appendix A.

***Evenings***

The reminder Email to complete the evening survey was sent at 9 p.m. This was considered a time by which most participants had probably completed their daily working routines and were thus available and able to concentrate on the diary study but were not already sleeping. After the baseline phase, the reminder Email also included instructions for completing the diary entry. Participants in both groups were instructed to write for a minimum of two and a maximum of five minutes. The lower threshold of two minutes was set to guarantee that participants took enough time for actual introspection and engagement with the past day and, hence, to give a potential effect the possibility to unfold. The upper threshold of five minutes was set to avoid participants wallowing in and getting lost in emotions which can be counterproductive in the event that excessive preoccupation with one's thoughts leads to rumination.

The reminder Emails for both groups featured a short explanation of the objective of the study and pointed out some of the scientifically acknowledged advantages of keeping a

diary. On the first day of the intervention, the Email also contained very detailed instructions as to how to complete the diary entry to make sure participants understood the objective and specific task at hand. This was to guarantee that participants followed the instructions, especially in the positive reappraisal group, and did not just resort to their personal style of journaling. This first Email also served as a cornerstone to give participants the option to find more detailed writing instructions in their inbox if needed. Instructions for the subsequent days were considerably shorter to avoid effects of fatigue through repetition. Upon completing their diary entry, participants of both groups were asked to indicate their emotional state by filling out the PANAS questionnaire (Breyer & Bluemke, 2016). The instruction was rephrased to assess only the past day and read *“Please state how you have felt today”*. Further details concerning this questionnaire are described above in the subsection *Emotional State* of the section specifying the cross-sectional study material.

**Positive Reappraisal Group.** Participants in the positive reappraisal group received an Email that first pointed out some of the known advantages of keeping a diary in general and, specifically, the advantages of concentrating on positive aspects while writing. They were made aware that *“looking on the bright side”* can reduce stress, increase positive affect and strengthen resilience. The subsequent instructions for the diary entry focused on reevaluating situations and experiences throughout the day in a positive light. Participants were asked to write down positive encounters they had despite or even because of the Covid-19 pandemic. In case they had experienced negative situations, participants were supposed to regard those as a challenge or opportunity for personal growth, or at least as a lesson learned. Participants were asked to concentrate on the skills they had employed to



manage the situation and in what way the event equipped them for future challenges.

**Active Control Group.** The Email sent to members of the active control group began with a short overview of the scientifically acknowledged advantages of keeping a diary. Participants were made aware that the daily recapitulation of their day and involvement with their own thoughts and experiences can promote a change of perspective and thus have a positive effect on emotional wellbeing and lead to reduced stress. This introduction was followed by specific instructions for the diary entry. Participants were asked to write down whatever they deemed important over the past day. Prompts were what had occupied their mind or things and people they encountered. Participants were specifically instructed to consider both positive and negative events.

### ***Mornings***

The reminder Email was sent at 6 a.m. to ensure that participants would be able to access it by the time they started their day and be prompted to complete the survey immediately upon waking up. The Email was identical for participants from both groups and asked them to indicate their cognitive pre-sleep arousal, their sleep duration, and their subjective sleep quality for the night before.

**Pre-Sleep Arousal.** Cognitive pre-sleep arousal was measured with the German version of the *Pre-Sleep Arousal Scale* PSAS (Gieselmann, de Jong-Meyer, & Pietrowsky, 2012). This instrument is characterized by high reliability ( $\alpha = .88$ ) and validity; the original version (Nicassio et al., 1985) has been widely used and called the gold standard for measuring arousal upon falling asleep (Gieselmann et al., 2012). The scale consists of two

subscales, *cognitive pre-sleep arousal* and *somatic pre-sleep arousal*. For the purpose of this study, only the cognitive subscale was of interest and the somatic subscale hence omitted. The cognitive subscale consists of seven items describing disruptive symptoms that potentially occur upon trying to fall asleep. Participants are instructed to state how intensely they experienced the described symptoms prior to falling asleep the night before. Answers are rated on a five-point scale with the options “*not at all*”, “*slightly*”, “*moderately*”, “*a lot*”, and “*extremely*”. The global score for cognitive pre-sleep arousal is calculated by summing up the individual values.

**Sleep Variables.** Sleep duration and subjective sleep quality were measured with the instruments described in detail in the according sections about the cross-sectional survey material. Instructions were changed slightly to account for the timeframe in question (last night). For sleep duration, the question now read “*How many hours did you sleep last night*”, for subjective sleep quality the questions read “*Overall, how would you rate the quality of your sleep last night?*”, “*Subjectively, how well did you sleep last night?*”, and “*How rested did you feel upon waking up this morning?*”. Further instructions and information were given as described in the section about the cross-sectional survey material.

### **Study Material Post-Intervention Survey**

To examine potential effects the diary intervention may have had on participants that were, however, not captured by the daily surveyed variables, participants were asked to complete several questionnaires they had already filled out during the cross-sectional survey. This allowed pre-post comparisons and the development of explorative research

questions for future studies. Specifically, participants repeated the following questionnaires: sleep variables, PSS-10, PANAS, RS-11, SWLS, LOT-R, and PPR. Details concerning these instruments are outlined in the according sections of the cross-sectional study material.

Participants were also given the opportunity to evaluate the study procedure. They were asked whether they had experienced any changes in their sleeping habits, their thoughts or their emotions while participating in the study. An open format question then asked for the quality of those changes and what people had gained from their participation. This question was included to obtain a more conclusive understanding of people's experiences with the intervention beyond the quantitative analysis of their data. Furthermore, participants were asked to state the average daily number of positive and negative events they had noted in their diary entries.

To gain insights for potential improvements for future research, participants were asked how time-consuming they rated their participation in the study, how interesting they found it, and how helpful they rated it for their personal daily routines. Answers were given on a five-point scale ranging from 1 – *“not at all”* to 5 – *“very”*. Participants were also asked whether or not they planned on continuing to keep a diary. Lastly, participants had the opportunity to state problems they had encountered, express criticism or other information they deemed important.

### **Data Preparation and Statistical Analysis**

Analyses were conducted with RStudio version 1.3.1093 (RStudio Team, 2020). For multilevel analyses, the R package nlme was used (Pinheiro, Bates, & R Core Team, 2022). Screening for missing values was omitted because the SoSci Survey preset prevents skipping questions without answering. Participants were excluded according to the criteria described in the “Recruiting and Sample” section of this thesis. Prior to the data analyses, assumptions of the respective tests were checked. Variables were tested for standard distribution with both graphic and statistical procedures, plotting histograms and employing the Shapiro-Wilk normality test. To test hypothesis 1, t-tests were performed, whereas the remaining hypotheses related to the diary data were tested with multilevel modeling.

### ***Multilevel Modeling***

By design, daily diary studies produce nested data as data is typically collected on various levels, in this case the person level and the diary level. However, nested data violates several of the assumptions of the traditional regression model or ANOVA. First, the single observations within the cluster are not independent from each other. All of the surveys completed by an individual participant have something in common, that is, they share the idiosyncracies of that particular participant. The same participant’s data will be influenced by factors within their personality, and the errors within those clusters will be correlated accordingly. However, the traditional regression model requires each datapoint and its errors to be independent. Likewise, within each cluster we are confronted with different sample sizes: participants were required to complete a certain number of surveys but not

necessarily all of them. This results in different levels of variability in different clusters and the assumption of homoskedasticity for regression and homogeneity of variance for ANOVA is violated. To avoid that, usually all cases with missing data are excluded to execute an ANOVA. However, in the present case this would result in excluding all participants that had not completed every single survey. In conclusion, in the case of diary studies, the traditional ANOVA and regression approach would call for disregarding plenty of valuable data. Multilevel modeling accounts for these violations with more sophisticated modeling techniques that estimate the adjustments to the error terms.

**Intraclass Correlation.** To assess whether the multilevel structure of the diary data should be considered for the analysis, the *Intraclass correlation* (ICC) was calculated. The ICC represents the ratio of level 2 variance to the total variance. A higher value indicates that differences on the person level (level 2) explain a higher percentage of the total variance, which means that the multilevel structure of the data should be taken into consideration for the data analysis. For the present data, the calculated ICC was 0.44 for subjective sleep quality, which indicates that differences between participants explain 44% of the total variance on the variable sleep quality. For both negative affect and pre-sleep arousal, the ICC was 0.49, indicating that 49% of the total variance of negative affect and pre-sleep arousal can be explained by differences between participants.

Huang (2018) reports alpha error rates of 20% for ICCs as low as 0.01 and hence recommends considering the multilevel structure for all ICCs  $> 0.01$ . Accordingly, the diary data was analyzed with multilevel modeling.

**Analysis of Baseline Data.** To ensure that potential effects during the diary phase could in fact be ascribed to the intervention, no significant change in subjective sleep quality during the baseline phase should be detected. Therefore, a multilevel model was calculated for the baseline data. Including the time variable as a predictor in the model did not improve model fit, which suggests that there was no significant change in subjective sleep quality during the baseline phase. For details, see appendix B, table 5. Subsequently, the participants' mean values for negative affect, pre-sleep arousal, and subjective sleep quality were included as the first data point for the analysis of the diary data to be able to observe potential improvements during the intervention compared to the baseline measures.

**Analysis of Diary Data.** To test hypotheses 2, 4, 5a and 5b, a linear growth curve model was calculated to estimate the influences of time, group affiliation, negative affect, and pre-sleep arousal on subjective sleep quality. First, an intercept only model was calculated to determine the ICC (Model 0), second, a random intercept model was calculated, allowing for different intercepts, that is, different initial values on subjective sleep quality for the different individuals, and adding time as an overall predictor for all observations on the diary level (Model 1). Next, a random intercept random slope model was calculated, allowing for the time predictor to vary between subjects, assuming that their rate of change of subjective sleep quality would differ. This way, larger and smaller gaps in time between subjects are accounted for, if, for example, an individual has missed one survey day (Model 2). Finally, the predictors group affiliation (Model 3), negative affect (Model 4), and pre-sleep arousal (Model 5) were added to the model step by step, all additionally as interaction terms with the time predictor. The models were based on the following equations:

- Model 0:      Diary level       $SQ_{ij} = \beta_{0j} + \varepsilon_{ij}$
- Person level       $\beta_{0j} = \gamma_{00} + \mathcal{U}_{0j}$
- Model 1:      Diary level       $SQ_{ij} = \beta_{0j} + \beta_{1j}(\text{TIME}_{ij}) + \varepsilon_{ij}$
- Person level       $\beta_{0j} = \gamma_{00} + \mathcal{U}_{0j}$
- $\beta_{1j} = \gamma_{10}$
- Model 2:      Diary level       $SQ_{ij} = \beta_{0j} + \beta_{1j}(\text{TIME}_{ij}) + \varepsilon_{ij}$
- Person level       $\beta_{0j} = \gamma_{00} + \mathcal{U}_{0j}$
- $\beta_{1j} = \gamma_{10} + \mathcal{U}_{1j}$
- Model 3:      Diary level       $SQ_{ij} = \beta_{0j} + \beta_{1j}\text{TIME}_{ij} + \beta_2\text{GROUP}_{ij} + \beta_3(\text{GROUP*TIME})_{ij} + \varepsilon_{ij}$
- Person level       $\beta_{0j} = \gamma_{00} + \mathcal{U}_{0j}$
- $\beta_{1j} = \gamma_{10} + \mathcal{U}_{1j}$
- Model 4:      Diary level       $SQ_{ij} = \beta_{0j} + \beta_{1j}\text{TIME}_{ij} + \beta_2\text{GROUP}_{ij} + \beta_3(\text{GROUP*TIME})_{ij} +$   
    $\beta_4\text{NegAffect}_{ij} + \beta_5(\text{NegAffect*TIME})_{ij} + \varepsilon_{ij}$
- Person level       $\beta_{0j} = \gamma_{00} + \mathcal{U}_{0j}$
- $\beta_{1j} = \gamma_{10} + \mathcal{U}_{1j}$
- Model 5:      Diary level       $SQ_{ij} = \beta_{0j} + \beta_{1j}\text{TIME}_{ij} + \beta_2\text{GROUP}_{ij} + \beta_3(\text{GROUP*TIME})_{ij} +$   
    $\beta_4\text{NegAffect}_{ij} + \beta_5(\text{NegAffect*TIME})_{ij} + \beta_6\text{PSA}_{ij} +$   
    $\beta_7(\text{PSA*TIME})_{ij} + \varepsilon_{ij}$
- Person level       $\beta_{0j} = \gamma_{00} + \mathcal{U}_{0j}$
- $\beta_{1j} = \gamma_{10} + \mathcal{U}_{1j}$

To test hypothesis 3, the calculations of Models 0 and 1 were repeated with negative affect as dependent variable. All models were fitted with a maximum likelihood estimation procedure. Models were compared using the likelihood-ratio test.

## Results

The following section outlines the results of the present study. Comments to the free response questions will be addressed, analyses of the initial cross-sectional survey will be reported, and the results of pre-post comparisons between the cross-sectional and the post-intervention survey will be presented. Finally, results of the multilevel modeling of the daily diary data will be provided.

### Free Response Format Questions

There was no formal analysis of the free response answers, such as *“Is your job situation affected by the Covid-19 pandemic?”*. The answers did however provide an insight into the manifold experiences participants made during the pandemic and helped gain an additional qualitative understanding of the quantitative data. Responses to the questions assessing how Covid-19 has changed the participants’ professional and private lives highlight the impact the pandemic and the implemented protective measures had. Many participants reported that they felt overwhelmed by the overall situation, that they missed interactions with other people, and that they were worried about their employment.

Comments and feedback concerning the study itself revealed that most participants enjoyed partaking in the study. The majority of participants who chose to comment



described positive takeaways from participating in the study, such as benefits from daily introspection and personal insights from answering the questionnaires. Specifically, participants mentioned that being compelled to actively reflect the experiences and events of their day brought about a heightened awareness and mindfulness. Paying attention to their daily stressors and how they tackled them was reviewed as positive by most participants. Plus, several participants stated that keeping a diary had a positive effect and that they intend to keep writing in the future. Participants did not report any technical or other problems, nor any relevant criticism concerning the study procedure or their participation in general.

### **Cross-Sectional Survey Analyses**

The following results refer to data collected in the cross-sectional survey prior to the diary intervention. Consistent with hypothesis 1, mean subjective sleep quality over all participants had significantly declined during the pandemic (within the two weeks prior to the survey) compared to prior to the pandemic, with  $t(62) = 2.62, p = 0.01, d = 0.67$ . Further, results show a significant deviation from the general population reference level for the Perceived Stress Scale with  $t(62) = 5.30, p < .001, d = 1.37$ , a significant deviation from the general population reference level for negative affect (PANAS) with  $t(62) = 3.36, p = 0.001, d = 0.43$ , and a significant deviation from the general population reference level for posttraumatic growth (PPR), with  $t(62) = 3.81, p < .001, d = 0.48$ . No significant deviations from the reference values were found for positive affect (PANAS), or resilience (RS-11). All relevant descriptive data with mean values and reference values is detailed in table 2.

**Table 2***Means, Standard Deviations, and Reference Values of the Relevant Variables*

Variable	<i>M</i>	<i>SD</i>	<i>Reference Value</i>
Sleep Duration 1 <sup>a</sup>	7.33	0.84	-
Sleep Duration 2 <sup>b</sup>	7.21	1.11	-
Sleep Quality 1 <sup>a</sup>	72.48	13.71	-
Sleep Quality 2 <sup>b</sup>	67.29	16.95	-
Perceived Stress	17.38	6.95	12.74
Positive Affect	3.05	0.76	3.21
Negative Affect	2.12	0.7	1.82
Resilience	60.48	8.75	59.61

*Note.* <sup>a</sup> = Prior to the Covid-19 Pandemic. <sup>b</sup> = During the Covid-19 Pandemic (within the two weeks prior to the survey).

Table 3 displays correlations between all relevant variables assessed on the cross-sectional survey. Results show a significant negative correlation between subjective sleep quality and negative affect as well as subjective sleep quality and perceived stress. In this context, higher negative affect and higher perceived stress are associated with lower subjective sleep quality. Further, perceived stress and negative affect were highly correlated. There was also a significant negative correlation between perceived stress and resilience, meaning, lower values on resilience are associated with higher perceived stress. Further, the results yield significant correlations between risk group and age, risk group and gender, sleep quality and age, children and gender, posttraumatic growth and age, perceived stress and gender, and a significant negative correlation between perceived stress and age.

To examine possible systematic differences in perceived stress between participants who consider themselves members of a risk group for severe Covid-19 cases and the

remaining participants, a t-test was performed. The result did not show any significant differences between the groups with  $t(62) = -1.21$ ,  $p = 0.268$ . Another t-test examining possible systematic differences between participants with and without children also did not yield any significant results with  $t(62) = -0.37$ ,  $p = 0.713$ . Results also suggest that the perceived stress of participants whose job was affected by the pandemic did not differ from those whose job had not changed with  $t(62) = -0.56$ ,  $p = 0.575$ .

Similar calculations were performed assessing systematic differences in subjective sleep quality. However, no significant differences were found for risk group with  $t(62) = 0.73$ ,  $p = 0.496$ , for having children with  $t(62) = -0.21$ ,  $p = 0.838$ , nor for job being affected by the pandemic with  $t(62) = 0.04$ ,  $p = 0.972$ .

Finally, t-tests were performed to examine systematic differences in negative affect. No significant differences were found for risk group with  $t(62) = -2.14$ ,  $p = 0.073$ , for having children with  $t(62) = 0.23$ ,  $p = 0.818$ , nor for job being affected by the pandemic with  $t(62) = -1.05$ ,  $p = 0.3$ .

**Table 3**  
*Correlations of Selected Variables for the cross-sectional survey (N = 63)*

	1	2	3	4	5	6	7	8	9	10
Age										
Gender	.18									
Risk Group <sup>a</sup>	-.25*	-.38**								
Children <sup>b</sup>	-.24	-.50***	.09							
Sleep Quality <sup>c</sup>	.35**	.17	-.10	.03						
Sleep Duration <sup>c</sup>	-.16	.02	-.14	.05	-.01					
Negative Affect	-.21	-.16	.23	-.03	-.50***	-.23				
Perceived Stress	-.26*	-.27*	.14	.06	-.60***	-.04	.77***			
Resilience	-.13	.05	.01	-.01	.24	-.17	-.24	-.33**		
Posttraumatic Growth	.29*	-.09	-.21	-.04	.12	-.09	-.04	-.03	.00	

Notes. <sup>a</sup> = Member of a risk group for severe Covid-19 cases. <sup>b</sup> = lives with children in the household. <sup>c</sup> = During the Covid-19 Pandemic (within the two weeks prior to the survey).

\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

### **Pre-Post Comparisons**

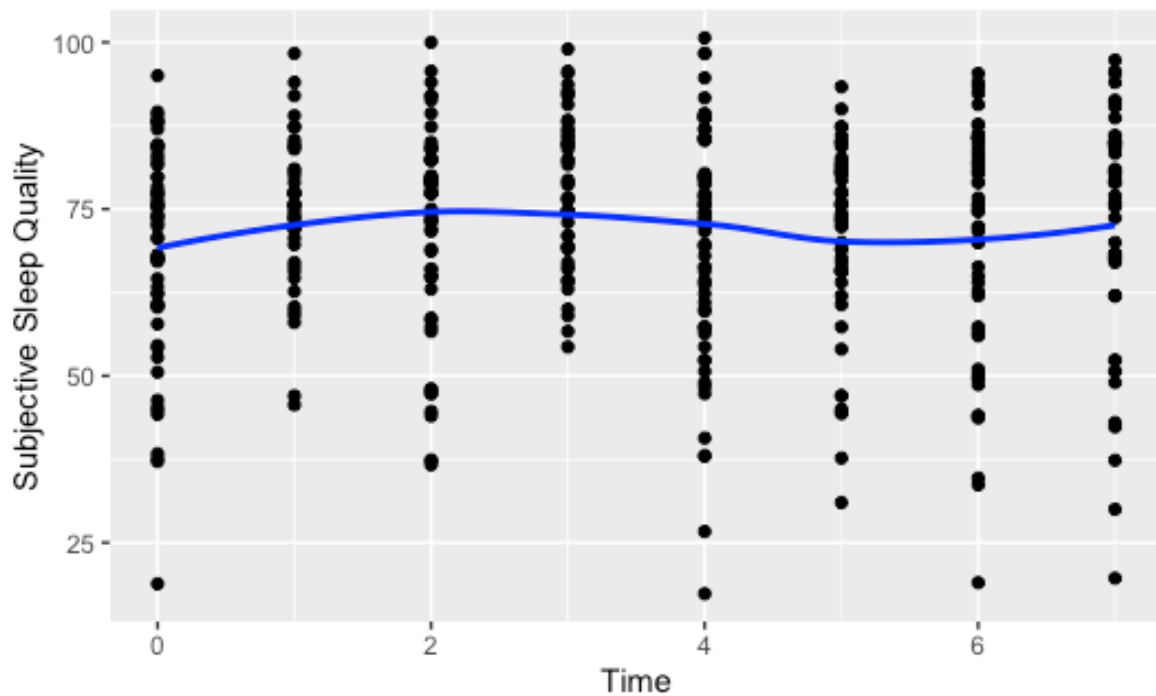
To assess whether potential effects had occurred that were not captured during the diary phase, a pre-post comparison between the initial cross-sectional survey and the post-intervention survey was performed for perceived stress. An assessment of perceived stress was not included in the diary phase to keep the surveys short and focused on the hypothesized main influences on subjective sleep quality in this particular study, that is, negative affect and pre-sleep arousal. However, since the concepts are so closely related and stress is a major maintaining factor in sleep disturbances, a pre-post comparison between perceived stress prior to and after the intervention seemed beneficial for exploratory reasons. The according t-test revealed a significant decline in perceived stress with  $t(62) = 2.59, p = 0.01$ .

### **Multilevel Analysis**

The random intercept model revealed an overall subjective sleep quality of 71.84 on average, on a scale ranging from 0 to 100. 44% of variance in subjective sleep quality could be attributed to differences between participants. Distribution of values in subjective sleep quality across all participants over the course of the intervention is displayed in figure 2. All step-by-step models predicting subjective sleep quality are specified in appendix B, table 6.

**Figure 2**

*Changes in Subjective Sleep Quality Across All Participants Over the Course of the Intervention*



To test hypothesis 2, time was added as a random intercept, which did not improve model fit,  $\chi^2(1) = 0.0006$ ,  $p = .98$ . Neither did adding a random slope for the effect of time across participants,  $\chi^2(2) = 0.895$ ,  $p = .639$ . Regarding hypothesis 4, results revealed that adding the predictor group affiliation did not improve model fit,  $\chi^2(3) = 2.233$ ,  $p = .526$ . To test hypotheses 5a and 5b, negative affect was added as a predictor, which significantly improved model fit,  $\chi^2(1) = 6.02$ ,  $p = .014$ . Adding pre-sleep arousal further improved model fit,  $\chi^2(2) = 77.066$ ,  $p < .001$ . However, the significant main effect for negative affect waned with the addition of pre-sleep arousal to the model,  $b = -2.99$ ,  $SE = 2.54$ ,  $p = .24$ . Prior to the inclusion of pre-sleep arousal as a predictor into the model, participants reported

significantly lower subjective sleep quality on days when their negative affect was high,  $b = -6.65$ ,  $SE = 2.46$ ,  $p = .007$ . High pre-sleep arousal was also significantly associated with poorer subjective sleep quality the subsequent night,  $b = -1.38$ ,  $SE = 0.26$ ,  $p < .001$ , meaning that an increase of one point on the pre-sleep arousal scale led to a reduction of 1.38 on the scale for subjective sleep quality. The interaction between time and negative affect was significant,  $b = 1.40$ ,  $SE = 0.57$ ,  $p = .015$ . To determine the type of interaction, a median split was performed to dichotomize negative affect and the time variable. Visual analysis revealed a hybrid interaction: later in the week, high negative affect was associated with even worse subjective sleep quality than earlier in the week. Details of the full model predicting subjective sleep quality with time, group affiliation, negative affect and pre-sleep arousal are outlined in table 4.

To test hypothesis 3, a random intercept model was calculated to predict negative affect, allowing for different initial values in negative affect for the different individuals. This random intercept model revealed an overall score of negative affect of 1.55 on average, on a scale ranging from 1 to 5. 49% of variance in negative affect could be attributed to differences between participants. Time was added as a random intercept, which narrowly did not improve model fit,  $\chi^2(1) = 2.76$ ,  $p = .097$ . Accordingly, the predictor time narrowly did not reach significance,  $b = -0.01$ ,  $SE = 0.008$ ,  $p = .098$ . Results of the final model predicting negative affect are detailed in table 4.

**Table 4***Results of the Final Models Predicting Subjective Sleep Quality and Negative Affect*

	Subjective Sleep Quality	Negative Affect
<i>Fixed Effects</i>		
Intercept	93.41 (4.54)***	1.59 (0.06)***
Time	-1.66 (0.98)	-0.01 (0.01)
Group Affiliation	1.20 (3.03)	
Negative Affect	-2.99 (2.54)	
Pre-Sleep Arousal	-1.38 (0.26)***	
Time*Group Affiliation	0.20 (0.55)	
Time*Negative Affect	1.40 (0.57)*	
Time*Pre-Sleep Arousal	-0.06 (0.06)	
<i>Random Variances</i>		
Intercept	9.07	0.36
Time	1.05	
Residual	10.60	0.39

Notes. Values are Unstandardized Estimates. Standard Error in Parentheses. \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

## Discussion

The following section provides a brief summary of the results of the present study, as well as interpretations of the findings with regard to research purpose and postulated hypotheses. The results will be evaluated in the context of the current state of research on the topic, with possible explanations for the findings. Further, strengths and limitations of the present study will be discussed. Finally, practical implications of the results, as well as suggestions for future research on the topic will be offered.



### **Summary of Results**

The goal of the present study was to assess whether and how the Covid-19 pandemic affected perceived stress, and in turn negative affect and subjective sleep quality. A daily diary intervention was conducted to examine whether positive reappraisal of current events and stressors could mitigate negative affect and improve subjective sleep quality. Results suggest that the population did in fact suffer immense mental health impairments. Participants reported significantly higher perceived stress and negative affect compared to prior to the pandemic, as well as significantly higher values than the general population reference level would suggest (Klein et al., 2016; Breyer & Bluemke, 2016). Further, participants reported a significant decline in subjective sleep quality compared to prior to the pandemic. Hypothesis 1 can hence be confirmed.

Results of the daily diary study corroborate the negative relationship between negative affect and subjective sleep quality. Participants reported poorer subjective sleep quality on days when negative affect was high. Additionally, pre-sleep arousal was identified as a significant and substantial predictor of subjective sleep quality the subsequent night. Hypotheses 5a and 5b can hence also be confirmed.

However, the positive reappraisal intervention did not yield any significant results. Participants' subjective sleep quality did not improve over the course of the intervention, neither in the positive reappraisal nor in the active control group. Hypotheses 2 and 4 must hence be rejected. Contradicting hypothesis 3, participants reported no significant decline in negative affect over the course of the intervention, although results suggest a clear trend towards decreasing negative affect.

### **Cross-Sectional Survey**

Results from the cross-sectional survey prior to the diary intervention confirm findings from existing research that the Covid-19 pandemic had detrimental effects on people's physical and mental wellbeing. Consistent with hypothesis 1, participants indicated on average significantly higher perceived stress during the Covid-19 pandemic than the reference value for the general population would suggest (Klein et al., 2016). Similarly, the mean value for negative affect deviates significantly from the normative data for the PANAS (Breyer & Bluemke, 2016), indicating that participants experienced considerably higher negative emotions during the pandemic. Participants also reported on average a significant decline in their subjective sleep quality during the Covid-19 pandemic, compared to prior to the pandemic. This finding needs to be interpreted with caution, however, considering that subjective sleep quality prior to and during the pandemic were both measured during the same assessment and retrospective self-reports are as such frequently subject to memory biases. Nevertheless, the result clearly suggests that participants felt a considerable deterioration of their subjective sleep quality since the beginning of the pandemic.

An additional finding that was not specifically postulated in a hypothesis is a significant deviation from the reference value for posttraumatic growth. Participants reported on average lower values than the mean value from the validation sample of the PPR would suggest (Maercker & Langner, 2001). This is surprising, considering the potentially severe traumatic nature of a world-wide pandemic. Based on prior findings surrounding post-traumatic growth one would expect at least a certain percentage of participants to find personal meaning in and benefit from the distress caused by the Covid-

19 circumstances. However, considering that the cross-sectional survey was administered roughly three months into the pandemic, participants were probably still immersed in the initial shock phase and had not yet had much opportunity to grow from the potentially traumatic experience of a global pandemic.

### **Pre-Post Comparison of Perceived Stress**

A pre-post comparison between the initial cross-sectional survey data and the post-intervention survey data suggests that perceived stress had significantly declined for participants in both groups after the ten-day diary intervention. This result is surprising in so far as there was no significant decline in negative affect observable over the course of the intervention. Since negative affect and perceived stress were so highly correlated in the cross-sectional survey in the beginning of the study, it is remarkable that perceived stress had declined significantly while negative affect had not.

One explanation relates to limited data on perceived stress. Since perceived stress was not assessed daily, the significant decline is based on two single observations and thus potentially less precise and informing as the daily assessment of negative affect. Further, the survey instruction for the perceived stress item read "*The following questions concern your thoughts and feelings over the last two weeks.*", whereas negative affect was inquired every day for that specific past day only. Two weeks is obviously a much broader timeframe that even encompasses the entire diary portion of the study. As such, the values for perceived stress on the post-intervention survey are probably less precise and reliable, and difficult to compare to the negative affect result.

It is also possible that participants were at least partially subject to a placebo effect. Considering that they had just participated in a ten-day diary study that they had spent a considerable amount of time and energy on, it is theoretically conceivable that participants felt like there *should* be an effect and thus reported one. This interpretation would, however, require participants to recall the exact answers they had given on the PSS-10 during the cross-sectional survey, to be able to deliberately adapt them.

Despite the curiosity, this result is still particularly interesting, as it suggests that perceived stress might not directly relate to subjective sleep quality, but that a mediator is at play that was not detected in the present study. It is also possible that a reduction in perceived stress does not immediately result in improved subjective sleep quality, but that the reduction in perceived stress needs to consolidate for a while before it effectively impacts sleep. An intervention duration of only seven days could have been too short for that effect to manifest.

### **Daily Predictions of Subjective Sleep Quality**

Consistent with prior findings, high negative affect and high pre-sleep arousal before bedtime are associated with a subsequent impairment of subjective sleep quality. Adding high negative affect significantly improved model fit. Participants' subjective sleep quality was in fact worse on days when they reported high negative affect. However, adding negative affect only yielded significant effects so long as pre-sleep arousal was excluded from the model. Adding pre-sleep arousal as a predictor significantly improved model fit, plus the main effect of pre-sleep arousal was highly significant. In the context of this study,

pre-sleep arousal thus seems to function as a mediator and at least partially explains the variance of negative affect. This could be an effect of item phrasing: Negative affect was assessed every night with the PANAS scale (Breyer & Bluemke, 2016), that asks for the emotional state of *today*, whereas the pre-sleep arousal scale (Giesemann, de Jong-Meyer, & Pietrowsky, 2012) asks for symptoms participants experience directly upon falling asleep.

This item-phrasing promotes the use of pre-sleep arousal in the context of sleep studies, as it is better suited to capture sleep-relevant arousal in the moment of interest. On the other hand, pre-sleep arousal is assessed retrospectively the subsequent morning. This approach carries the risk that participants incorporate implicit assumptions about their pre-sleep arousal the night before, since they are aware of their effective subjective sleep quality upon completing the survey. This hindsight bias could explain the superiority of pre-sleep arousal as a predictor compared to negative affect.

Nevertheless, the identification of pre-sleep arousal as a powerful predictor is an important contribution to the scientific literature concerning subjective sleep quality. It complements findings of Morin et al. (2003), that pre-sleep arousal plays a crucial role in the relationship between stress and poor nighttime sleep. The present results now indicate that pre-sleep arousal further plays a crucial role in the relationship between negative affect and poor nighttime sleep.

### **The Non-Decline of Subjective Sleep Quality**

Based on findings from expressive writing and diary studies, it was hypothesized that subjective sleep quality would increase for all participants regardless of the specific writing

instruction (e.g., Harvey and Farrell, 2003; Pogrebtsova et al., 2018). However, analysis of the daily diary data revealed that overall subjective sleep quality did not improve over the course of the intervention. One explanation for the non-significant result is the increased awareness that an intervention generates. For example, Carter, Day, Cinciripini, and Wetter (2007) point out that recordkeeping “increases awareness of the frequency, patterns, and circumstances attendant to a target behavior” (p. 293). In terms of the present thesis, it could be hypothesized that prompting subjects to indicate their sleep quality over a specific period of time could in of itself alter their sleeping habits. Several participants in the present study did indeed report increased awareness of their emotional state and in some cases a subsequent alteration of their answers on the survey (e.g., “Die Phase des Einschlafens (...) erlebe ich intensiver. Ich denke mehr darüber nach, welche Faktoren auf meinen Schlaf einwirken.“ „Ich denke, hätte ich erst den Fragebogen ausgefüllt, ohne aufzuschreiben wie der Tag war, hätte ich anders geantwortet.“). Participating in a study with regular reminders might have shifted participants’ attention towards their sleep routines. For a subject as sensitive as sleep, however, the heightened awareness could lead to an impairment instead of an improvement.

Another possible explanation is the comparatively short duration of the intervention. As outlined before, sleep is a highly complex matter with a multitude of contributing factors. While being an intensive study, seven days of diary keeping were probably not enough to produce a significant change in a behavior as multifaceted. Years of habits, underlying assumptions, and subconscious processes make it extremely difficult to alter sleep at all, not to mention that many of those processes remain largely unknown to the current state of

research. In conclusion, the timeframe of an intervention would probably have to be extended considerably to see significant results.

In general, the results once more emphasize the elusiveness of sleep and the uncertainty of what contributes to its manifestation. As figure 2 illustrates, variance for subjective sleep quality in the sample was relatively high. 44% of the total variance of subjective sleep quality could be explained by differences between participants, which also means that 56% of variance could be ascribed to intraindividual differences. While most other health behaviors like diet or exercise remain relatively stable in the short run, sleep remains virtually uncontrollable, and it is still largely unclear what contributes to this massive intraindividual variance.

A curious finding lies in the comparison of subjective sleep quality between the cross-sectional survey and the diary results. Mean subjective sleep quality in the cross-sectional survey was 67.29, which is significantly lower than the mean subjective sleep quality of 71.84 during the daily diary portion of the study. Granted, on the cross-sectional survey, participants were asked to rate their subjective sleep quality for the timeframe "*within the last two weeks*", whereas the daily assessment asked for a rating of subjective sleep quality for the previous night only. Accordingly, the results are not entirely congruent. Nevertheless, the finding purports a change in subjective sleep quality that must have happened in the very beginning of the daily diary portion of the study. Indeed, mean subjective sleep quality across all participants during the baseline period was 67.90, which is considerably closer to the cross-sectional survey result than to the daily diary result. This difference is visually captured in figure 2, which suggests an improvement of subjective

sleep quality between day 0, which represents the mean values of the baseline phase, and day 1, which represents the first actual intervention day. A possible explanation for this finding is an effect of anticipation. The prospect of participating in a study that promised the introduction of a helpful method to improve general wellbeing and sleep quality during a very stressful time (see appendix A for information Email) may have triggered participants to indicate better subjective sleep quality during the intervention. This effect could not be captured by the calculated growth model because subjective sleep quality in fact did not improve over time after the very first day.

### **The Almost Decline of Negative Affect**

Numerous studies over the last decades have found that cognitive reappraisal is an effective approach to reduce negative affect (e.g., Folkman, 1997; Webb, Miles, & Sheeran, 2012). It was therefore hypothesized that the daily diary intervention conducted in this study would lead to a significant decline in negative affect. While the results could not confirm a significant effect, there is a clear trend towards lower negative affect observable across all participants, regardless of group-affiliation. This suggests that the intervention was at least partially successful.

If negative affect did in fact decrease, why did that not affect and improve subjective sleep quality? The answer could be similar to why perceived stress seems to have declined without it impacting subjective sleep quality: It is possible that the intervention was effective but that, contrary to the results of Görlich (2021), negative affect is not the only mediating influence on subjective sleep quality and did therefore not have a direct impact.



Plus, negative affect as a construct is easier to manipulate than a volatile and virtually uncontrollable behavior such as sleep. It is hence conceivable that it merely takes longer for decreased negative affect to have a positive impact on subjective sleep quality.

### **Positive Reappraisal as Coping Mechanism**

One of the main objectives of the present study was to determine whether positive reappraisal is a particularly beneficial coping mechanism in times of crisis and specifically, whether keeping a diary with a positive reappraisal approach in mind can improve subjective sleep quality and reduce negative affect. However, results revealed that there was no significant difference in subjective sleep quality and negative affect between participants who employed positive reappraisal and those who were in the active control group. This suggests that positive reappraisal as a coping mechanism needs to be reconsidered in this context.

The goal was to reduce pre-sleep arousal, a state characterized by experiencing intrusive and uncontrollable *cognitions* (Nicassio, Mendlowitz, Fussell, & Petras, 1985). Positive reappraisal is a strategy that actively reframes thoughts about negative events and emotions as benign or positive (Folkman, 1997). In theory, positive reappraisal should thus be a very appropriate strategy to alter unwelcome cognitions during the pre-sleep phase. However, the present results suggest that cognitive reappraisal might not be that adequate after all. Ogilvie (2001) points out that a crucial part in the process of falling asleep is a decline in cortical activity. Positive reappraisal however is demanding for the brain. Buhle et al. (2014) conducted a meta-analysis that examined 48 neuroimaging studies involving

cognitive reappraisal to regulate emotion. Results show considerable cortical activity in all of the studies. It is hence conceivable that in the context of sleep, positive reappraisal as a cognitive strategy further activates the mind rather than calming it down. In that case, participants in the present study might even have successfully altered their negative emotions, but the positive thoughts still resulted in high cognitive arousal which in turn delayed the successful transition to sleep state.

Another explanation challenges the notion that the cognitive reappraisal instruction effectively differed from the active control group. While there is broad agreement that writing about emotional experiences as a form of intervention does work and can reduce negative affect, the underlying mechanisms of diary keeping have not been studied to the same extent. One explanation outlined by Pennebaker (1997) suggests that cognitive changes occur when writing about emotional experiences. He found that subjects that used a greater amount of positive emotion words benefitted the most from the writing process in terms of improved health. Another predictive factor was the use of both causal and insight words. Similar processes are believed to drive the beneficial effects of positive reappraisal, that is, a form of cognitive restructuring, seeing things in a more positive light and giving purpose to negative emotional experiences occurs. However, if writing is in of itself a form of cognitive reappraisal, it is reasonable to assume that a positive reappraisal intervention does not result in better subjective sleep quality compared to an active control group that similarly writes about emotional experiences. Under this assumption, both groups in the present study were essentially executing reappraisal interventions and thus by definition could not differ significantly from each other. Similarly, Nezlek (2012) points out that

recordkeeping with a specific goal in mind (such as, in the present case, improving sleep quality) can in of itself be considered an intervention, regardless of the specific instruction. This would provide yet another explanation for why the experiment could not identify any differences between the two diary groups. To account for that possibility, future studies should make efforts to include a third control group that is not assigned a writing task.

### **Strengths and Limitations**

One of the strengths of the present study is the rather diverse sample. As is often criticized, the typical sample in laboratory studies in psychological research consists to a large portion of young, female psychology students. However, the present study sampled a high percentage of non-students (55%) with a higher average age (33 years) and a slightly more balanced gender distribution (70% female). Albeit in different ways, global health crises such as pandemics affect the entire population, regardless of occupation, age, and gender. Accordingly, a diverse sample is of utmost importance to draw valid conclusions for the general public. However, the possible limitation of a selection bias must also be addressed: there is good case to believe that interest in participating in the present study was sparked mostly in people who felt like their subjective sleep quality was impaired, and who wanted to try techniques to improve it. Accordingly, it should be considered that participants were affected more by impairments of subjective sleep quality than people who decided not to take part in the study.

Another strength is the high commitment of participants. The dropout rate over the course of the daily diary period of the study was very low. In total, 36 of 99 subjects who

had originally agreed to participate in the study had to be excluded, however, almost all of them dropped out very early on, suggesting that subjects who actively participated, were in it for the long run. This commitment can be attributed to high compliance and a sense of duty towards the researchers, however, drawing from the comments on the free response option, the heavy commitment might have at least partially been due to perceived benefits from participating in the study. Strong commitment was particularly important in the present study because the diary entries themselves were not monitored, so it is impossible to guarantee that participants had in fact gone through with the intervention. As a result, the study required high compliance with the study protocol without the oversight of an experimenter.

A limitation of this thesis that needs to be disclosed concerns the study material. For the present study, a short version of the sleep scale by Flock and Zintel (2019) was employed because it has shown to be a very efficient, timesaving and yet reliable measure. Considering that participants had to fill out several surveys every day, high dropout rates were a real concern that was addressed by employing shorter scales, justifying the use of the short scale in this context. However, future research should consider employing the full German version of the PSQI (Riemann & Backhaus, 1996) that the short scale is based on. As opposed to the PSQI, the short scale merely produces three values, two of which assess overall subjective sleep quality, plus an evaluation of one's feeling of waking up well-rested. However, studies show that other factors contribute to subjective sleep quality, for example, whether subjects evaluated their sleep duration as sufficient (Harvey et al., 2008). Also, feeling awake (or tired respectively) during the day is another important factor in determining subjective sleep

quality. Both factors were not considered in the present study. Given that examining subjective sleep quality was the present study's main objective, employing the full PSQI and exploring the variable in more detail could have been beneficial to the results.

Another limitation that should be addressed in the future is the duration of the intervention. To keep the assignment of a master thesis within reason, the daily diary intervention was limited to seven days plus three days of baseline assessment. For a matter as sensitive as sleep to change, however, a much longer intervention would probably be beneficial and could reveal significant results. Similarly, the limited resources of a master thesis prevented the implementation of a real control group, which makes it difficult to draw valid conclusions from the intervention.

A further limitation draws from a more fundamental criticism of diary data. Some researchers have questioned the validity of diary data in general. According to Nezelek (2012), recordkeeping with a specific goal in mind shifts focus to the behavior in question and can in of itself be considered an intervention. Further, results derived from diary data frequently pose a problem concerning comparability and generalizing the results to the general public. Circumstances for each participant are highly individual and unique as opposed to rather constant conditions in laboratory studies. This trade-off between high ecological validity and generalizability was a conscious choice in the present study, it must however be mentioned as a possible limitation.

Another limitation for this specific study lies in the extraordinary circumstances of the Covid-19 pandemic. While other daily diary studies rely on the fact that participants maintain a daily routine and participate in a study while the rest of their life stays virtually

unchanged, for a large part of the population, the concept of normalcy did not exist during those first months of the pandemic. Even on days without any external factors impacting the study variables, it is conceivable that participants experienced tremendous internal change. With any day the pandemic progressed, feelings of so-called cabin fever potentially intensified, and fears and concerns about job loss, the economy, and the future in general might have increased. These factors make the interpretation of any findings during extraordinary times like a global pandemic particularly difficult. To illustrate, no significant change in negative affect and subjective sleep quality could very well mean that participants managed to still sleep okay and maintain their levels of negative affect in the face of intense adversity, and that the diary intervention provided the necessary support for their emotional state and subjective sleep quality not to deteriorate.

### **Future Research**

Future research should address the lack of objective measures by implementing the use of wearables. Devices that track bedtime, wake up time, sleep duration and sleep quality independent from the individual's assessment erase potential memory biases and other challenges related to subjectivity. Objective measures could yield more reliable results and, hence, constitute a valuable addition to future studies on sleep. It could also be interesting to assess whether subjective and objective evaluations of sleep quality differ, and to what extent and quality objective measures might affect and influence subjective estimates.

Other potential risk factors for impaired subjective sleep quality during a pandemic need to be examined. For example, a study conducted by Wang et al. (2020) found that 80%

of participants stayed home for more than 20 hours a day during the onset of the Covid-19 pandemic. It is plausible to suggest that this behavior is associated with less physical activity, fewer social contacts, and less emotional support. Those factors have been identified as risk factors for impaired sleep quality and should accordingly be taken into consideration in future studies. Another interesting factor to look at is the shift of circadian rhythms. The Covid-19 pandemic prompted many people to work from home, deviate from fixed mealtimes, generally work and live within less structured schedules, and thus altering their wake and sleep rhythms. This can impair circadian rhythms (Moss et al., 2015) and thus compromise subjective sleep quality (Kutana & Lau, 2020). In conclusion, future research should address the possibility that factors other than perceived stress and negative affect can be associated with poor sleep and examine their relationship.

Future research should further explore pre-sleep arousal as a potential mediator between negative affect and subjective sleep quality in a longitudinal design. Since pre-sleep arousal was identified as a major factor predicting subjective sleep quality, it still seems reasonable to use it as a leverage point in the endeavor of improving sleep. In light of the failure of positive reappraisal to yield significant results, future studies should, however, consider relaxation techniques and meditation instead. Interventions that focus on calming the mind down as opposed to employing cognitive strategies such as positive reappraisal could be a promising approach. For example, Cincotta, Gehrman, Gooneratne, and Baime (2011) found that an 8-week mindfulness-based meditation intervention significantly reduced pre-sleep arousal and improved subjective sleep quality, albeit not objectively measured sleep. Similarly, a sample with sleep disturbances in a study by Huberty et al.

(2021) achieved a significant decline in pre-sleep arousal and improvements in sleep quality by meditating with a commercial mindfulness app.

Finally, future diary studies involving writing interventions should imperatively implement a real control group that is not assigned any writing task. Further, the time span of the intervention should be extended considerably to provide a real chance of detecting a significant effect.

### **Practical Implications**

The results of the present study clearly highlight the demand for effective mechanisms to relieve the psychological burdens the Covid-19 pandemic has imposed on society. Two years after the conduction of this study, Covid-19 is still not defeated. Beyond that, experts predict that the currently raging pandemic is not going to be the last public health emergency caused by a virus. Novel coronaviruses have been around for decades and are unlikely to be deterred (Hui et al., 2020). This makes it even more indispensable to protect the population not only from the immediate medical dangers of a virus outbreak, but also to strengthen their skillset to protect themselves against mental health threats such as increased stress and the resulting negative affect and deteriorating sleep.

Despite the non-significant result, the present data shows a trend toward a reduction of negative affect that can be achieved by diary keeping. Further, qualitative analyses of participants' feedback imply that diary-keeping as a low threshold, low effort, and low-cost intervention can entail notable benefits when dealing with increased stress and negative emotions. The intervention discussed in this thesis can hence be considered as one factor



to help prepare the population for the psychological implications of future virus outbreaks and other states of emergency. In this regard, the identification of pre-sleep arousal as a powerful predictor of subjective sleep quality is a particularly important lever to develop future interventions with the goal to provide strategies and mechanisms to be able to cope short- and long-term in situations of crisis.

### **Conclusion**

The present thesis provides insights into the initial impact of the Covid-19 pandemic on the psychological wellbeing of a diverse sample in Germany. It is thus an important addition to the current accumulation of knowledge about how the Covid-19 pandemic has affected the general public all around the world. It confirms prior research that reveals the massive burden the pandemic and its countermeasures have caused for the psychological wellbeing of the population. Specifically, this study focuses on the ramifications for subjective sleep quality. Results show higher perceived stress and negative affect and indicate impaired subjective sleep quality during the Covid-19 pandemic. Results also confirm prior research that clearly links high daytime negative affect and high pre-sleep arousal to poorer subjective sleep quality. The presented positive reappraisal daily diary intervention did not yield the expected results, however, if future research considers the presented takeaways and suggestions, this study could serve as a steppingstone to develop successful interventions in the future. Given the serious costs that poor sleep causes in individuals and society, it is imperative to conduct more research to finally capture the elusive and volatile nature of sleep and develop effective strategies to improve it.

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## Appendix

### Appendix A: Diary Study Email Reminders

#### *General Information Email for the Diary Phase*

Hallo liebe/r Studienteilnehmer/in,

vielen Dank, dass Sie sich bereit erklärt haben, an unserer Tagebuchstudie zum Thema **Schlaf und Resilienz** teilzunehmen.

Heute und die folgenden zwei Tage werden zunächst Ihr derzeitiger Schlafzustand und das aktuelle Stressempfinden erfasst. Dafür bekommen Sie jeweils morgens um 6 Uhr und abends um 21 Uhr eine Erinnerungsmail mit dem Link zum jeweiligen kurzen Fragebogen.

Auf diese Weise können wir später messen, ob sich durch das Tagebuch schreiben etwas verändert. Füllen Sie den morgendlichen Fragebogen bitte nach dem Aufstehen und den abendlichen vor dem Schlafengehen aus.

Ab Donnerstag, den 04.06., beginnt dann der praktische Teil der Tagebuchstudie. Dieser dauert insgesamt 7 Tage und Sie werden währenddessen eine hilfreiche Methode zur Verbesserung des Wohlbefindens und der Schlafqualität ausprobieren.

Hierzu erhalten Sie am Donnerstag nochmal gesonderte Informationen und Instruktionen. Auch während dieser 7 Tage bekommen Sie tägliche Erinnerungsmails mit den entsprechenden Links zu den Fragebögen.

Bitte füllen Sie heute diesen kurzen Fragebogen aus:

[→ Zum Fragebogen](#)

Vielen Dank und schlafen Sie gut,  
Amelie und Mareike

#### *Nightly Reminder Email Baseline Phase*

Hallo liebe/r Studienteilnehmer/in,

vielen Dank, dass Sie sich bereit erklärt haben, an unserer Tagebuchstudie zum Thema **Schlaf und Resilienz** teilzunehmen. Bitte füllen Sie heute diesen kurzen Fragebogen aus:

→ [Zum Fragebogen](#)

Vielen Dank und schlafen Sie gut,  
Amelie und Mareike

### ***Detailed Diary Instructions Positive Reappraisal Group***

Hallo liebe/r Studienteilnehmer/in,

Eine Reihe wissenschaftlicher Studien zeigt, dass das Schreiben über alltägliche und belastende Ereignisse positive Auswirkungen auf das körperliche und psychische Wohlbefinden haben kann. Dabei kann es besonders günstig sein, einen positiven Blick auf den Tag einzunehmen und die positiven Aspekte einer Situation wahrzunehmen. Dies steigert nicht nur das Erleben von positiven Emotionen und reduziert das Stressempfinden, sondern stärkt auch die psychische Widerstandskraft, sodass langfristig besser mit Stress und negativen Emotionen umgegangen werden kann.

Deshalb ist es jetzt Zeit für Ihren täglichen **“look on the bright side of life”!**

Bitte lehnen Sie sich einen Moment lang zurück, entspannen Sie sich und lassen Sie Ihren Tag nochmal mindestens 2 bis max. 5 Minuten lang Revue passieren.

Schreiben Sie auf, welche Chancen eine Krise wie die gegenwärtige Ihrer Meinung nach mit sich bringt.

Welche positiven Aspekte sind Ihnen heute trotz, oder gerade wegen der Corona-Pandemie begegnet?

Wenn Sie heute negative Dinge erlebt haben, versuchen Sie diese Erlebnisse bewusst als eine Herausforderung zu sehen, die Sie gemeistert haben oder noch meistern werden. Betrachten Sie das Erlebnis als eine Gelegenheit zum persönlichen Wachstum.

Vielleicht haben Sie eine wertvolle Lektion gelernt, oder gelernt, wie Sie auf eine souveräne Art mit Konflikten umgehen?

Denken Sie an die positiven Veränderungen, die Sie persönlich durch das Erlebnis gewonnen haben, wie zum Beispiel ein besseres Verständnis von Ihnen selbst oder Ihren Beziehungen.

Konzentrieren Sie sich darauf, was Sie durch diese Erfahrung gelernt haben, welche Ihrer Stärken Sie einsetzen konnten und wie Ihnen das in der Zukunft helfen könnte.

Wenn Sie Ihren Tagebucheintrag erledigt haben, füllen Sie bitte noch heute den folgenden kurzen Fragebogen aus:

[→ Zum Fragebogen](#)

Vielen Dank und schlafen Sie gut,  
Amelie und Mareike

***Nightly Diary Instructions Positive Reappraisal Group (Short Version)***

Hallo liebe/r Studienteilnehmer/in,

es ist Zeit für Ihren täglichen **“look on the bright side of life”!**

Bitte lehnen Sie sich einen Moment lang zurück, entspannen Sie sich und lassen Sie Ihren Tag nochmal mindestens 2 bis max. 5 Minuten lang Revue passieren.

Welche positiven Aspekte sind Ihnen heute trotz, oder gerade wegen der Corona-Pandemie begegnet?

Wenn Sie heute negative Dinge erlebt haben, versuchen Sie diese Erlebnisse bewusst als eine Herausforderung zu sehen, die Sie gemeistert haben oder noch meistern werden. Betrachten Sie das Erlebnis als eine Gelegenheit zum persönlichen Wachstum.

Vielleicht haben Sie eine wertvolle Lektion gelernt, oder gelernt, wie Sie auf eine souveräne Art mit Konflikten umgehen?

Denken Sie an die positiven Veränderungen, die Sie persönlich durch das Erlebnis gewonnen haben, wie zum Beispiel ein besseres Verständnis von Ihnen selbst oder Ihren Beziehungen.

Konzentrieren Sie sich darauf, was Sie durch diese Erfahrung gelernt haben, welche Ihrer Stärken Sie einsetzen konnten und wie Ihnen das in der Zukunft helfen könnte.

Wenn Sie Ihren Tagebucheintrag erledigt haben, füllen Sie bitte noch heute den folgenden kurzen Fragebogen aus:

[→ Zum Fragebogen](#)

Vielen Dank und schlafen Sie gut,  
Amelie und Mareike

***Detailed Diary Instructions Active Control Group***

Hallo liebe/r Studienteilnehmer/in,

Eine Reihe wissenschaftlicher Studien zeigt, dass das Schreiben über alltägliche und belastende Ereignisse positive Auswirkungen auf das körperliche und psychische Wohlbefinden haben kann. Die tägliche Auseinandersetzung mit den eigenen Gefühlen, Gedanken und Erlebnissen kann dabei helfen, diese Gefühle loszulassen, den Umgang mit belastenden Situationen verbessern und zur persönlichen Entwicklung beitragen. Das Tagebuch schreiben hilft dabei, eine Außenperspektive einzunehmen und das Erlebte besser einordnen zu können. Regelmäßiges Schreiben hat sich so als wirksame Methode erwiesen, um das Stressempfinden zu reduzieren.

Deshalb ist es jetzt Zeit für Ihren Blick zurück auf den Tag!

Bitte lehnen Sie sich einen Moment lang zurück, entspannen Sie sich und lassen Sie Ihren Tag nochmal mindestens 2 bis max. 5 Minuten lang Revue passieren.

Schreiben Sie auf, was Ihnen am heutigen Tag wichtig war. Lassen Sie Ihren Gedanken dabei freien Lauf.

Was hat Sie beschäftigt?  
Welche Dinge sind Ihnen passiert?

Berücksichtigen Sie dabei sowohl positive als auch negative Ereignisse.

Wenn Sie Ihren Tagebucheintrag erledigt haben, füllen Sie bitte noch heute den folgenden kurzen Fragebogen aus:

[→ Zum Fragebogen](#)

Vielen Dank und schlafen Sie gut,  
Amelie und Mareike

***Nightly Diary Instructions Active Control Group (Short Version)***

Hallo liebe/r Studienteilnehmer/in,

es ist Zeit für Ihren Blick zurück auf den Tag!

Bitte lehnen Sie sich einen Moment lang zurück, entspannen Sie sich und lassen Sie Ihren Tag nochmal mindestens 2 bis max. 5 Minuten lang Revue passieren.

Schreiben Sie auf, was Ihnen am heutigen Tag wichtig war. Lassen Sie Ihren Gedanken dabei freien Lauf.

Was hat Sie beschäftigt?  
Welche Dinge sind Ihnen passiert?

Berücksichtigen Sie dabei sowohl positive als auch negative Ereignisse.

Wenn Sie Ihren Tagebucheintrag erledigt haben, füllen Sie bitte noch heute den folgenden kurzen Fragebogen aus:

[→ Zum Fragebogen](#)

Vielen Dank und schlafen Sie gut,  
Amelie und Mareike

### ***Morning Reminder Email***

Guten Morgen liebe/r Studienteilnehmer/in,

bitte nehmen Sie sich kurz einen Augenblick Zeit, um den folgenden Fragebogen zu Ihrem Schlaf in der letzten Nacht auszufüllen:

[→ Zum Fragebogen](#)

Vielen Dank und einen schönen Tag,  
Amelie und Mareike

### ***Reminder Email Post-Intervention Survey***

Liebe/r Studienteilnehmer/in,

vielen herzlichen Dank für Ihre Teilnahme an unserer Erhebung zum Thema **Schlaf und Resilienz**.



Die Tagebuchphase ist nun beendet. Um unsere Studie abzuschließen und die Daten zu vervollständigen, möchten wir Sie nun noch bitten, unseren Abschlussfragebogen auszufüllen.

Ihre Teilnahme an dieser letzten Befragung ist wichtig, um aussagekräftige Ergebnisse zum Einsatz der Tagebuch-Methode und ihrer Wirkung auf das Schlafverhalten zu erhalten.

Hierfür benötigen Sie etwa 10-15 Minuten.

**→ Zum Fragebogen**

Nochmals danke für Ihre Unterstützung, bleiben Sie gesund und schlafen Sie gut.

Viele Grüße,  
Amelie und Mareike

## Appendix B: Supplementary Tables

**Table 5**

*Multilevel Models Predicting Subjective Sleep Quality During Baseline Period*

	Random Intercept Model	Model 1 <sup>a</sup>
<i>Fixed Effects</i>		
Intercept	67.90 (2.00)***	66.10 (2.66)***
Time		1.51 (1.47)
<i>Random Variances</i>		
Intercept	13.32	13.29
Time		0.61
Residual	12.13	12.06

*Notes.* Values are Unstandardized Estimates. Standard Error in Parentheses. <sup>a</sup>Including Time as Predictor.  
\*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

**Table 6***Multilevel Models Predicting Subjective Sleep Quality During Diary Phase*

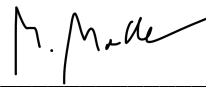
	Model 0	Model 1	Model 2	Model 3	Model 4
<i>Fixed Effects</i>					
Intercept	71.84 (1.38)***	71.82 (1.66)***	71.85 (1.59)***	71.51 (2.31)***	82.40 (4.45)***
Time		0.006 (0.27)	0.003 (0.28)	-0.18 (0.39)	-2.07 (0.96)*
Group				0.27 (3.38)	0.05 (3.05)
NA <sup>a</sup>					-6.65 (2.46)**
Time*Group				0.50 (0.57)	0.52 (0.56)
Time*NA <sup>a</sup>					1.14 (0.55)*
<i>Random Variances</i>					
Intercept	9.78	9.78	9.02	9.54	8.24
Time			0.57	0.25	0.68
Residual	12.24	12.24	12.16	12.35	12.07

Notes. Values are Unstandardized Estimates. Standard Error in Parentheses. <sup>a</sup> Negative Affect. Full Model Not Included. \*  $p < .05$ ; \*\*  $p < .01$ ; \*\*\*  $p < .001$

### **Eigenständigkeitserklärung**

Hiermit versichere ich, dass ich die Masterarbeit mit dem Titel „The Effect of a Daily Diary Intervention on Subjective Sleep Quality During the Covid-19 Pandemic: Does Positive Reappraisal Make a Difference?“ selbstständig verfasst, noch nicht anderweitig zu Prüfungszwecken vorgelegt, keine anderen als die angegebenen Quellen oder Hilfsmittel benutzt, sowie wörtliche und sinngemäße Zitate als solche gekennzeichnet habe.

Heidelberg, den 26.07.2022



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