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Working Mechanisms and Factors influencing the Efficacy of an
Ecological Momentary Intervention for Somatic Symptom
Disorder

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Introduction

In 2013, the DSM-5 (American Psychiatric Association, 2013) was released and proposed a new disorder: somatic symptom disorder (SSD). This novel disorder replaced the previous somatoform disorder. SSD is characterized by somatic complaints, such as back pain, headaches, or dizziness, which cause significant impairment in daily life (American Psychiatric Association, 2013). Furthermore, those affected by this disorder frequently experience disproportionate thoughts, feelings, or associated health anxiety, causing significant psychological distress, or engage in excessive behaviors related to their physical symptoms. SSD depicts a mental disorder, affecting multiple dimensions of human perception and experience, including somatic, cognitive, emotional, and behavioral aspects. This disorder presents with a high prevalence of around 5-7% in the general population (D'Souza & Hooten, 2023) and even 17% within the clinical population (Vesterling et al., 2023). While these numbers merely include individuals who are officially diagnosed with the disorder, the prevalence of typical symptomatology and subclinical symptom presentation lays even higher. Rief and Hiller (2011) found that 82% of the general population report a slight impairment through physical complaints and up to 22% report that they are strongly impaired by such. According to Toussaint and Herzog (2020), SSD and related disorders are the fourth most prevalent psychiatric disorder group regarding its 12-month prevalence, underscoring the importance of thorough investigation of this disorder.

In psychological research and clinical practice, if individuals present with comparable symptomatology, they usually receive similar therapeutic treatments. However, the efficacy of these treatments and interventions may drastically differ between individuals. Treatment efficacy can be defined in various ways and it is crucial to consider that depending on disorder and symptomatology, treatment goals can widely differ. Generally, treatment efficacy is understood as the extent to which a treatment produces the desired outcomes or displays positive effects (American Speech-Language-Hearing Association, 2001). Depending on the symptomatology of a mental disorder and the areas the affected individual perceives as most taxing, treatment goals are defined and efficacy can be made measurable.

Upon closer examination of treatments for SSD, the question arises as to how treatment efficacy should be defined in this context. Despite physical complaints being the core symptom of SSD, this disorder is classified as a mental health condition. Therefore, medical care is usually not the recommended form of treatment and instead, a psychological approach is necessary to treat individuals affected by this disorder (Kurlansik & Maffei, 2016). Consequently, a variety of different approaches exist to define treatment efficacy for

SSD-specific interventions.

Some research suggests to first and foremost target general quality of life (QoL) when treating SSD (Kleinstäuber et al., 2017), proposing a holistic understanding of how this disorder may negatively impact various domains of daily life.

Alternatively, when assessing the efficacy of treatments for SSD, disorder-specific symptoms such as the presence of physical symptoms and the associated perceived impairment may also be considered. This poses a focus on the A-criterion of SSD, which refers to the presence of somatic symptoms that cause significant impairment, as defined by the DSM-5 (American Psychiatric Association, 2013). Assessing the impact an intervention has on physical symptom severity and the caused impairment in order to investigate treatment efficacy therefore is an alternative, reasonable measure.

Independent of the specific definition of treatment efficacy, the individual factors which influence whether an individual is responsive to treatment – or hinder treatment success – are still widely unknown.

Theoretical Background

SSD

SSD is a relatively new diagnosis, only proposed in the DSM-5 in 2013 (American Psychiatric Association, 2013). Individuals diagnosed with SSD display a history of one or more physical complaints leading to significant impairment in an important area of functioning, such as occupational or interpersonal, or significant distress, posing the A-criterion. Before diagnostic criteria of SSD were developed for the DSM-5, individuals with these kinds of symptoms were often diagnosed with somatoform disorder (Kurlansik & Maffei, 2016). One of the criteria for somatoform disorder was the presence of physical complaints that cannot be medically explained. To obtain a diagnosis of SSD, however, it is irrelevant whether these physical symptoms can be attributed to a medical cause or remain medically unexplained. Notably, yet about 40 to 49% of those diagnosed with SSD present with at least one medically unexplained symptom (Haller et al., 2015).

Additionally, a diagnosis for SSD requires meeting the B-criterion, which defines either excessive thoughts, feelings or behaviors related to somatic symptoms or disproportionate anxiety concerning one's health. This criterion manifests as at least one of the following characteristics: first, as the cognitive dimension where the individual demonstrates a certain preoccupation by evaluating their symptoms as disproportionately serious and threatening; second, the emotional dimension where the individual experiences high levels of anxiety related to their health, and third, the behavioral dimension, where the individual

dedicates an excessive amount of time towards their symptoms and health, for instance by researching their symptoms online or frequently visiting medical professionals. Importantly, for diagnosis, even though one individual somatic symptom does not have to be present for a specified duration, the overall burden caused by somatic symptoms and related cognitions, feelings, and behaviors must persist for at least six months (American Psychiatric Association, 2013).

SSD has a typical onset before the age of 30, and although there is a possibility for spontaneous remission, its course is usually chronic or recurrent (Toussaint & Herzog, 2020). This implies that affected individuals commonly present with this disorder over a long period of time or at least display a phasic illness trajectory. Here, chronicity does not imply the persistence of one specific symptom or a fixed set of symptoms but rather their fluctuation, which means that while the physical symptomatology is generally present over time, the nature and presentation of symptoms may change.

As explained above, physical complaints may often appear as the core symptom of SSD. However, presence of symptoms related to the B-criterion classifies SSD as a mental disorder rather than a somatic condition. This classification suggests that affected individuals are recommended to primarily receive psychological treatment instead of medical care. Nonetheless, affected individuals often perceive their physical symptoms to be most taxing and tend to merely consider care by medical healthcare professionals. Continuously experiencing burdensome physical symptoms without receiving a clear medical diagnosis then often leads to numerous visits of doctors, as affected individuals hope to eventually obtain a diagnosis and clear medical explanation for their somatic symptoms (Ringel et al., 2015). Here, SSD often remains unrecognized by medical professionals for an extended period of time, further delaying appropriate treatment. Additionally, many medical professionals show a lack of awareness for this diagnosis and report a certain hesitation for referral to psychologists or psychiatrists (Wangler & Jansky, 2023). Therefore, psychological care is often not sought, or patients are referred to receive psychological or psychiatric aid only after a prolonged period of time of seeking professional investigation of their physical issues.

Especially if appropriate psychological treatment is not provided, individuals with SSD most often present with severe impairment in their daily life. As stated above, experiencing severe distress or impairment in an important area of functioning besides physical complaints is required to meet the diagnostic criteria. Important areas of functioning may include work-related duties, societal engagement, maintenance of close relationships, or

engagement in hobbies, amongst others. As such, individuals affected by this disorder are usually not able to pursue their occupational obligations (Huang et al., 2017) and tend to experience increased loneliness and less social support (Vos et al., 2023). Most often, widely impaired functioning and reduced quality of life (QoL) are the main concerns of those affected, which makes reducing functional restriction and improving QoL among the main targets of psychotherapy for SSD (Liao et al., 2019; Verdurmen et al., 2017).

As applies generally to mental disorders, the etiopathogenesis of SSD is not monocausal, which means that there are various aspects which can contribute to its onset. Taking these facets into account when investigating and treating SSD is highly valuable as different factors may impact how individuals respond to treatment and in turn pose potential intervention targets. Given this complexity, it is important to consider the biopsychosocial model to identify predisposing, triggering, and maintaining factors as this model presents a holistic understanding of the disorder's etiology (Allen & Woolfolk, 2013).

The biopsychosocial model, as first introduced by Engel (1977) is a multi-dimensional approach integrating multiple causes of pathology. Originally developed to gain a more holistic view on medical issues, this model is now the gold standard in understanding and explaining psychopathology (Bridley & Duffin, 2022). As its name suggests, the biopsychosocial model rejects the idea of illness and health being attributable to single causes and instead, aims to view psychopathology as a result of various causes from different domains. These include a biological, psychological, and social dimension. Thus, in understanding the etiopathogenesis of SSD, it is crucial to recognize that each factor for predisposing, triggering, and maintaining agents can arise from the biological, psychological, or social dimension.

In determining predisposing agents, it is central to consider risk and protective factors as well as general vulnerability; these shape an individual's susceptibility for the development of SSD. Generally, predisposing factors may comprise a wide range of different factors, for instance early childhood experiences, genetics, or even personality traits (Selzer & Ellen, 2014). Triggering factors are understood as aspects which immediately precede the onset of a disorder and are thought to be causally associated with this onset. Triggering factors display a wide variety, ranging from acute stressors to highly taxing life events, such as job loss, sudden illness or disturbance of relationships or separation. Lastly, maintaining factors are such which influence persistence, chronicity, remission, and treatment response. These factors may include illness-related cognitions, such as health-beliefs or treatment expectation, reinforcement of illness-related behavior patterns by the social environment, or troubled

coping strategies, amongst others (Toussaint & Herzog, 2020). Oftentimes, however, factors cannot be exclusively assigned to either one of these categories (predisposing, triggering, maintaining) and it might be reasonable to principally concentrate on a differentiation according to the biopsychosocial model.

For SSD, numerous risk factors can come to play for its onset and maintenance, oftentimes interacting in complex manners. From a biological perspective, these include amongst others, female gender (Kurlansik & Maffei, 2016), predisposition for altered neurological pain response (Çolak et al., 2021), a dysregulation of the HPA-axis (Kozłowska et al., 2020), and a history of chronic diseases. In turn, these factors may contribute to outcomes such as higher pain sensitivity, increased bodily awareness, or altered pain processing (Sauer & Eich, 2007; Wolters et al., 2022).

Social factors may also be considered when looking at factors influencing the development and trajectory of SSD. These include low education level and socioeconomic status, unemployment, and unstable relationships (Obimakinde et al., 2015; Martin, 2021), whereas these factors may contribute to reduced access to adequate healthcare and increased stress levels.

As for psychological factors, there are multiple aspects which are potentially relevant for predisposition and illness trajectory of SSD. Besides a self-concept for bodily weakness, alexithymia, and health anxiety, as found in a meta-analysis by Smakowski et al. (2024), there are also other factors which are thought to play a key role not only in the onset and maintenance of SSD, but also in regard to treatment response and thus experienced individual treatment efficacy. Specifically, this study will focus on three of these psychological factors, namely comorbidity in terms of depressiveness, coping style, and emotion regulation (ER), as these agents are highly relevant in SSD and are likely to impact symptom persistence and treatment response, as further derived hereafter.

Comorbidity in SSD

As with most psychiatric disorders, comorbidity is rather the rule than exception, and this is particularly evident in SSD. This disorder most often appears together with comorbid diagnoses, predominantly with anxiety disorders and major depressive disorder (MDD; Rief & Hiller, 2011). While anxiety disorders have a comorbidity prevalence of around 40%, MDD is the most prevalent comorbid diagnosis, with about half of all those suffering from SSD being additionally diagnosed with MDD (Rief & Hiller, 2011). Depressiveness does not only constitute a risk factor for SSD, but can also contribute to its maintenance, for example by endorsing avoidance behavior (Toussaint & Herzog, 2020). Furthermore, as proposed by Liao

et al. (2019), comorbid depression negatively impacts daily life functioning, predicting for example reduced physical exercising, decreased novelty seeking behavior, and fewer self-reported functioning in areas of home, work, and family responsibilities. Additionally, as found by Baumeister et al. (2005), comorbid depression can negatively impact treatment outcome by exacerbating treatment resistance and further lowering QoL in individuals with somatic illnesses. Findings on the impact of comorbidity generally and, specifically, comorbid depression in SSD are inconsistent but repeatedly suggest a negative impact of comorbidity on treatment success (Rief & Hiller, 2011). However, Rief and Hiller (2011) stress that generally, both illness trajectory and prognosis may be negatively impacted by comorbidity, partially due to more multi-layered symptomatology and thus more complex treatment objectives. They argue that through comorbid disorders, impairment in different areas of functioning can create a feedback loop, with each impairment exacerbating the others, aggravating the treatment progress. Differences in comorbid depressiveness and its possible impact on treatment efficacy in individuals with SSD has not been investigated by previous research yet.

Coping in SSD

Coping generally refers to the use of strategies, either cognitive or behavioral, in dealing with demanding situations to alleviate negative emotions or stress (American Psychological Association, 2018b). Coping is a concept mostly understood to have two dimensions, problem-focused and emotion-focused coping (American Psychological Association, 2023b; American Psychological Association, 2023c). Both concepts exist independently from each other, meaning that an individual who demonstrates frequent use of one strategy does not automatically display low or no use of the other. Besides categorization into problem- and emotion-focused coping, the literature also proposes a discrimination between functional and dysfunctional coping, mostly independent from the prior mentioned coping style categories (Carver, 1997; Chao & Wang, 2013).

The preferred coping style is another factor which is suggested to be relevant for onset, maintenance, and eventually treatment outcome in SSD. SSD has previously been linked to rather maladaptive coping; specifically, individuals with SSD tend to display more emotion-focused instead of problem-focused coping (Nath et al., 2018). Essentially, this means that people suffering from SSD are more likely to target their unpleasant emotion instead of the direct stressor in dealing with a stressful or taxing event. Individuals affected by SSD often display disturbed coping styles and resort to functional coping strategies less frequently (Tominaga et al., 2013). Tominaga et al. (2013) conducted a questionnaire-based study which

examined the associations between alexithymia and coping styles in individuals with somatoform disorder. Here, it was shown that alexithymia – the inability or difficulty to describe, recognize, or express one's own emotions (American Psychological Association, 2018a) – was negatively associated with habitual use of functional coping strategies such as planning, seeking social support, and cognitive reappraisal. This is especially important as symptoms of alexithymia, such as reduced awareness and precision of own emotional perceptions, are frequently found in individuals with SSD (Schnabel et al., 2022b).

Problem-focused Coping

Problem-focused coping is a kind of coping strategy which is implemented whenever an individual, exposed to a somehow stress-evoking situation, directly accosts the stressor, attempting to reduce or depose of it (American Psychological Association, 2023c). Problem-focused coping may involve finding possible solutions for their unpleasant situation or targeting others who directly cause the stressor. In developing the Brief-COPE for assessing coping strategies, Carver (1997) names several specific strategies which he classifies as problem-focused. These involve active coping, seeking instrumental support, and planning. Strategies like these are often seen as adaptive and yield various positive outcomes, as described above. Usually, these strategies are used more if an individual judges their capacity to change the stressor to be sufficient.

An everyday-life example for problem-focused coping may be the response of an individual who experiences stress through their housemates' persistent untidiness. In response, they may want to establish a cleaning schedule, engage more in cleaning themselves or seek to talk with their housemates about this issue.

When confronted with SSD-typical stressors such as physical symptoms, individuals who regularly engage in problem-focused coping may actively try to make a plan on how to alleviate their symptoms and try to think of something they can do to enhance their current situation (Carver, 1997). For instance, in times of high symptom intensity, an individual may resort to physical exercising if they experienced this strategy to be useful in the past.

Emotion-focused Coping

Contrarily, emotion-focused coping describes a strategy where the individual who finds themselves in an unpleasant situation primarily targets their experienced stress (American Psychological Association, 2023b). This strategy is used more often if an individual judges their capacity to change the stressor to be insufficient.

Sticking with the example from earlier, confronted with the untidiness of their

housemates, an individual may cope in an emotion-focused way by turning to a friend for emotional support or trying to take the situation with humor.

Emotion-focused coping is often associated with mindfulness and relaxation exercises, prayer, and wishful thinking (American Psychological Association, 2023b). Naturally, there are coping strategies which are seen as rather maladaptive and are classified as emotion-focused coping, such as self-blame and social withdrawal (American Psychological Association, 2023b). Nonetheless, emotion-focused coping does not solely involve maladaptive strategies, which is why the Brief-COPE, used in this study to assess coping styles, separately discriminates for dysfunctional strategies.

The Brief-COPE (Carver, 1997) lists several specific, non-dysfunctional strategies for emotion-focused coping. These include acceptance, seeking emotional support, humor, positive reframing, and turning to religion, which are all suggested to be adaptive and show far-reaching positive effects if implemented. For instance, receiving emotional support can heighten psychological well-being (Morelli et al., 2015), humor may significantly assist in the downregulation of negative emotions (Samson & Gross, 2011), and turning to religion may facilitate positive psychological adjustment (Yangarber-Hicks, 2004).

In SSD, emotion-focused coping may be elicited if, for instance, an individual is confronted with the stressor of experiencing physical symptoms. Implementing this strategy, an individual may, for example, try to distract themselves by listening to an audio book and otherwise engaging in their hobbies, or perform a mindfulness task such as a breathing exercise.

Dysfunctional Coping

Coping can alternatively be understood in terms of functional versus dysfunctional coping (Erschens et al., 2018). Within his Brief-COPE questionnaire, Carver (1997) considers dysfunctional coping strategies besides problem- and emotion-focused coping strategies. Therefore, dysfunctional strategies are seen as a distinct category here, indicating that both emotion- and problem-focused coping involve functional strategies, which are listed separately.

Generally, dysfunctional coping can be understood as the implementation of strategies which are not helpful in effectively and persistently reducing stress (Chao & Wang, 2013). The strategies that depict dysfunctional forms of coping as proposed in the Brief-COPE are behavioral disengagement, denial, self-distraction, self-blaming, substance use, and venting (Cooper et al., 2008). Effects of these kinds of approaches are mostly negative and inefficient. For instance, applying coping in terms of denial is thought to solely lead to a fragile and

temporary reduction of distress (Folkman & Lazarus, 1990). For self-blame, Voth et al. (2009) found that engaging in this coping strategy significantly reduces psychological adjustment in those with inflammatory bowel syndrome. Venting describes how an individual copes with a stressor by verbally expressing their negative feelings to others and is associated with even greater intensification of negative emotions and distress (Brown et al., 2005). Applying substance use as a form of coping likewise has significant negative effects, such as a higher risk for developing depressive and anxiety symptoms (Colder et al., 2019; Kotozaki, 2022), besides an elevated risk for developing a substance use disorder.

If individuals with SSD are confronted with intense physical and psychological symptoms or stressors associated with the disorder, dysfunctional coping can occur in different ways. For instance, the individual might engage in venting by complaining to their relatives or friends about their symptoms while not seeking professional advice or treatment. Alternatively, they might resort to using alcohol or sedatives in an attempt to reduce their pain or physical discomfort. As explained above, while possibly appearing effective in reducing symptoms short-term, both these strategies may reinforce distress and preoccupation with the symptoms in the long-term.

Emotion Regulation in SSD

Previous research repeatedly suggested an association between emotion regulation (ER) and SSD, emphasizing the crucial role of ER in pathogenesis and maintenance of this disorder. ER is defined as the ability of an individual to change an emotion or a set of emotions (American Psychological Association, 2018c). It poses a highly relevant feature of functioning in daily life, impacting daily positive and negative affect (Brockman et al., 2016). Furthermore, its effects branch into different domains, such as general well-being (Quoidbach et al., 2010), perception of one's surroundings, and the behavioral and physical responses to these surroundings (Walden & Smith, 1997). ER also has a social function, with the ability to successfully regulate one's emotions enabling to experience effective and positive social interactions (Fischer & Manstead, 2016). In investigating the effects of ER on mental health and other domains, literature often discriminates between two strategies, specifically between the more adaptive cognitive reappraisal and the rather maladaptive expressive suppression (Gross & John, 2003). While these are distinct and independent strategies with different effects, the goal of both strategies is to decrease the frequency and intensity of unpleasant emotions.

Cognitive Reappraisal and Mental Health

Cognitive reappraisal is one of the two strategies belonging to ER. Cognitive reappraisal describes a process in which an individual attempts to change their way of mentally approaching an emotion-eliciting or stress-evoking event or stimulus (Buhle et al., 2013). For example, if confronted with a negative event, an individual who applies cognitive reappraisal may try to think of positive aspects of this event and see it in a different light.

Implementation of cognitive reappraisal involves reflection and recognition of negative thought patterns and their adjustment towards more effective and positive ones. The ability to regulate one's emotions by means of cognitive reappraisal is linked to greater life satisfaction (Haga et al., 2007), as well as enhanced well-being and social functioning (Cutuli, 2014; Greenberg et al., 2017). Additionally, studies by Hu et al. (2014) and Ungar and Theron (2020) indicated that the habitual application of this ER strategy may act as a protective factor against mental health issues, such as depressive symptoms and other psychiatric disorders.

Various research has found that individuals suffering from SSD display significantly less use of cognitive reappraisal compared to the general population (Berking & Wupperman, 2012; Okur Güney et al., 2019; Schnabel et al., 2022b). Yet, with SSD, applying cognitive reappraisal might be especially useful to deal with unpleasant emotions coming with the disorder. Only sporadic use of cognitive reappraisal may not only predispose and maintain symptoms of SSD but also possibly impede treatment success and aggravate illness management.

Expressive Suppression and Mental Health Adversities

Another ER strategy that has been identified is expressive suppression. Contrary to cognitive reappraisal, expressive suppression refers to an individual's attempt to modify their behavioral response when faced with an emotion-eliciting event (Cutuli, 2014). For instance, an individual may try to reduce their negative emotions by refraining from expressing them. Habitually resorting to this ER strategy has been associated with heightened negative affect (Moore et al., 2008), increased self-reported stress (Butler et al., 2003), and reduced emotional well-being (Brockman et al., 2016).

Individuals affected by SSD often present with disturbed ER (Schnabel et al., 2022a) and frequently rely on maladaptive strategies expressive suppression to regulate their emotions. Habitually resorting to maladaptive ER strategies does not only precede the onset of SSD but can also significantly contribute to its maintenance – for instance by affecting the quality of stress responses and perception of self-efficacy in dealing with unpleasant bodily perceptions and emotions (Schnabel et al., 2022a; Schnabel et al., 2022b). According to Okur Güney et al. (2019), affected individuals further display incoherent bodily and cognitive

responses during emotion regulatory processes.

In a systematic narrative review by Schnabel et al. (2022b), concerning the emotional regulatory processes in individuals with SSD and related conditions, it has been shown that affected individuals rely significantly more on maladaptive ER strategies. The authors found that ER in those with SSD is disturbed on multiple levels. These include deficits in correctly identifying emotions, as well as selecting and implementing adaptive ER strategies.

Concerning the identification of feelings and emotions, individuals with SSD reported lower understanding and clarity of their own emotional sensations, according to Schnabel et al. (2022b). The authors also found that those with SSD more frequently exhibited dysfunctional beliefs about their emotions, such as oftentimes judging their capacity to change them as insufficient. This also makes proactive ER initiation less likely, as individuals might not be aware of the necessity or their ability to regulate their emotions. Interestingly, Schnabel et al. (2022b) hypothesize that this lack of emotional awareness may prevent individuals from identifying physical sensations as signs of emotional activation. As a result, those with SSD tend to direct their attention towards bodily symptoms instead of utilizing ER strategies. This increased focus on somatic sensations may contribute to the onset and intensification of symptoms.

In regard to deficits in selecting and implementing adaptive ER, Schnabel et al. (2022b) found that individuals with SSD habitually resort to rather maladaptive strategies, such as suppression, e.g. not expressing emotions and rumination, which both can be understood as forms of response modulation. Less frequently used strategies are those which involve attention deployment, cognitive change, and acceptance. These results were found in both experimental and self-report measures.

Taken together, this frequent dysregulation may have an influence on onset and trajectory of SSD by impeding a successful adaptation to stressors. Until this point in time, however, there is no research on the effect of habitual ER strategy use on treatment efficacy in SSD.

All three variables – comorbid depressiveness, coping style, and ER style – are associated with SSD and were selected for further investigation in this study as they represent key psychological mechanisms that contribute to the onset and maintenance of SSD. Individual variations within these domains may impact therapeutic processes and outcomes, ultimately affecting the efficacy of treatments for individuals receiving them. So far, research has not specifically focused on investigating these differences in individuals with SSD.

Therefore, the present study partly aims to investigate how individual differences in these three variables impact the efficacy of an intervention for SSD.

Common Treatments for SSD

There are various therapy approaches for SSD. A meta-analysis by van Dessel et al. (2014) found that cognitive behavioral therapy (CBT) is the most effective form of psychological treatment for SSD, but also the most extensively studied one. In a review paper by Kurlansik and Maffei (2016), pharmacotherapy and mindfulness-based therapies showed some significant effects in reducing overall symptom severity, reducing depressive and anxiety symptoms, and improving global well-being. Furthermore, their study revealed that implementation of CBT may have positive effects on psychological distress and impairment caused by the disorder, which makes CBT a successful and effective form of treatment for SSD.

CBT for SSD is defined in terms of multiple disorder-specific treatment goals. Firstly, SSD-specific CBT generally aims to improve the individual's dealing with their symptoms (Kleinstäuber et al., 2017). Secondly, it focuses on achieving a long-term reduction in symptom intensity through gradually changing cognitions, emotions, and behaviors associated with the disorder. Here, an emphasis on the B-criterion when defining treatment objectives is apparent. Lastly, the third goal of CBT for SSD targets an improvement of self-efficacy and QoL.

As SSD depicts a serious mental health condition affecting various domains of daily life, it has previously been linked to a vastly reduced QoL (Löwe et al., 2021). QoL is defined as the extent to which an individual can obtain satisfaction from life (American Psychological Association, 2023d). The extent of QoL is dependent on multiple factors such as societal participation, the ability to make self-determined decisions, and the experience of emotional, physical, as well as material well-being (American Psychological Association, 2023d). All these abilities may be limited by SSD, highlighting the importance of interventions targeting not solely physical symptom reduction but also more holistic concepts such as QoL. This is because often, somatic symptoms alone are not responsible for lower perceived QoL, but other aspects that come with the disorder. For instance, individuals are no longer able to experience societal participation or pursue their hobbies and other recreational activities such as traveling. Reinstalling aspects which potentially heighten QoL should be targeted despite physical complaints. As proposed by Kleinstäuber et al. (2017), therapy, especially CBT, for SSD should focus first and foremost on improving QoL of those affected by the disorder.

Ecological Momentary Interventions

An extension for the classic in-person delivery of CBT are ecological momentary interventions (EMIs). With long waitlists and economical barriers to traditional treatment in clinical settings, new forms of treatment for common mental health issues have been developed and currently rise in their popularity. An EMI is a form of intervention delivered in a flexible and individual manner, for instance via apps. EMIs are tailored to fit in the day-to-day life of clients in natural settings and include real-time assessment responses (Balaskas, 2021), ensuring high ecological validity. Embedded in daily life and cost-effective, EMIs are a form of low-threshold treatment available for a large population suffering from mental health adversities. EMIs present with multiple advantages compared to classical treatment forms and delivery. Through their flexible delivery mode where users are able to access therapeutical aid on demand, independent of time and place, their independence from professional resources, low risk profile and high user compliance (Wrzus & Neubauer, 2022), EMIs are suggested to be a useful tool for tackling common mental health conditions.

The majority of app- or smartphone-delivered EMIs is based on principles of CBT, one of the most researched forms of psychotherapy (Butler et al., 2006) and often seen as the gold standard for the treatment of most mental health disorders and issues (David et al., 2018). Due to their solid research backing and structured approach, CBT-based interventions are appropriate for digital delivery, for example in the form of EMIs. As the EMI in this study, CBT-based treatments which are digitally delivered and largely self-administered without personal contact to a clinician or other professional are considered as low-intensity cognitive behavioral therapy (LICBT; Papworth & Marrinan, 2019). LICBT in the form of guided self-help and computerized CBT (CCBT) is recommended for mild to moderate levels of mental health adversity. Hence, an app-based intervention like the present EMI is an appropriate form of treatment for up to moderate levels of SSD. In this study, the nature of low intensity is marked through digital delivery, a widely self-administration format, and a relatively short time span of the total intervention. LICBTs are suggested to be appropriate for treating any kind of mental disorder as long as these treatments match the needed intensity of care (Papworth & Marrinan, 2019).

Importantly, EMIs have been shown to effectively reduce symptomatology in depression (Schueller et al., 2017) and different forms of anxiety (Loo Gee et al., 2015) and even demonstrated efficacy in treating psychotic disorders (Bell et al., 2017). Research on the efficacy of EMIs specifically for SSD and related disorders is still limited.

Given the widespread impact of SSD and the limited awareness surrounding it,

tackling this disorder through targeted and low-threshold interventions is of high relevance. The current study utilizes an EMI developed specifically for SSD which contains therapeutic exercises in the range of music listening and cognitive restructuring (CR). As such, it includes two fundamental building blocks of the traditional real-life delivered CBT: one focusing on attention-shifting and distraction (music listening) and the other targeting cognitive processes of evaluation and reappraisal (CR).

Cognitive Restructuring

CR is a psychotherapeutic technique which is commonly used in cognitive therapy (CT) and CBT. CR aims to assist individuals to recognize maladaptive thought patterns, challenge these distortions with counterevidence, and guide them in restructuring their beliefs into more adaptive, rational alternatives (American Psychological Association, 2023a). Generally, CR is recommended to be used in any situation where one might experience unpleasant or negative emotions. A complete implementation of CR consists of multiple steps targeting these emotions. An exemplary procedure was proposed by Hamblen and Mueser (2021). In their publication, the first step focuses on identifying the current situation which triggers the negative thought or feeling. The situation may be acute in form of an actual event but can also pose a memory of an event. Step two involves the identification of the upsetting feeling, typically by instructing the individual to concentrate on the strongest and most present feeling and precisely naming it. In the third step, the associated negative thought underlying the experienced feeling is identified. This thought is worked with in the remaining two steps. The fourth step comprises an evaluation of the accuracy of the concerned thought by questioning it and gathering evidence for its accuracy or against it. Eventually, in the last step, the individual is instructed to decide whether the targeted thought is accurate or not, based on the evidence gathered in step four (Hamblen & Mueser, 2021). CR has been shown to be efficient in the treatment of a wide range of mental health disorders, such as PTBS (Mueser et al., 2018), depressive disorders (Ciharova et al., 2021), and obsessive-compulsive disorder (Rosa-Alcázar et al., 2008), amongst others. As a fundamental building block of CBT, implementation of CR has been shown to not only reduce severity of symptoms in various disorders, but also to significantly improve QoL (Mueser et al., 2018).

In the context of SSD, CR is supposed to tackle catastrophizing thoughts concerning health. A typical cognitive pattern in SSD is the cognitive interpretation of physical sensations to be a sign of a serious illness (Ji et al., 2021). Exemplary for a negative thought common in SSD might be, “My headache indicates that I have a brain tumor.” Implementing CR, individuals are guided to generate alternative, more realistic and functional thoughts

(Hamblen & Mueser, 2021). This may be, for instance, “Although I'm experiencing a headache right now, I know that headaches can result from many common causes such as stress or dehydration. The likelihood of this headache being a sign of a serious condition like a brain tumor is very low.” As with worries concerning a headache and subsequent catastrophizing, it is possible to formulate alternative, more adaptive thoughts for any dysfunctional thought coming with this disorder. From a therapeutical perspective, the aim here is to establish an understandable link between cognitive processes and physical complaints and demonstrate how maladaptive cognitions can facilitate somatic symptoms (Liu et al., 2019).

As CR marks one of the fundamental building blocks of CBT, it is commonly delivered as a part of app-based interventions which utilize a CBT approach. As described above, these interventions were frequently suggested to be an effective form of treatment. The main difference to in-person delivered treatments is that app-delivered CR is self-administered and occurs without direct feedback or support of the clinician.

Music-based Interventions

Music based interventions (MBIs) are a well-researched therapeutic tool which can be applied in the treatment of various mental health conditions. Interest in application and efficacy of such interventions has risen as they are accessible and self-administered and therefore pose a low-risk as well as cost-effective treatment option. As such, existing literature has found that music-listening interventions are helpful in the treatment of anxiety disorders (Harney et al., 2022), depression (Leubner & Hinterberger, 2017), and sleep issues (Zhao et al., 2024).

MBIs in terms of music listening work through different mechanisms and previous research has revealed promising, far-reaching effects. For instance, music listening has been shown to alleviate pain symptoms (Lee, 2016), facilitate affect regulation (van Goethem & Sloboda, 2011), and positively affect biological stress systems (Finn & Fancourt, 2018). The effects of music listening manifest through different working mechanisms, one of them being elevated relaxation (van Goethem & Sloboda, 2011). Furthermore, as suggested by van Goethem and Sloboda (2011), music listening works through distraction and active coping. The most important underlying mechanisms which subjectively influenced the efficacy of music listening as found by the aforementioned study were the type of music, whether the music was familiar, simultaneous participation in unrelated activities (e.g. exercising, housework), and the valence of the music.

A systematic review by Finn and Fancourt (2018) investigated the effects of music

listening on biological responses, both in the clinical and non-clinical population. This study gives insight into the working mechanisms of music listening on a physiological level, beyond subjective perception and impressions. First and foremost, music listening can induce relaxation by affecting different biological stress response systems, which include reduction of cortisol and blood glucose level. These stress alleviating, physiological effects hold across different conditions, appearing to be independent of music genre, whether music was self-selected, and timespan of music exposure. These study findings suggest that music listening poses a universal tool to significantly decrease stress.

Research utilizing MBIs is not only suitable for administration in laboratory settings but also via EMIs. Feneberg and Nater (2022) examined the applicability of music through an EMI among chronically stressed young women. The authors describe a research gap concerning music interventions for acute stress in daily life. To address this within their study, participants were instructed to log self-initiated entries in an app whenever they experienced acute stress, followed by encouragement to listen to a self-selected playlist. Feneberg and Nater (2022) considered the stress response both in terms of subjective (questionnaire) and objective (saliva samples) measures. Essentially, their findings demonstrated that participants experienced immediate stress-relief through the music intervention, reporting subjective increased relaxation and distraction.

In the context of an ambulatory assessment study, Feneberg et al. (2021) demonstrated that music listening significantly reduced somatic symptoms in women with SSD through its alleviating effect on stress. Furthermore, it was found that music listening did have direct effects on somatic symptom intensity when considering specific characteristics of music such as valence. Here, music rated as happier predicted lower symptom intensity while music which was rated as sadder predicted higher symptom intensity.

These studies suggest that music listening is an effective form of intervention, specifically when delivered in a flexible and accessible manner through EMIs and also for somatic symptoms.

Factors Influencing Treatment Efficacy

Naturally, treatments and interventions for mental disorders and mental health adversities are not equally efficacious for everyone receiving them. The extent to which an individual benefits from interventions depends on various factors and this study specifically focuses on characteristics of the individual who receives the treatment. For example, in anxiety disorders, as found by Prasko et al.(2016), a series of personal factors may determine treatment response. Here, amongst others, comorbid personality disorders and self-stigma

predicted lower treatment success while higher scores of hope and self-directedness were associated with more beneficial treatment outcomes.

There are additional factors related to the individual that also influence the treatment trajectory and likelihood of remission. Besides symptom severity and chronicity (Rief & Hiller, 2011), comorbidity (Han et al., 2014), coping style (Li et al., 2014), and ER (Feurer et al., 2024) may also be relevant variables affecting treatment outcomes.

Comorbidity and Treatment Efficacy

Comorbidity, generally understood as the simultaneous presence of two or more disorders, is especially important to consider in diagnosis and treatment of mental disorders. This is because often, treatment trajectories differ depending on presence and presentation of comorbid disorders (Toussaint & Herzog, 2020). In this case, it is important to consider which symptoms are most dominant, causing the highest perceived psychological burden, and thus come first in treatment hierarchy. The presence of comorbidity adds complexity to both illness presentation as well as treatment planning and execution. Previous research regarding the impact of comorbidity yielded mixed results and has not consistently demonstrated an association with treatment outcome or resistance. Some studies found that comorbidities and thus more scattered and complex symptomatology are associated with treatment resistant depression (Souery et al., 2007).

As stated above, SSD is a mental disorder which most often presents as comorbid, predominantly with anxiety and depressive disorders (Rief & Hiller, 2011). Research findings on the impact of comorbidity differ depending on method, treated disorder, and form of comorbid disorder. For example, a meta-analysis by Olatunji et al. (2010), which investigated the influence of comorbidity on treatment outcome in anxiety disorders, demonstrated that overall comorbidity did not significantly impact treatment outcome across all anxiety disorders. Looking at specific anxiety disorders, however, they found both positive and negative associations between comorbidity and treatment success.

Furthermore, Han et al. (2014) investigated the influence of comorbid somatic symptoms on treatment and symptomatology of depression among Korean females and found that in the treatment of depression, more additional somatic symptoms significantly predicted worse post-treatment outcomes and lower symptom reduction. Considering the established association between somatic symptoms and depression in regard to treatment efficacy, it appears useful to investigate whether this association also holds the other way around, namely whether depression influences the treatment outcome for SSD.

Generally, research examining the impact of comorbidity on treatment outcomes is

very limited. This is especially true for SSD, a disorder which has not been extensively investigated yet. All the more, it is vastly important to investigate which factors might potentially hinder or facilitate treatment of this highly prevalent disorder. With MDD being one of the most prevalent psychiatric disorders worldwide and the most prevalent comorbid diagnosis for SSD (Toussaint & Herzog, 2020), examination of their co-occurrence and its impact on the treatment of SSD is crucial for improving therapeutic approaches and patient outcomes.

Coping Styles and Treatment Efficacy

Research on the effect of an individual's habitual coping style on treatment efficacy is scarce. A longitudinal study by Li et al. (2014) investigated the mediating effects of coping style on the efficacy of a psychological intervention for reducing hospital anxiety and depressiveness in family carers for dementia. Their intervention was targeted at improving coping skills, with coping style assessed with the Brief-COPE at baseline and at two further points in time to allow for investigation of changes in coping. Essentially, the authors found that heightened emotion-focused coping mediated treatment effects, but only if initial scores of depressiveness and anxiety were high. This implies that individuals with higher use of emotion-focused coping benefited more from the intervention compared to those who displayed lower levels of emotion-focused coping. Here, no significant effects for dysfunctional and problem-focused coping were found. Generally, problem-focused coping is associated with various positive and beneficial outcomes, such as more happiness (Rajabimoghaddam & Bidjari, 2011), higher QoL (Alok et al., 2014), and even with a lower risk for depression (Cong et al., 2019). Also being inherently related to self-efficacy (Taiwo, 2015), which is again associated with better treatment outcomes and trajectory for multiple mental disorders (Keshen et al., 2017; Kores et al., 1990), it is possible that the habitual use of problem-focused coping strategies facilitates the success of psychological interventions.

Furthermore, previous research found that an individual's coping style may impact treatment success if the intervention is not fitted to the habitual coping style of an individual (Beutler et al., 2018). However, the authors of the aforementioned study did not distinguish between emotion-focused, problem-focused, and dysfunctional coping, but between two other styles.

Although associations between presence of SSD and coping style preference have been found by previous research, no research exists on whether habitual coping style, differentiating between problem-focused coping, emotion-focused coping and dysfunctional coping, impacts the treatment efficacy of a psychological intervention for SSD. This is despite

clear evidence supporting the role of coping style in the development and management of mental health adversities (Santarnecchi et al., 2018; Woo et al., 2024), as well as its well-researched impact on factors that are partly responsible for therapy outcomes such as treatment adherence (Jeżuchowska et al., 2024).

ER Strategy Use and Treatment Efficacy

When considering cognitive reappraisal as a factor in treatment efficacy, there is evidence that higher pre-treatment brain activity associated with reappraisal predicts success of CBT for both anxiety disorder and MDD (Feurer et al., 2024). The authors concluded that differences in brain response associated with cognitive reappraisal ahead of the treatment partially explained the variability in clinical improvement as a response to an intervention. Thus, individuals with more activity for reappraisal showed a stronger treatment response and benefited more from a targeted intervention compared to those with less activity for reappraisal.

While research has frequently associated the presence of SSD with maladaptive ER, there is no research on whether habitual ER strategy selection and implementation possibly influences the treatment efficacy of SSD-specific interventions. Repeatedly associated with SSD, ER might impact the extent to which an intervention for SSD is efficacious, as efficiency in adaptively regulating emotions may impact treatment engagement and symptom improvement. Despite overwhelming evidence for the significant influence of ER in mental health disorders, there is no research on its impact on direct illness trajectory or treatment success, especially in individuals with SSD.

Research Questions and Hypotheses

As described above, treatments for SSD are suggested to primarily focus on improvement of QoL. Hence, investigation of whether interventions for SSD can positively impact QoL is highly relevant. This is especially the case for rather new forms of interventions rising in popularity such as EMIs. Yet, research covering this relationship is still scarce. The first research question (RQ) therefore asks whether an EMI using music listening and CR can improve QoL in individuals with SSD. Based on existing literature, which suggests that EMIs are an effective form of intervention (Balaskas et al., 2021; Schueller et al., 2017), it is hypothesized that QoL improves from baseline to post measure in participants after the intervention (H1a).

As outlined above, understanding which factors potentially facilitate and hinder treatment success is a highly important objective in psychological research. The second RQ

thus asks which factors influence the efficacy of an EMI using music listening and CR for patients with SSD. As derived previously, three variables potentially affecting treatment outcome were identified and according hypotheses were formulated. This study therefore focuses on comorbid depressiveness, coping style, and emotion regulation (ER) strategies.

H1b: Higher baseline depression scores are associated with lower symptom reduction in response to the intervention.

H1c: Higher baseline problem-focused coping is associated with higher symptom reduction in response to the intervention.

H1d: Higher baseline emotion-focused coping is associated with higher symptom reduction in response to the intervention.

H1e: Higher baseline dysfunctional coping is associated with lower symptom reduction in response to the intervention.

H1f: Higher baseline use of cognitive reappraisal is associated with higher symptom reduction in response to the intervention.

H1g: Higher baseline use of expressive suppression is associated with lower symptom reduction in response to the intervention.

Method

Research design

The current study utilizes an EMI, using music listening and CR and aims at improving symptomatology associated with SSD. The focus of the main study project is to investigate whether this intervention can elevate physical symptoms and reduce impairment caused by these symptoms. The research project is situated in a longitudinal framework spanning six weeks per participant, allowing for investigation of immediate and long-term effects of music listening and CR. All participants undergo both control as well as intervention condition, where randomization for control or intervention group occurs daily during the intervention phase, depicting a within-subjects format. The current study poses a quantitative experimental research design. The EMI is applied in the every-day life of participants and presents a combination of time-based and event-based assessments with multiple measurement times per day.

Target Population

The current study focused on a clinical population, aiming at individuals suffering from SSD, aged between 18 and 65. Specifically, the intervention targeted individuals who presented with physical complaints that significantly impaired their daily lives.

Eligibility and Exclusion Criteria

Pre-selection eligibility criteria for the present study included high level of German and residency in or near Vienna to allow for pick-up of the study smartphones at the laboratory. Participants had to be aged between 18 and 65 and fulfill diagnostic criteria of SSD. Exclusion criteria involved currently being in psychotherapeutic treatment, substance dependence (alcohol, drugs, or medication) within the last 6 months, acute suicidality, acts of non-suicidal self-injury within the last 14 days, acute psychotic or manic episode, and presence of a medically fully explained disease responsible for the somatic complaints.

Procedure

Ethical Considerations

In order to participate in the study, participants had to complete an app-based intervention for a total of 6 weeks. Before the start of the participation, potential participants were verbally informed about the aim and general topic of the research, inclusion criteria, duration, content, voluntariness of participation, as well as monetary compensation of 120€ in the case of entire completion. Further, they were informed that their data would be used for research purposes and handled confidentially.

The monetary incentive was proportional to the prospective time spent participating in the study. The study was non-invasive and participants were unlikely to be negatively impacted as the delivery of the program was not location-bound and integrable into everyday life. By engaging in this study, participants were not exposed to any risk, either physical or mental, but engagement rather held potential to advantage them. Targeting individuals affected by SSD, the current study intended to both benefit participants' symptomatology and also generate new knowledge about digitally delivered intervention programs specifically for SSD. Prior to the start of the study, participants were instructed to create a personal code, by which they would appear in the SPSS datasets. In this way, privacy was protected and anonymity was granted as participants' responses were not linkable to their identity.

Recruitment

Potential participants were approached by distributing flyers in both clientele-specific spaces such as pharmacies and practices for pain therapy, physiotherapy, or gastroenterology,

as well as in clientele-unspecific ones such as supermarkets or cafés. The flyer briefly described topic and compensation of the study and provided contact information interested individuals would use to reach out to the research team. Prospective participants underwent a screening via a semi-standardized telephone interview where study procedure was explained and main eligibility criteria such as age and symptomatology were assessed. Subsequently, if interested individuals met these criteria and agreed to taking part in the study, another appointment was scheduled. There, participants would receive the study smartphone, the study manual, and, if applicable, access data to a Spotify account.

Study procedure

The current study shows a within-subjects design, where participants receive both intervention and the control condition. Before participation in the study, interested individuals were required to fill out an online screening form where eligibility criteria and physical symptoms were assessed. If they fulfilled these criteria, prospective participants underwent a telephone interview, as explained above.

There are pre- and post-study assessments where participants answer various questionnaires in Unipark. The study spans 6 weeks, divided into three phases: a baseline phase (7 days), an intervention phase (28 days), and a post-phase (7 days). Data collection, across all three phases, occurs three times per day, at 11 a.m., 4 p.m., both following app notifications, and an evening assessment which is self-initiated with a reminder set to 9 p.m. During the intervention phase, an additional measurement point takes place 20 minutes after the evening assessment. Participants are also instructed to self-report event-based entries when experiencing acute somatic symptoms, triggering an immediate questionnaire followed by another one 20 minutes later.

Each day during the intervention phase, participants are randomly assigned to either receive the control condition (50%), or an intervention event (25% for music listening (intervention 1), 25% for cognitive restructuring (intervention 2)). On intervention days, participants complete a guided exercise for either music listening or CR after the evening assessment, followed by a questionnaire 20 minutes later. On control days, no exercise is performed, and participants are instructed to resume their current activity.

Data Analysis

To assess the first hypothesis, whether QoL improves from baseline to post measure, which covers the first RQ, a paired samples t-test will be conducted ($\alpha = .05$).

Investigating the second RQ, which factors influence the efficacy of an EMI for SSD,

for each hypothesis, associations between average symptom reduction (dependent variable) and depressiveness, coping style, and ER style will be assessed. All predictors are considered isolated. Therefore, linear regression analyses will be conducted ($\alpha = .05$). For all statistical analyses, IBM SPSS will be utilized.

Prior to the analysis, the data will be checked for outliers and the assumptions of a paired samples t-test (normality of differences) and linear regression analysis (linearity, normality, heteroscedasticity, no multicollinearity) will be tested for each hypothesis.

Materials

There are five variables for which operationalization is necessary; these are SSD, QoL, comorbidity, coping style, and ER. Treatment efficacy is defined in terms of heightened QoL regarding the first RQ. For the hypotheses examining the second RQ, treatment efficacy is defined as average symptom reduction from baseline to post measure. For all questionnaires described hereafter, the German versions were used.

SSD

Most importantly, one of the eligibility criteria for taking part in the current study is diagnosis with SSD. Its presence is assessed prior to the study through a structured interview (Mewes et al., 2021) which is conducted via telephone, the Somatic Symptom Disorder – B Criteria Scale (SSD-12; Toussaint et al., 2016), as well as the PHQ-15 (Kroenke et al., 2002) for somatic symptoms.

The structured interview used for this study was derived from an ecological momentary assessment study by Mewes et al. (2021) and enables diagnostic assessment of SSD. Altogether, this interview contains five questions which cover different aspects of SSD. For example, item 1 assesses whether there are any physical symptoms causing significant burden lasting at least six months, while the other items cover prior medical examination of the symptoms, whether there is a full medical explanation for the present symptoms, psychological criteria of SSD (cognitions, emotions, behaviors), and whether the somatoform symptomatology is predominant compared to other present comorbidities. If any one of these criteria is not met, diagnosis with SSD is excluded.

Additionally to the telephone interview, the SSD-12 is utilized for diagnostic assessment of SSD. The SSD-12 is a self-report questionnaire and composed of 12 items which assess presence and severity of the B-criterion for SSD, which comprises excessive behavioral, emotional or cognitive characteristics related to persistent somatic symptoms. Each item (e.g. item 1: „I think that my physical symptoms are signs of a serious illness.”/”Ich

denke, dass meine körperlichen Beschwerden Anzeichen einer ernsthaften Erkrankung sind“.) is answered on a 5-point Likert-scale ranging from 1 (“never”/”nie”) to 5 (“very often”/”sehr oft”). For interpretation, sum scores are used which range between 12 and 60. Scores of 23 or above indicate psychological burden due to somatic symptoms (Toussaint et al., 2016). The SSD-12 presents with excellent reliability ($\alpha = .92$; Toussaint et al., 2017).

For assessment of somatic symptoms, the PHQ-15 is utilized. It is generally suitable to be used in combination with the SSD-12 (Toussaint et al., 2016). This survey is composed of 15 items and explores type and perceived impairment through somatic symptoms (Kroenke et al., 2002). For each symptom (e.g. item 1: “stomach pain”/”Bauchschmerzen”), participants are asked how much they were bothered by it within the past four weeks. Here, the answering format depicts a 3-point Likert scale where participants can select either 0 (“not bothered at all”/”nicht beeinträchtigt”), 1 (“bothered a little”/”wenig beeinträchtigt”) or 2 (“bothered a lot”/”stark beeinträchtigt”), according to their perceived impairment caused by the symptoms. Reliability was acceptable ($\alpha = .60$; van Ravesteijn et al., 2009). For this study, the scores on the PHQ-15 at baseline and post-measure are compared and average reduction in PHQ-15 total scores are computed to examine treatment efficacy.

QoL

The independent variable QoL is assessed through the Short Form Health Survey (SF-12; Ware et al., 1996), which is a self-report questionnaire and assesses health-related QoL. It consists of 12 items assessing eight different domains of health, for example general health perception, vitality, and mental health. Response formats differ per item, so while for instance item 1 (“In general, would you say your health is:...”), is answered on a 5-point Likert-scale ranging from 1 (“poor”) to 5 (“excellent”), item 6 (“During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?: 6. Accomplished less than you would like.”) is answered on a binary response format with “yes” or “no”. Items 1, 8, 9 and 10 are recoded. Total scores on the SF-12 are computed by simply summing up all item scores and range between 12 and 47. Higher attained scores are interpreted as higher health-related QoL. The SF-12 presents with good reliability ($\alpha = .84$) and internal consistency (Silveira et al., 2013).

Comorbidity

Comorbidity is considered in terms of depression scores assessed prior to the pre-phase. This construct is measured on the Patient Health Questionnaire - 9 (PHQ-9; Kroenke et

al., 2001; Williams, 2014). Here, higher scores are interpreted as more severe depressiveness. As suggested by its name, the PHQ-9 consists of 9 items which are each answered on a 4-point Likert-scale ranging from 0 (“not at all”/”überhaupt nicht”) to 3 (“nearly every day”/”beinahe jeden Tag”). The instruction questions asks, “Over the last 2 weeks, how often have you been bothered by any of the following problems?” and each subsequent item proposes a symptom of depressiveness, e.g. “Little interest or pleasure in doing things” (item 1) or “Poor appetite or overeating” (item 5). Here, total scores are constituted through summing up all item scores and range between 0 and 27. While higher scores generally correspond to more severely pronounced depressiveness, there are also four additional categories for depression severity. Scoring in this manner, these categories are ranked by score, ranging from minimal (total score of 1-4) to severe depression (total score of 20-27). As found by Kroenke et al. (2001), the PHQ-9 presents with excellent reliability ($\alpha = .89$) and test-retest reliability.

Coping Strategies

To assess coping styles, the Brief-COPE (Carver, 1997) is utilized. The Brief-COPE is composed of 14 subscales, each capturing different coping strategies and measured by two items. Furthermore, each one of the coping strategies is categorized as either problem-focused (active coping, instrumental support, and planning), emotion-focused (acceptance, emotional social support, humor, positive reframing and religion) or dysfunctional (behavioral disengagement, denial, self-distraction, self-blaming, substance use and venting) as identified by Cooper et al. (2008). Thus, the total number of items counts 28 (e.g. item 1: “I’ve been turning to work or other activities to take my mind off things.”/ “Ich habe mich mit Arbeit oder anderen Sachen beschäftigt, um auf andere Gedanken zu kommen.”), each answered on a Likert-scale ranging from 1 (“not at all”/”überhaupt nicht”) to 4 (“doing a lot”/ “sehr”). The questionnaire is evaluated based on the sum scores of each subscale. The total sum score cannot be interpreted as higher scores on a subscale indicate a more frequent resorting to these strategies. Carver (1997) reports that reliability of the subscales ranges between acceptable (venting; $\alpha = .50$) and good (religion; $\alpha = .82$).

ER

Lastly, ER is assessed utilizing the 10-item self-report Emotion Regulation Questionnaire (ERQ; Gross & John, 2003). This inventory measures how individuals tend to regulate their emotions. The ERQ also consists of two subscales, which each measure one ER strategy. One is measuring cognitive reappraisal, the other assessing expressive suppression.

Each of the ten items (e.g., item 2: “I keep my emotions to myself”/“Ich behalte meine Gefühle für mich”) is answered on a 7-point Likert scale ranging from 1 (“strongly disagree”) to 7 (“strongly agree”). Total scores are computed by summing up scores on each subscale separately and subsequently taking the mean. Thus, total scores reach from 1 to 7, where higher scores indicate greater use of this particular ER strategy, while lower scores represent a less frequent use. Both subscales display acceptable to excellent internal consistency reliability. The subscale for cognitive reappraisal ($\alpha = .89 - .90$) presents with excellent reliability, while the subscale for expressive suppression ($\alpha = .76 - .80$) displays acceptable reliability (Preece et al., 2019). Psychometric properties of this questionnaire have been examined in different settings and the ERQ has been found to be appropriate for cross-cultural usage within a wide population (Enebrink et al., 2013; Kim et al., 2022; Preece et al., 2019). The ERQ is suited for all age groups and thus appropriate to use among the selected sample.

Remark. Due to time constraints and delays in the process of the original study, data from the original study will no longer be used. Instead, data from the study “Assessing the efficacy of a digital stress management application in everyday life: A randomized controlled trial“ by Dreisoerner et al. (2024) will be used for analyses. This study will hereafter be referred to as EPIGRAM 2. Visualization of differences and similarities in the study designs of both studies can be found in appendix C (figures C1 and C2).

The EPIGRAM 2 study focuses on individuals experiencing chronic stress and physical complaints and the management of these symptoms via an ecological momentary assessment (EMA) and a digitally delivered health prevention program (EPIGRAM) which uses an EMI approach.

The EPIGRAM 2 study spans seven weeks in total: seven days of baseline phase, five weeks intervention phase, and seven days of post phase. Baseline and post phase are identical, with three fixed assessment points and one self-initiated evening assessment per day. During the intervention phase, there is only the evening assessment. Additionally, during all phases, participants are instructed to log data-entries whenever they experience acute stress. During the intervention, participants in the intervention group are presented with different evidence-based stress-management techniques such as mindfulness-based tasks, breathing exercises, music-listening, and problem-solving tasks. Whenever they log acute stress within the app, they can freely choose among these tasks as a just-in-time intervention. Additionally, they are

asked to reflect on their day in a daily diary along with the evening assessment. In the EPIGRAM 2 study, there is a differentiation between the control and intervention group, where the control group does not use EPIGRAM during the intervention phase. Instead, participants assigned to the control group are instructed to continue their current task whenever they self-initiate a data entry.

Similar to the original study, participants answer several questionnaires before the baseline and after the post phase in Unipark software. Similarly, these surveys include the PHQ-9. Items from the situational version of the Brief-COPE (Monzani et al., 2015) are assessed not at pre- and post-measurement but daily during the baseline, intervention, and post-phase. The ERQ is not included here.

Participation requirements related to age were the same as in the original study; thus, participants had to be aged between 18 and 65. Moreover, to participate in the EPIGRAM 2 study, individuals had to present with a minimum score of 12.79 on the Perceived Stress Scale (PSS-10), constituting an above average stress level (Klein et al., 2016), and a score above 5 on the PHQ-15, which is the cut-off for mild bodily symptoms as identified by Kroenke et al. (2010). Exclusion criteria for participation in the study were auditory impairment, alcohol abuse, current pregnancy or breastfeeding, and current or past presence of one of the following mental disorders: eating disorder, substance-induced disorder, bipolar disorder, schizophrenia, borderline personality disorder. Additionally, individuals who indicated illegal drug intake within the last year, cannabis intake within the last 14 days, or intake of psychiatric drugs within the last 14 days were also excluded from participation in the study.

Fundamentally, both studies investigate akin issues and are similarly constructed. However, to account for the methodological differences, some constructs are measured differently now. As in the EPIGRAM 2 study, QoL is not assessed, the Multidimensional Fatigue Inventory (MFI; Schwarz et al., 2003) is used instead. Fatigue is understood as the subjective perception of weariness, exhaustion, tiredness, or reduced levels of energy (Riley et al., 2010). Fatigue poses a common and burdensome symptom in SSD (Doerr et al., 2021; Herman, 2013) and is inherently related to both QoL and mental health adversities (Bazazan et al., 2019). Furthermore, fatigue was further often suggested to drastically impact QoL across both physical and mental health conditions (Fortier-Brochu et al., 2010; Yeni et al., 2025). Hence, while fatigue and QoL are inherently different constructs, they are closely associated in the way that increased levels of fatigue are consistently linked to diminished QoL across various populations and clinical conditions. Through experiencing increased levels of fatigue, individuals are restricted in important areas of functioning predisposing

them for avoidance behavior, a negative attribution style, decreased psychological well-being, reduced social functioning, and low levels of self-efficacy (Vercoulen et al., 1994). More recent research replicated these findings, suggesting fatigue to have further widespread negative effects. For example, fatigue has been repeatedly linked to decreased physical activity and exercise, which again displayed a negative impact on cognitive functioning, including memory (Abd-Elfattah et al., 2015). Furthermore, a systematic review and meta-analysis by Knoop et al. (2021) investigated fatigue as a predictor for negative health outcomes. This study found that there are various outcomes which are negatively impacted by fatigue and these effects were found in physical, mental, and other key areas. Specifically, fatigue was suggested to be related to decreased global physical functioning, more loneliness, higher risk for the development of depression, and poorer sleep quality. All of these dimensions are related to QoL and each negatively impact this construct.

Consequently, this study will alternatively assess whether fatigue, measured with the MFI (Schwarz et al., 2003), can be improved, examined through comparing pre- and post-intervention measurements; thus, measures from before the baseline and after the post phase. The MFI depicts a 20-item inventory assessing five dimensions of fatigue: general fatigue, physical fatigue, reduced motivation, reduced activity, and mental fatigue. Each item (e.g. items 1: “I feel fit”/“Ich fühle mich leistungsfähig”) is scored on a 5-point Likert scale ranging from 1 (“yes, that is true”/“Ja, das trifft zu”) to 5 (“no, that is not true”/“Nein, das trifft nicht zu”). Items 2, 5, 9, 10, 13, 14, 16, 17, 18, and 19 are reversely coded. Total scores are then composed by adding up each item score and range between 20 and 100. Higher scores indicate more acute levels of fatigue.

In order to measure coping, five items from the situational version of the Brief-COPE are used. These items can also each be categorized to belong into the original subscales from the Brief-COPE by Carver (1997). Alternatively, coping is not considered prior to the baseline phase, but in terms of average use during the total study phase. During all three study phases, coping was assessed during the evening query. As ER does not appear in the EPIGRAM 2 study, the according hypotheses will not be further investigated. The newly formulated hypotheses regarding QoL and coping are:

H1a: Fatigue decreases from baseline to post measure in participants after the intervention.

H1c: Higher average problem-focused coping is associated with higher symptom reduction in response to the intervention.

H1d: Higher average emotion-focused coping is associated with higher symptom

reduction in response to the intervention.

H1e: Higher average dysfunctional coping is associated with lower symptom reduction in response to the intervention.

Results

Descriptives

Cases were excluded from data analysis if participants did not provide any data entries, completed less than 50% of the scheduled EMA assessments (with an intended average completion rate of 75%), or failed to provide data necessary for testing specific hypotheses. This means that for the purpose of this study, only data from participants in the intervention group was included in the statistical analyses. Additionally, data entries which have been unintentionally triggered were also removed from the data set prior to analyses.

Only cases which presented data points at pre and post measurement were included in the analysis. For hypotheses utilizing measures from pre and post assessments, 43 subjects ($N_1 = 43$) from the intervention group were included. All following demographics only relate to this sample. For the analyses related to coping styles, only data from participants who presented with complete data for intervention phase and post measure were included. Cases with missing data for coping were excluded from analyses. Here, data from 21 subjects ($N_2 = 21$) was used for analyses of coping-related hypotheses.

Sample

The selected sample was drawn from a population with heightened physical symptoms and increased stress levels. It consisted of 43 participants and included 7 men (16.3%) and 36 women (83.7%). These participants were aged between 19 and 55 ($M = 25.37$, $SD = 8.52$).

Scores on the SSD-12, which assesses the B-criterion for SSD and thus the psychological burden caused by physical symptoms, ranged between 13 and 41 ($M = 26.10$, $SD = 8.23$). With 23 being the cut-off for significant psychological distress related to somatic symptoms, the mean score laid above that in this sample.

Scores on the PHQ-15 which measures somatic symptoms ranged between 4 and 20 ($M = 11.30$, $SD = 3.86$) at baseline. At post-measure, scores on the PHQ-15 ranged between 2 and 19 ($M = 9.81$, $SD = 4.35$). A variable to measure symptom reduction, comparing baseline and post measure, was calculated by subtracting the total score on the PHQ-15 at post measure from the total score of the PHQ-15 at baseline measure. The variable was recoded so that higher scores would indicate higher symptom reduction. Thus, scores lower than 0

indicate a symptom augmentation, with lower scores indicating higher symptom increase. Scores above 0 imply symptom reduction, with higher scores suggesting higher reduction. A score of 0 indicates no change in symptom severity. Scores on this variable ranged between -7 and 10 ($M = 1.50$, $SD = 4.03$).

In this sample, baseline scores on the MFI ranged between 32 and 90 ($M = 56.40$, $SD = 15.00$). After the intervention, total scores ranged between 31 and 79 ($M = 55.09$, $SD = 14.60$).

Baseline scores on the PHQ-9 which assesses depressiveness ranged between 3 and 22 ($M = 9.74$, $SD = 4.50$).

Scores on the situational version of the Brief-COPE, which assesses an individual's application of coping strategies, had to be interpreted with respect to the subscales the items were assigned to. For problem- and emotion-focused coping, the possible average values participants may achieve ranged between 1 and 10. In this sample, the scores on the subscale for problem-focused coping ranged between 3.32 and 8.28 ($M = 5.52$, $SD = 1.56$) at average, while mean scores on the emotion-focused coping subscale ranged between 2.16 and 8.43 ($M = 4.38$, $SD = 1.82$). Achievable mean scores on the dysfunctional coping subscale ranged between 1 and 5. Here, values on the subscale for dysfunctional coping spanned between 2.27 and 4.6 ($M = 3.11$, $SD = .57$).

Inferential Statistics

Hypothesis A: Fatigue

Scaling of the variables was appropriate as both were scored on a Likert-scale. Another assumption of the paired-samples t-test is that the differences between the pre- and post-scores are normally distributed. The Shapiro-Wilk test was significant ($p = .012$, see appendix A, table A1). However, visual inspection of the Q-Q plot of the differences showed an approximately straight line, suggesting that the differences were approximately normally distributed (see appendix A, figure A1).

To assess the hypothesis of whether an EMI for SSD can reduce fatigue, a paired samples t-test was conducted in SPSS, comparing fatigue scores before and after the intervention. There was no significant difference in scores between pre-intervention ($M = 56.40$, $SD = 14.96$) and post-intervention ($M = 55.09$, $SD = 14.60$); $t(42) = 0.67$, $p = .254$.

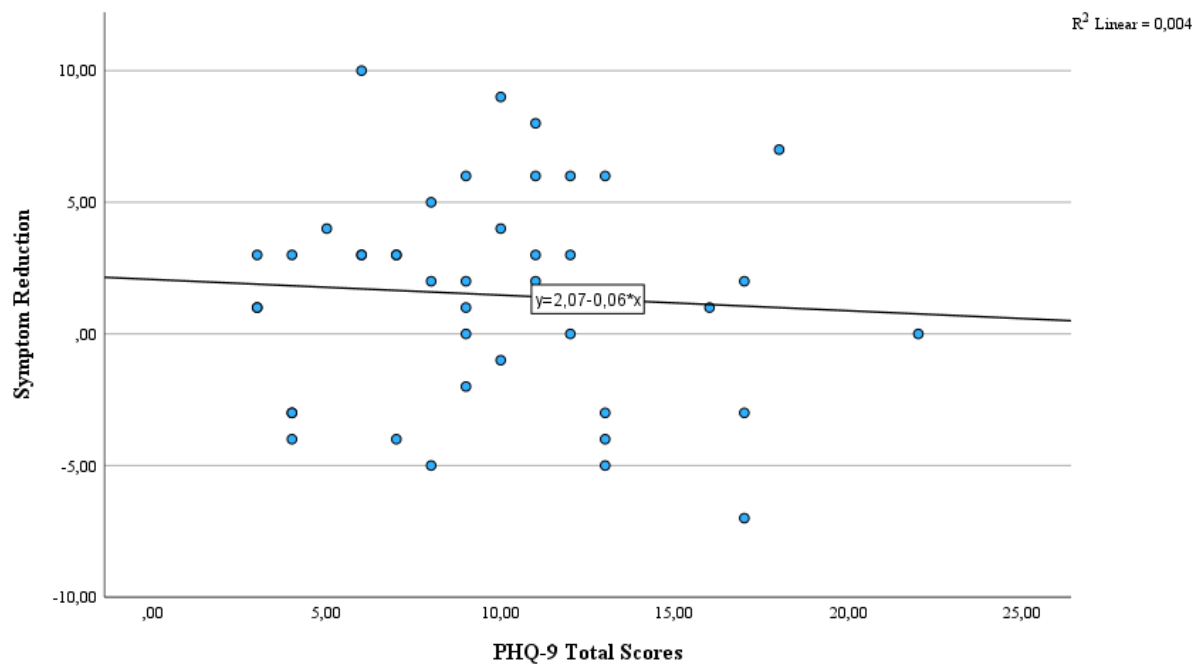
Hypothesis B: Comorbidity

First, assumptions of linear regression were tested for this hypothesis. The assumption of linearity was met and tested through visual inspection of a scatterplot. Likewise, the assumptions of homoscedasticity and normality were assessed through visual inspection of residual plots. The residual plot for testing homoscedasticity displayed a random distribution of residuals, thus the assumption was not violated. The assumption of normality was met as the PP-plot of residuals showed a normal distribution (see appendix A, figure A2).

To test the hypothesis of whether higher baseline depression scores are associated with lower symptom reduction in response to the intervention, a linear regression analysis was conducted in SPSS. The variance in symptom reduction which was explained by baseline depression score was insignificant ($F(1, 41) = .182, p = .672$). The R^2 was .004 indicating that baseline total scores on the PHQ-9 explained approximately 0.4% of the variance in symptom reduction assessed through the PHQ-15. Here, these results suggest that individuals with high and low baseline scores of depressiveness experienced approximately equal symptom reduction after the intervention. The relationship between these two variables is visualized in Figure 1.

Figure 1

Relationship Between Baseline Depressive Symptoms and Physical Symptom Reduction



Note. Depressiveness was measured with the PHQ-9.

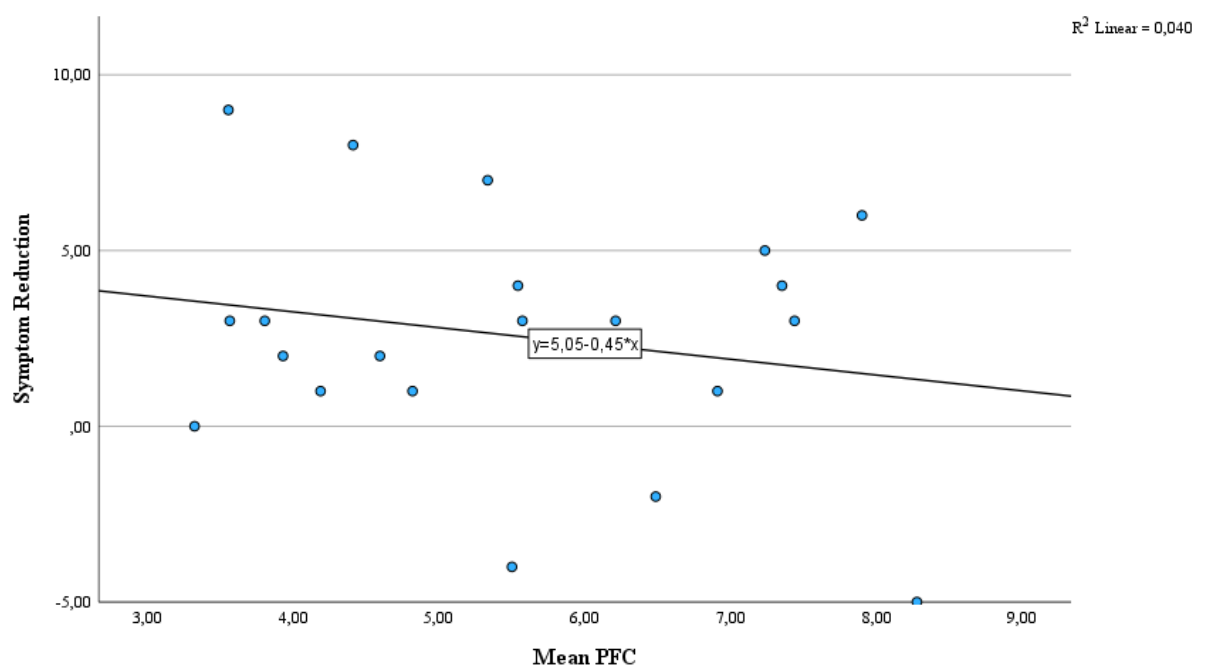
Hypothesis C: Problem-focused Coping

First, the assumption of linearity was tested through visual inspection of a scatterplot. The assumption was met as problem-focused coping and symptom reduction appeared to have a linear relationship. Second, the assumptions of normality was tested through visual inspection of the histogram displaying distribution of residuals (see appendix A, figure A3). Homoscedasticity was assessed through visual inspection of the residual plot (see appendix A, figure A4). There was no indication of violation for either of these assumptions.

To test the hypothesis of whether higher average problem-focused coping is associated with higher symptom reduction, a linear regression analysis was executed. The variance in symptom reduction which was explained by average use of problem-focused coping was not significant ($F(1, 19) = .785, p = .387$). The R^2 was .040 indicating that problem-focused coping explained only about 4% of the variance in symptom reduction after the intervention. These results suggest that participants with high and low scores on the problem-focused subscale did not differ in their degree of symptom reduction. The relationship between problem-focused coping and symptom reduction is visualized in figure 2.

Figure 2

Relationship Between Average Problem-focused Coping and Physical Symptom Reduction



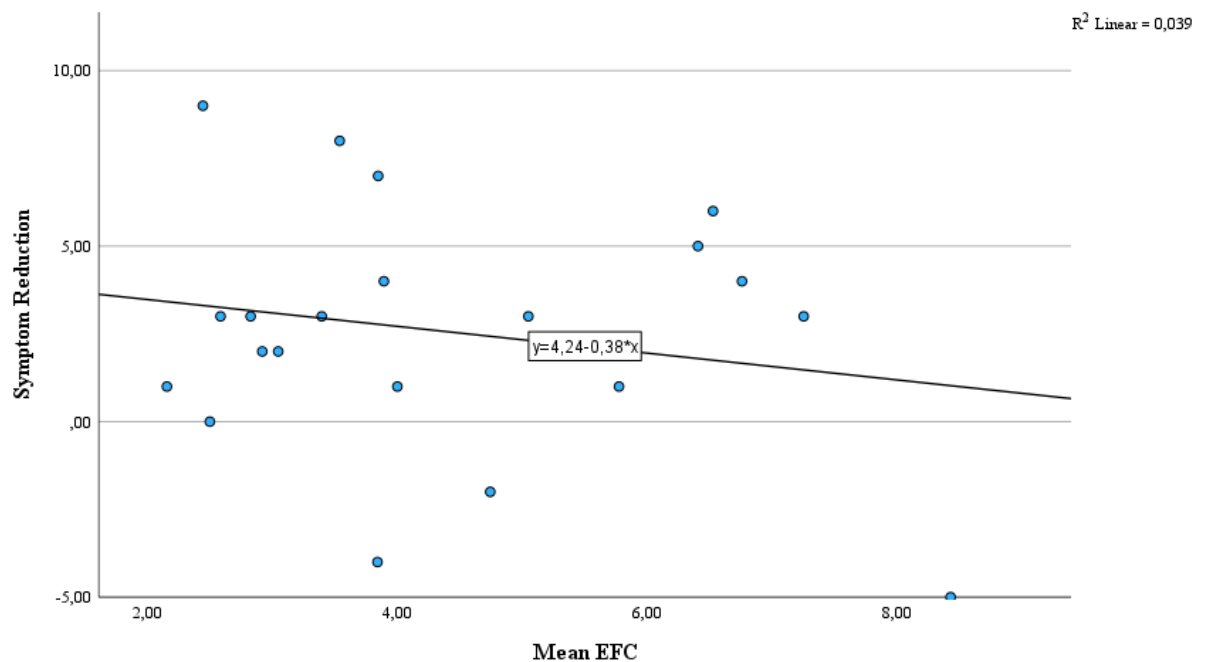
Hypothesis D: Emotion-focused Coping

The assumptions of linearity, normality, and homoscedasticity were all tested through visual inspection of according graphs. The scatterplot for the relationship between average score on emotion-focused coping and symptom reduction indicated a linear relationship. A histogram for testing normality displayed a normal distribution of residuals (see appendix A, figure A5). Scatterplot for residuals indicated no heteroscedasticity (see appendix A, figure A6).

To test the hypothesis of whether higher average emotion-focused coping is associated with higher symptom reduction, a linear regression analysis was conducted. The variance in symptom reduction which was explained by emotion-focused coping was not significant ($F(1, 19) = .762, p = .394$). The R^2 for this model was .039 indicating that variation in problem-focused coping only accounted for 3.9% of variance in symptom reduction after the intervention, posing insignificance. These results indicate that participants with higher and lower use of emotion-focused subscale did not differ in their degree of symptom reduction. These results are visualized in figure 3.

Figure 3

Relationship Between Average Emotion-focused Coping and Physical Symptom Reduction



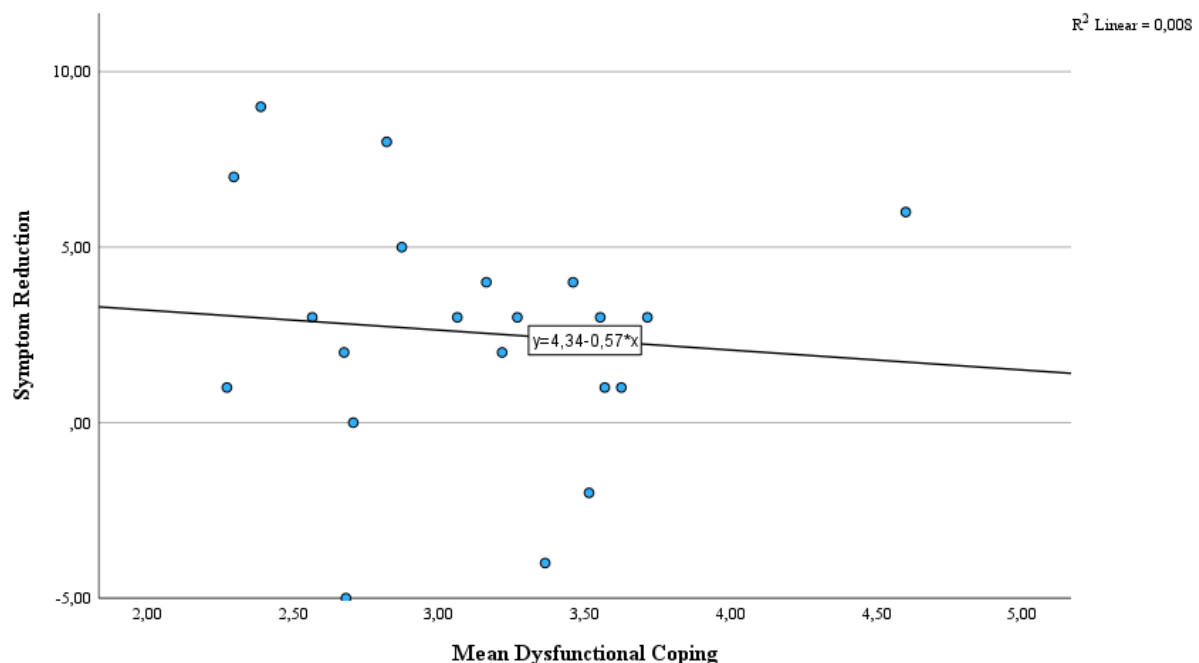
Hypothesis E: Dysfunctional Coping

The assumption of linearity was met and tested through visual inspection of the scatterplot for the relationship between average dysfunctional coping scores and symptom reduction. Normality was given as the histogram of residuals displayed a normal distribution (see appendix A, figure A7). Furthermore, the assumption of homoscedasticity was met as the residual scatterplot showed random distribution of residuals (see appendix A, figure A8).

The association between average application of dysfunctional coping and symptom reduction was not significant ($F(1, 19) = .161, p = .692$). An R^2 of .008 indicated that the average use of dysfunctional coping did not significantly predict symptom reduction in response to the intervention. This means that participants with higher and lower use of dysfunctional coping did not differ regarding their symptom reduction. The relationship between these two variables is visualized in figure 4.

Figure 4

Relationship Between Average Dysfunctional Coping and Physical Symptom Reduction



Discussion

The current study posed two main focuses. The first research question asked whether an EMI using music listening and CR can improve QoL in individuals with SSD. This research question aimed at investigating the real-life impact of this form of intervention. More specifically, as QoL is often suggested as the main target in SSD-specific treatment, this study aimed at investigating whether this construct can successfully be targeted and improved.

The second RQ asked which factors influence the efficacy of an EMI using music listening and CR for patients with SSD. As it is still widely unknown which aspects impact the treatment efficacy, the second RQ focused on two agents which are highly relevant in SSD; these are comorbid depressiveness and coping style.

QoL as an Outcome for SSD-specific Treatment

As outlined before, the first hypothesis had to be adjusted in order to fit the data of the alternatively used study. This means that instead of a direct assessment of QoL, a measure for fatigue was used.

In this study, no effects of the intervention on fatigue were found. In other words, fatigue was not significantly reduced after the intervention. This can be due to different aspects. First, fatigue was not directly targeted in this study, as the main focus of this research laid on reducing daily stress levels. As suffering from fatigue and experiencing stress are substantially different from one another, an intervention primarily targeting stress may not effectively reduce fatigue levels. Interventions targeting stress levels predominantly utilize relaxation and mindfulness techniques (Rogerson et al., 2024), aiming for example at reducing cortisol levels. Contrarily, interventions targeting fatigue were shown to be most effective when implementing physical exercise tasks (Lopes-Júnior et al., 2015). Considering this, the nature of interventions for stress and fatigue essentially differ from one another. Furthermore, prior research suggested that interventions specific for fatigue are more effective in reducing such when compared to non-specific interventions (Goedendorp et al., 2009). Fundamentally, these findings suggest that interventions incorporating components such as fatigue-specific psychoeducation and activity management may be particularly effective and should be prioritized when aiming to reduce fatigue (Goedendorp et al., 2009). Consequently, interventions such as the present one – primarily designed to reduce stress – may not demonstrate improvements in fatigue, potentially explaining the lack of observed change in fatigue in this study.

Individual Factors as Predictors for Treatment Efficacy

The second RQ focused on gaining a better understanding of the influence of individual factors (comorbidity, coping style, ER) on treatment efficacy. Here, the overarching goal was to provide valuable insights for eventually optimizing therapeutic interventions tailored to individuals with SSD. Treatment efficacy was understood in terms of reduction in physical symptoms. While ER eventually was not assessed, effects of comorbid

depressiveness and coping style were more closely investigated and interindividual differences in subsequent treatment outcome were examined.

Depressiveness as a Predictor for Treatment Efficacy

The results of the study revealed that depressiveness before the beginning of the study phase did not predict the treatment outcome in terms of physical symptom reduction. Specifically, this means that individuals with higher depressiveness prior to the study did not differ in the reduction of their somatic symptoms compared to individuals with lower initial depressiveness. Interestingly, this indicates that more severely depressed individuals tended to equally benefit from an intervention for stress reduction and were comparably able to experience a reduction in physical symptoms. This outcome is especially remarkable given that even severe comorbidity did not significantly interfere with the treatment efficacy. Thus, not specifically addressing this comorbidity did not negatively impact the success of this intervention.

One explanation for these findings is that depression-related factors which were initially thought to negatively impact the treatment efficacy were attenuated. For instance, reduced drive poses one of the core symptoms of depressive disorders (Bridley & Duffin, 2022), oftentimes leading to lower levels of study engagement. Previous research repeatedly suggested an association between lower treatment engagement and less beneficial treatment outcomes, especially in digitally delivered formats (Forbes et al., 2023; Gan et al., 2021). Thus, higher depression rates were initially thought to possibly impact treatment efficacy through lower engagement levels caused by reduced drive. However, an explanation for the finding that more severe baseline depression scores did not predict symptom reduction may be that the format of the intervention was low-threshold and did not depend on high levels of self-initiative or active engagement. Specifically, the intervention presented with high structure and frequent reminders encouraging individuals to consistently participate in the program. A less structured format might have negatively impacted study engagement for those with lower drive as higher levels of self-initiative would have been necessary. Thus, it is plausible that the intervention's supportive structure played a key role in minimizing the impact of initial depressiveness on study engagement, which in turn may explain why depressive symptom severity did not predict treatment efficacy.

In its content and exercise focus, the present study primarily concentrated on treating individuals with increased levels of stress and physical complaints, without specifically considering potential comorbid diagnoses such as depression. This is despite previous research repeatedly stressed the common co-occurrence of stress, physical complaints, and

depression (Chew et al., 2020; Haftgoli et al., 2010; Yang et al. 2015). However, the present findings suggest that symptom-specific interventions may not be disadvantageous and yield similar outcomes even if comorbidities are not distinctly considered.

A transdiagnostic perspective has been widely recommended in the literature, suggesting that comorbid disorders should not be regarded as separate units but may be rather interpreted as a product of similar underlying mechanisms and factors (Dalglish et al., 2020). In line with the findings of this study, prior literature found that with treating the disorder which is more clinically significant, symptomatology of the comorbid disorder is supposed to simultaneously improve as well (Spijker et al., 2020).

Previous research on transdiagnostic approaches and interventions has predominantly focused on depressive and anxiety disorders (Fusar-Poli et al., 2019). Findings on anxiety-related interventions may be partially applicable to stress-related interventions, like the intervention of this study, as anxiety- and stress-related symptoms share various overlapping characteristics, such as bodily symptoms (Konstantopoulou et al., 2020) and frequent worrying (van den Bergh et al., 2020).

In addition, several studies have repeatedly found that comorbid depression did not negatively impact treatment efficacy for anxiety disorders (Davis et al., 2010; Ollendick et al., 2008) and even revealed that treatment for anxiety disorders was equally efficacious in treating depressive disorders (Cuijpers et al., 2016). Cuijpers et al. (2016) argued that this might be due to indirect effects where a reduction in symptoms related to anxiety disorders leads to decreased depressive symptoms. More importantly, the authors explained their findings through direct effects, where symptoms of anxiety disorders are overlapping with those of depressive disorders and by treating these overlapping symptoms, depressive symptoms were similarly reduced. In the present study, this relates to stress and physical complaints representing the primary sources of impairment and suffering and by treating these, there may be simultaneous positive effects on depressiveness.

Prior research identified shared symptomatic characteristics among depression, stress, and physical symptoms. Thus, in an intervention specifically developed for stress and physical complaints, such as the EMA employed in this study, core symptoms of depression are concurrently targeted. For instance, physical complaints and depression are inherently related, with physical symptoms posing one distinct symptom cluster in depressive disorders (Bridley & Duffin, 2022). Physical complaints typical for depressive disorders include, amongst others, pain symptoms (Garcia-Cebrian et al., 2006), sleep disturbances (Bridley & Duffin, 2022), and gastrointestinal problems (Trivedi, 2004). These symptoms can equally be

found in chronically stressed individuals (Abdallah & Geha, 2017; Nixon et al., 2011). Taking these similarities into account, the findings of the current study can be explained by considering that specifically targeting stress and physical complaints through an intervention may similarly address depressive symptoms, thereby attenuating potential negative impacts of baseline depressiveness.

Coping as a Predictor for Treatment Efficacy

The results of the study did not find an association between coping style and treatment efficacy in terms of physical symptom reduction. Specifically, this implies that in this sample, the coping style an individual habitually resorted to did not affect treatment efficacy as individuals with high functional coping did not differ in their symptom reduction compared to those with low functional coping. This was also the case for the investigation of individuals who regularly applied dysfunctional coping and those who indicated infrequent use of this strategy.

Coping was assessed on a daily basis, using items from the situational version of the Brief-COPE (Monzani et al., 2015). As the name suggests, this inventory focuses on situational coping, measuring coping reactions to specific situations and events. Participants were required to answer these items daily during the study phase, assessing how they handled taxing events on each day. For the purpose of the present study, this may have posed a methodological construct problem as this study originally intended to consider coping as a long-learned and rather fixed trait, assessed prior to the intervention. In this way, effects of differences in initial coping style on treatment outcome would have been examined. In the literature, coping style is often described as a rather stable trait (Kirchner et al., 2010) even though there is a general tendency for an increase in adaptive and problem-solving coping strategies with aging (Eschenbeck et al., 2018; Wingo et al., 2015). One possible explanation for the finding that differences in daily coping strategies did not influence treatment outcome in this sample may relate to the specific nature of the intervention itself. The essence of the intervention was to help participants apply adaptive coping strategies when confronted with a stressful event or when generally experiencing subjective stress. Hence, underlying differences in coping preferences might have been erased by instructed coping exercises during self-initiated and planned events. If participants were following the instructions, they would be guided to apply an adaptive coping strategy such as breath-work techniques, problem-solving training, or seeking social support whenever they experienced stress. As a result, participants would not execute their habitual coping style but resort to more functional strategies as proposed by the intervention program. This is especially relevant for

investigating dysfunctional coping. Hence, individual differences in coping strategy preference would not have been captured and thus did not influence the efficacy of the intervention.

A rather methodological approach to explaining these findings concerns the item use and construction. In assessing coping style, only five items were used in total. Two items each were used per functional coping style, measuring problem-focused and emotion-focused coping, and one item assessed dysfunctional coping. Measuring these constructs with such a limited number of items may give rise to several methodological concerns. First, using merely one or two items may limit the construct validity of these measurements as it oversimplifies the nature of these constructs. Hence, usage of one or two items for each coping style might not be sufficient to capture their complexity (Gregory, 2014). Furthermore, single-item measures tend to display lower reliability and it is not possible to measure internal consistency (Fisher et al., 2016). As a result, these items are less likely to yield stable response behavior across repeated measures, thereby limiting accurate presentation of the underlying construct. Lastly, these measures are susceptible to bias. For instance, wording can disproportionately impact response behavior when the item is formulated in an ambiguous or otherwise misleading way. In this case, the item assessing dysfunctional coping was translated to, “Heute habe ich meinen Gefühlen freien Lauf gelassen.“ In the original English version of the questionnaire, the phrasing was, “I’ve been saying things to let my unpleasant feelings escape”, which technically corresponds to rather maladaptive venting. In the German wording, however, this may possibly have been misunderstood as simply expressing emotions, for instance in contrast to suppressing them, which then again would be considered more adaptive.

Furthermore, dysfunctional coping encompasses further dimensions beside the assessed venting. These include, amongst others, substance-use and self-blaming, which are highly relevant in SSD (Hassan & Ali, 2011; Hyphantis et al., 2013). Not considering these facets of dysfunctional coping may distort the measurement of this construct, hence impeding making an accurate statement about whether increased dysfunctional coping leads to less symptom reduction in SSD. As a result, it was solely measured whether the tendency to cope through venting affects treatment efficacy, not the general resorting to dysfunctional coping mechanisms. Ignoring the problematic phrasing of this item and assuming that it accurately measures this construct, one can still merely draw the conclusion that applying venting to deal with stress does not impact the efficacy of this intervention.

This issue also applies for the assessment of problem- and emotion-focused coping, as

only two facets of each style were considered. For problem-focused coping, these facets included seeking instrumental support and active coping, while ignoring planning as a form of problem-focused coping. Applying planning as a coping strategy involves developing behavioral or cognitive steps when faced with a stressor and finding a strategy in anticipation of upcoming stressful events or experiences (Carver, 1997). Regularly applying planning as a coping strategy is related to higher self-efficacy across various contexts (Arbour-Nicitopoulos et al., 2009; Freire et al., 2020). Self-efficacy is understood as an individual's subjective perception of their capability to successfully control their own activities or to accomplish their goals (American Psychological Association, 2023e). In SSD, this concept is especially relevant as this disorder is suggested to be associated with low levels of perceived self-efficacy (Petersen et al., 2023). As identified by Schnabel et al. (2022b), individuals with SSD and related disorders regularly display low self-efficacy in regard to dealing with stressors as well as low confidence in their ability to effectively regulate their emotions. As explained above, self-efficacy is closely linked to the regular application of self-directed planning as a coping mechanism. If application of this strategy does not occur regularly, it is possible that this might have a negative impact on symptomatology and clinical presentation. Contrarily, if individuals are familiar with habitually engaging in planning to handle taxing events, this might positively affect their clinical presentation and even treatment response. Assessing planning as a coping strategy might have given valuable insights into whether habitual use of this approach positively impacts the individual treatment outcome.

For emotion-focused coping, the present items cover seeking emotional support and turning to religion. However, other important emotion-focused coping strategies, including acceptance, humor, and positive reframing, were not assessed. For the coping strategy of accepting, which involves tolerating unpleasant experiences to have happened and learning to live with them (Carver, 1997), it is especially important to investigate its association with treatment response and trajectory. Lacking acceptance for the non-physical origin of somatic symptoms presents one of the main issues of those affected by SSD, which consequently leads to numerous visits of medical professionals (Löwe et al., 2021). Seeking a clear medical explanation for burdensome somatic symptoms and physical care and symptom-related rumination pose some of the key characteristics of this disorder (Schnabel et al., 2022b), contrasting the habitual application of acceptance strategies. Acceptance and commitment therapy (ACT) was found to be an effective form of treatment for SSD, improving global functioning, acceptance, and well-being, while reducing somatic symptoms, depression, and anxiety levels (Khanam et al., 2019). Furthermore, research has found an association between

implementing acceptance and lower annoyance with unexplained somatic symptoms (Kleinstäuber et al., 2018). It can be concluded that the ability to regularly apply acceptance as a coping strategy may be relevant for disorder trajectory and treatment response. In terms of the present study, as acceptance was not assessed, there is no insight into whether daily resorting to this strategy would have affected the treatment outcome, possibly increasing the degree of symptom reduction.

Limitations

The current study presents with multiple limitations, affecting both interpretability as well as validity. First and foremost, both considered samples ($N_1 = 43$; $N_2 = 21$) presented with relatively small sample sizes, especially in relation to the originally planned sample size of 120 (Dreisoerner et al., 2021). Analyzing data from such small samples yields significant power loss (Jhangiani et al., 2019). Consequently, this poses several issues for interpretation of this study's results. Specifically, low power indicates that the probability of not detecting true significant effects, thus the likelihood of committing type II errors, is high (Jhangiani et al., 2019). This means that even if there were true effects in the proposed models, the chance of not detecting them in the investigated sample was high. Most importantly, with small sample sizes, findings can hardly be generalized and interpretation of the results cannot be applied to the general population. In this case, it is inappropriate to make general statements about the examined associations in the general population (Jhangiani et al., 2019). Thus, it is still possible that depressiveness and coping style preference have significant impacts on treatment efficacy in the general population even though these effects were not observable in the chosen sample.

Furthermore, the original research questions and hypotheses did not entirely align with the data that was eventually used for analyses. First, where the original focus of the study intended to investigate factors which impact treatment efficacy specifically for individuals with SSD, the current sample did not consist of individuals diagnosed with this disorder. Additionally, variables that were initially chosen for investigation, QoL and ER, specifically, were not investigated, while coping was assessed in an entirely different way, averaging the daily use of a much restricted range of specific coping strategies. These adjustments in methodological aspects yielded a significant loss of information, where the original research questions remain to be answered properly.

Lastly, the present study chose a rather narrow operationalization of treatment efficacy, where for the second block of hypotheses (depression, coping), reduction in physical

symptoms was utilized as a measure of treatment efficacy. This might have given rise to an incomplete insight into the true impact of the intervention.

Practical Implications

Despite the null findings of this study, there are several practical implications arising from these results. First, the absence of an effect of the EMA intervention on fatigue suggests that there is a necessity for more tailored and specific interventions. As explained above, fatigue-specific interventions should be prioritized if the primary aim is to improve levels of fatigue (Goedendorp et al., 2009).

The findings that neither depression nor coping style preference interfered with treatment efficacy imply that in mild to moderate symptomatology where individuals may still be targeted through low-intensity, online delivered treatment, as in the present sample, these interventions do not necessarily require an individualized adaptation. The findings suggest that the intervention may show efficacy across different psychological baseline characteristics. Hence, individuals with for instance different severity of depression besides experiencing chronic stress and somatic symptoms may be equally addressed through interventions such as the present EMA. This indicates a high degree of practical applicability, particularly in primary care settings or in low-threshold contexts where comprehensive diagnostic procedures are usually not performed. Subsequently, this allows for a reduction in utilization of financial and timely resources as these interventions can be developed in a more universal way, addressing a wide range of individuals with different extent and presentation of symptomatology.

Future Research

The current study provides several indications for objectives of future research. Most importantly, as explained in the limitations, a larger sample size is needed to investigate the research questions posed in this study. Additionally, the sample may be drawn from a population diagnosed with SSD to allow for investigation of this group specifically.

Future research may also aim at further investigation of whether QoL can be improved through interventions, specifically for individuals with SSD where diminished QoL poses the primary target of treatment (Kleinstäuber et al., 2017). As in this study, QoL was examined indirectly through a measure for fatigue, it is suggested that future research should utilize a measure for QoL which is more holistic, such as the WHOQOL (World Health Organization, 1998). The WHOQOL measures QoL not in a solely health-related way but considers various domains impacting overall, subjective QoL. These facets include physical and psychological

QoL, as well as the quality of an individual's environment and quality of and satisfaction with social relationships. As SSD may negatively impact any of these domains (Selker et al., 2024; Vos, et al., 2023) and QoL posing the most important objective in the treatment of SSD (Kleinstäuber et al., 2017), future research should be concerned with examining whether interventions developed specifically for SSD can increase global QoL instead of measures which are solely related to it such as fatigue. At this point in time, SSD-specific interventions which directly target QoL are extremely scarce. Key aspects in the development of these kinds of treatments may involve maintaining social connections, improvement of fulfilling occupational obligations, pursuing hobbies, and a more positive and secure self-concept (World Health Organization, 1998); in contrast to current interventions which oftentimes prioritize a reduction in physical symptoms as their primary objective (Liu et al., 2019). This would pose a more hands-on and less theoretical therapy concept, where for example social skills are strengthened. For individuals affected by SSD, physical symptoms might subjectively appear to be most burdensome and may be interpreted as the origin of their suffering (Henningsen, 2018). However, a multicausal understanding of this disorder is required for affected individuals in order to understand that there are various aspects that can and should be targeted beside reduction of physical symptoms (Kleinstäuber et al., 2017).

Besides measures for the efficacy in improving QoL, future research may also be concerned with alternative operationalizations of treatment efficacy. In the present study, treatment efficacy was understood in terms of reduction of physical symptoms. As stated above, this poses a focus on the A-criterion of SSD (American Psychiatric Association, 2013). Alternatively, prospective research may investigate treatment efficacy in terms of aspects related to the B-criterion which involves the psychological, cognitive, and behavioral dimension of SSD. Investigation of the efficacy of treatments in terms of these dimensions allows for more comprehensive insights into the general efficacy of SSD-specific treatments.

Furthermore, individual factors influencing the efficacy of psychological treatments remain unknown. Further investigation of factors which potentially impact this efficacy is needed to allow for the development of treatments which directly address individual differences and difficulties, especially in terms of comorbidity, coping, and ER. Identification of other factors is necessary to gain understanding in why treatment efficacy differs between individuals.

Conclusion

The present study assessed factors influencing the efficacy of a 7-week EMA intervention and whether implementing such an intervention allows for real-life

improvements in participants. Treatment efficacy was defined in terms of reduction in fatigue and physical symptoms. The results showed that the intervention did not predict a significant reduction in fatigue. Furthermore, it was found that neither baseline depressiveness nor average daily coping style affected the degree to which individuals experienced a reduction in their somatic symptoms in response to the intervention. Whether general QoL in individuals with SSD can be improved through such low-threshold interventions yet remains unknown and may be further investigated by future research. Which individual factors may impact whether an intervention displays efficacy for an individual remains unknown, posing another objective for future research.

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Appendix A: Tables and Graphs of Assumptions

Assumptions of Hypothesis A

Table A1

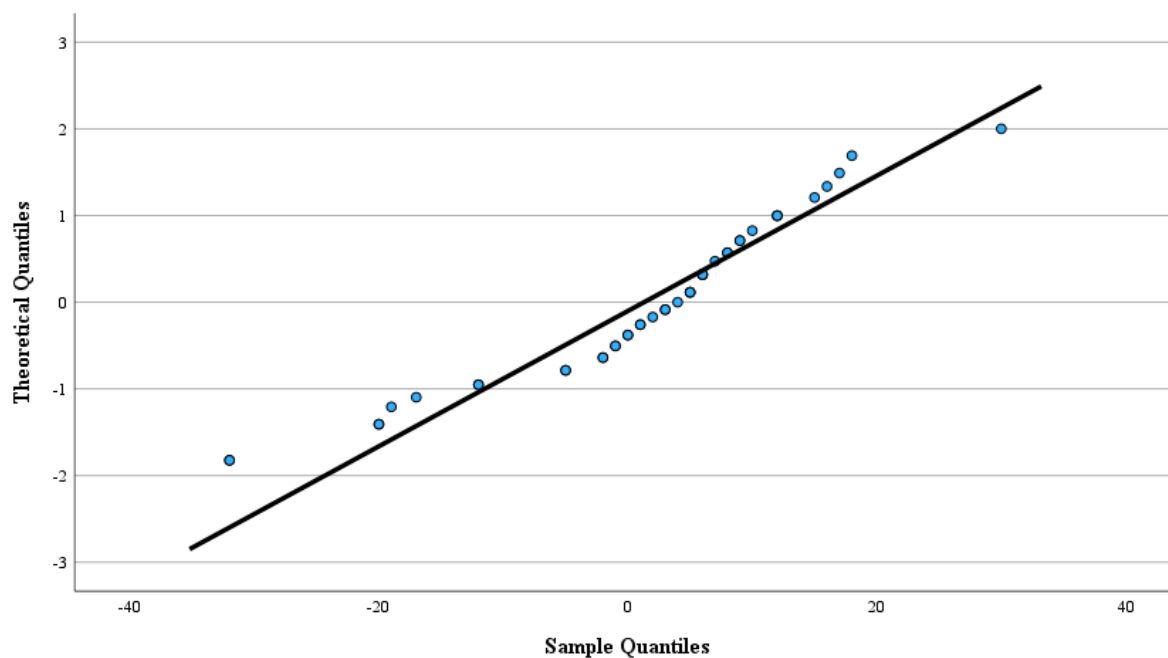
Tests of Normality for the Difference in MFI Scores

	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
diff_MFI	.166	43	.005	.931	43	.012

a. Lilliefors-corrected significance

Figure A1

Q-Q Plot of Differences in MFI scores

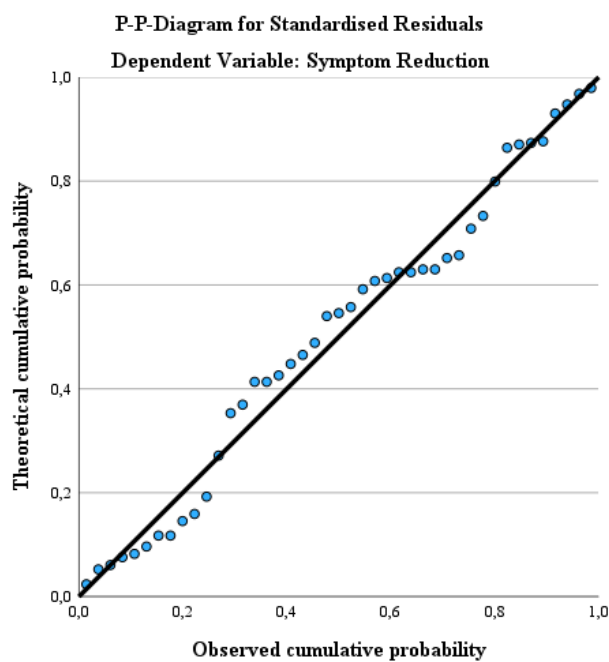


Note. The approximate straight line indicates a normal distribution of differences in MFI total scores.

Assumptions of Hypothesis B

Figure A2

P-P Plot Comparing Observed and Expected Cumulative Probabilities

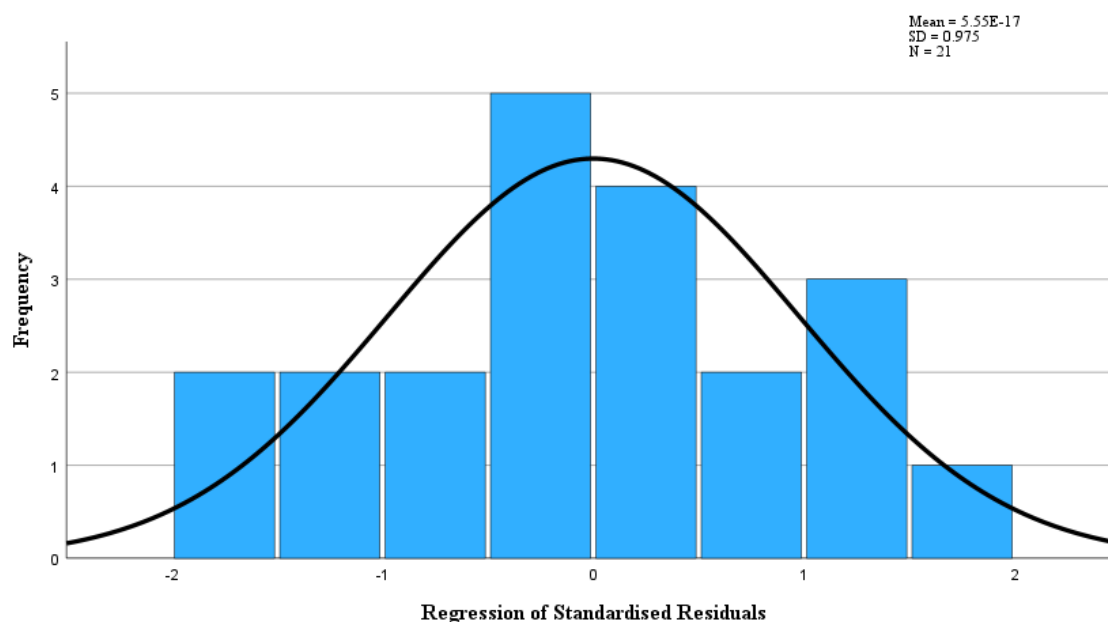


Note. The approximately straight line indicates normality.

Assumptions of Hypothesis C (Problem-focused Coping)

Figure A3

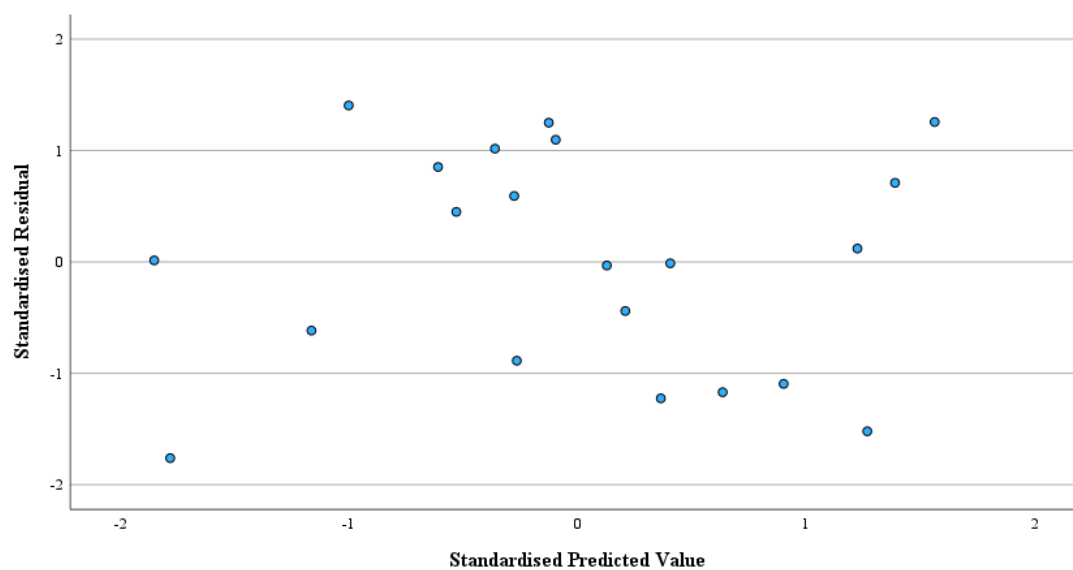
Histogram of Residuals of Symptom Reduction Scores



Note. The distribution illustrates the normality of residuals used in the analysis. Symptom reduction is the dependent variable.

Figure A4

Scatterplot of Standardized Residuals Versus Predicted Values for Symptom Reduction

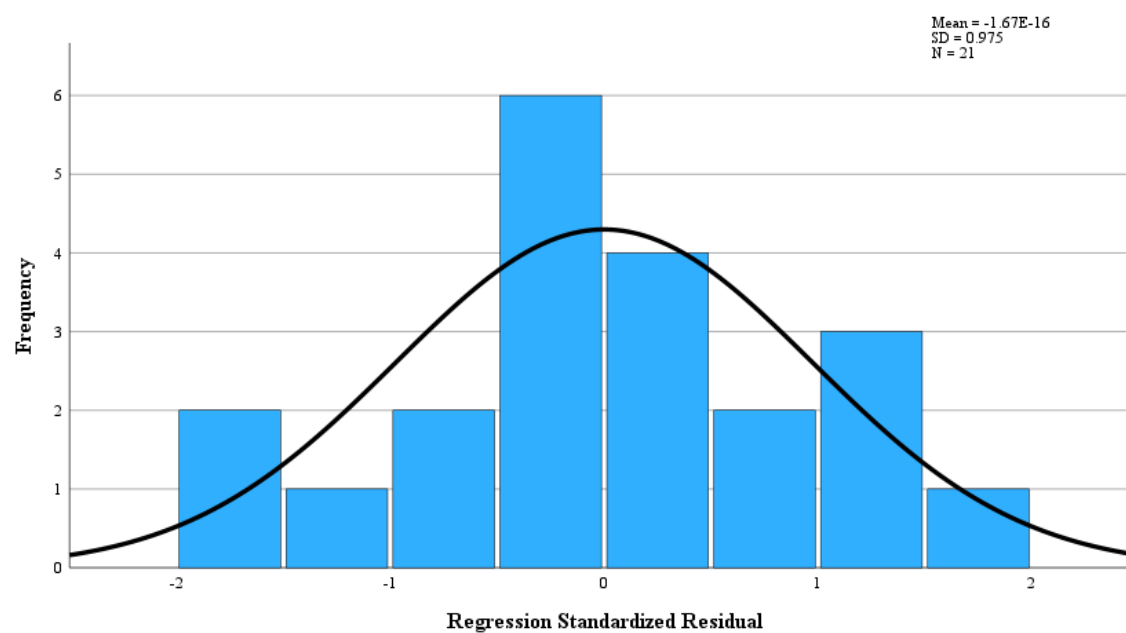


Note. The scatterplot shows a random distribution of residuals, supporting the assumption of homoscedasticity.

Assumptions of Hypothesis D (Emotion-focused Coping)

Figure A5

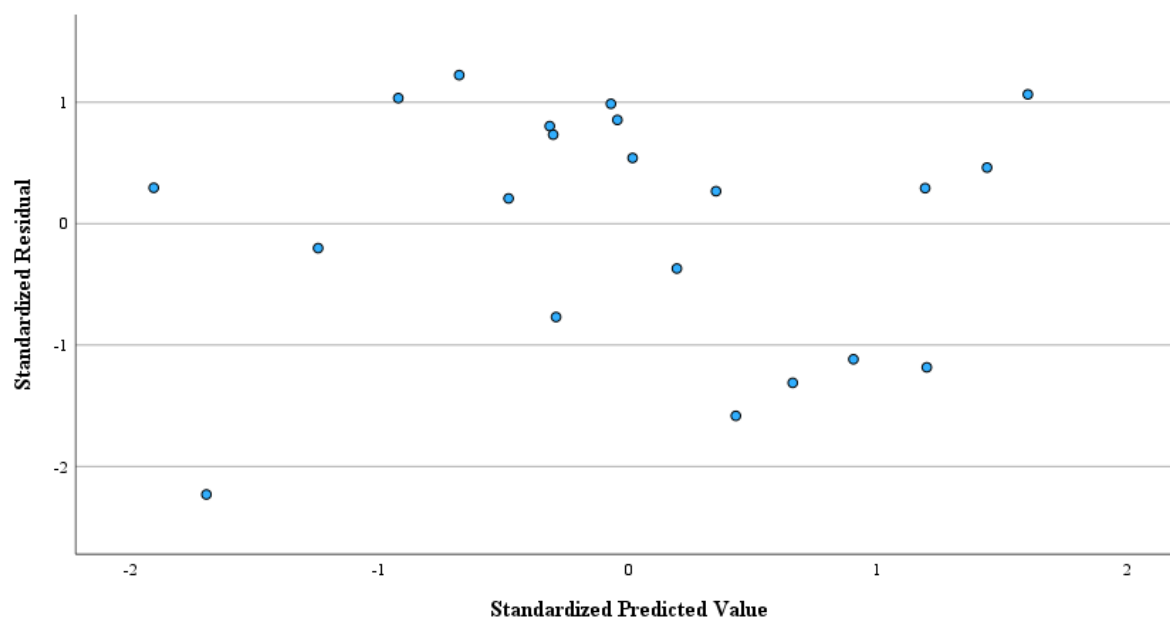
Histogram of Residuals of Symptom Reduction Scores



Note. The distribution illustrates the normality of residuals used in the analysis.

Figure A6

Scatterplot of Standardized Residuals Versus Predicted Values for Symptom Reduction

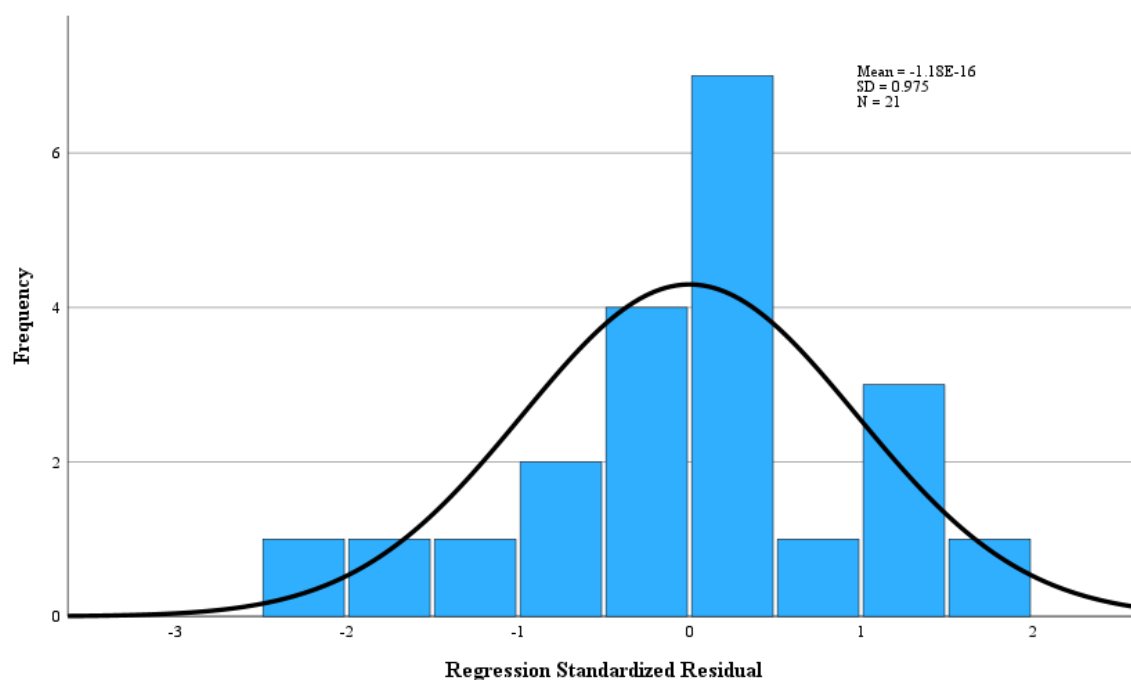


Note. The scatterplot shows a random distribution of residuals, supporting the assumption of homoscedasticity. Emotion-focused coping is the independent variable.

Assumptions Hypothesis E (Dysfunctional Coping)

Figure A7

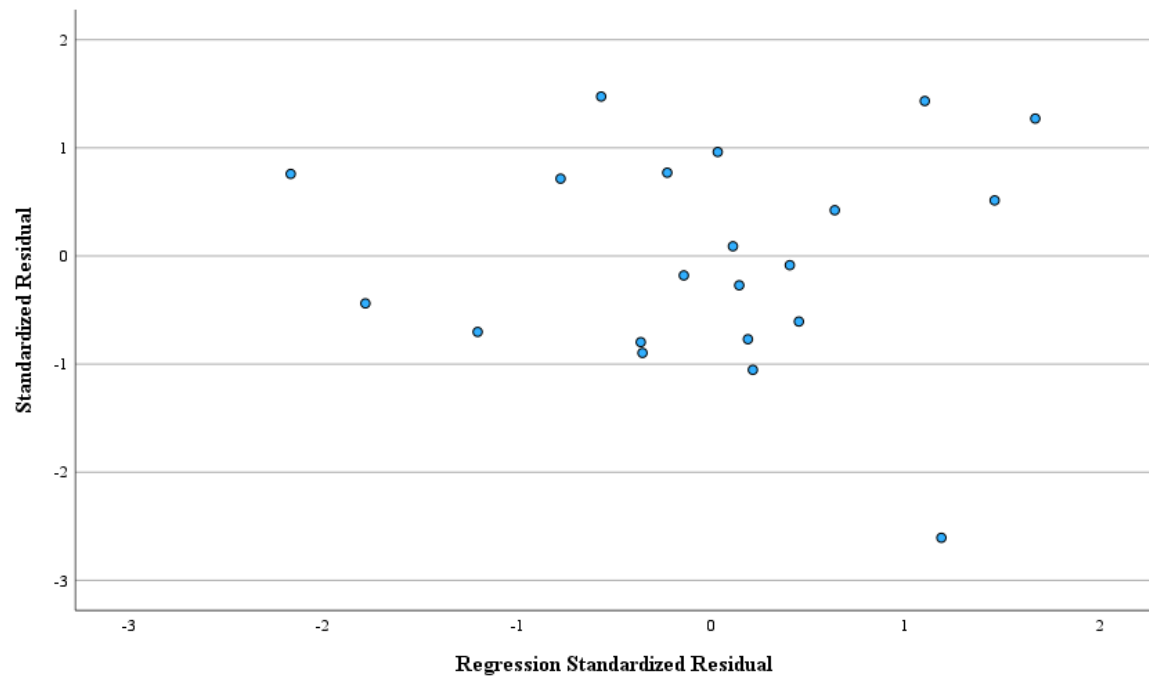
Histogram of Residuals of Symptom Reduction Scores



Note. The distribution illustrates the normality of residuals used in the analysis.

Figure A8

Scatterplot of Standardized Residuals Versus Predicted Values for Symptom Reduction



Note. The scatterplot shows a random distribution of residuals, supporting the assumption of homoscedasticity.

Appendix B: Abstracts

English Abstract

Somatic symptom disorder is a relatively new diagnosis that is highly prevalent and causes significant psychological distress. Often, treatment of SSD focuses primarily on reducing physical symptoms, ignoring that this disorder affects multiple domains of functioning and well-being. Therefore, previous research has often suggested that improved quality of life (QoL) should be the primary goal of SSD-specific treatment. The first aim of this study was to investigate whether a 7-week EMA intervention would improve QoL, measured through reduced fatigue levels after the intervention, as fatigue is inherently related to QoL. Second, the study aimed to identify individual factors (depressiveness, coping style) that influence the treatment efficacy of this EMA. 43 participants with elevated somatic symptoms completed a 7-week, stress-specific, app-based intervention, including various stress-reducing tasks, either at specified event times or upon self-report of acute stress. Fatigue and depression scores were assessed before and after the intervention. Use of three coping strategies (problem-focused, emotion-focused, dysfunctional) was assessed daily. No significant reduction in fatigue was found between pre- and post-intervention. Higher baseline depression scores did not correspond to lower physical symptom reduction. None of the coping strategies were significantly associated with physical symptom reduction. The results suggest that stress-specific treatment also poses an effective intervention form for individuals with and without comorbid depression and regardless of their habitual coping style. Future research should further focus on individual factors that influence treatment efficacy and develop SSD-specific interventions that primarily target QoL.

German Abstract

Die Somatische Belastungsstörungsstörung (SSD) ist eine relativ neue Diagnose, die hochprävalent ist und mit erheblichem psychischem Belastungserleben einhergeht. Die Behandlung von SSD fokussiert sich häufig primär auf die Reduktion körperlicher Symptome, wobei vernachlässigt wird, dass die Störung multiple Bereiche der Funktionsfähigkeit und des subjektiven Wohlbefindens beeinträchtigt. Vor diesem Hintergrund wurde in der bisherigen Forschung wiederholt vorgeschlagen, die Verbesserung der Lebensqualität (Quality of Life, QoL) als vorrangiges Ziel SSD-spezifischer Interventionen zu verfolgen. Ziel der vorliegenden Studie war es zunächst, zu untersuchen, ob eine siebenwöchige EMA-Intervention (Ecological Momentary Assessment) zu einer Verbesserung der Lebensqualität beitragen kann, gemessen anhand einer Reduktion des

Fatigue-Erlebens, welches eng mit QoL assoziiert ist. Außerdem wurde untersucht, inwiefern individuelle Faktoren wie Depressivität und Copingstil die Wirksamkeit der Intervention beeinflussen. Insgesamt nahmen 43 Personen mit ausgeprägten somatischen Beschwerden an der siebenwöchigen, app-basierten Intervention teil, die verschiedene stressspezifische Aufgaben umfasste, die entweder zu festgelegten Zeitpunkten oder nach selbsteingegebenen Stressereignissen durchgeführt wurden. Fatigue- und Depressivitätswerte wurden vor und nach der Intervention erhoben, der Gebrauch dreier Copingstile (problemfokussiert, emotionsfokussiert, dysfunktional) wurde im Rahmen täglicher Erhebungen erfasst. Es zeigte sich keine signifikante Veränderung des Fatigue-Erlebens im Prä-Post-Vergleich. Höhere Baselinewerte depressiver Symptomatik waren nicht mit einer geringeren Reduktion somatischer Symptome assoziiert. Der Zusammenhang zwischen Copingstil und Symptomreduktion zeigte sich als nicht signifikant. Die Ergebnisse legen nahe, dass komorbide psychische Störungen, insbesondere Depressivität, in einer stressspezifischen Behandlung nicht zwingend berücksichtigt werden müssen, da betroffene Individuen trotz Komorbidität profitieren. Zukünftige Forschung sollten sich weiter auf individuelle Faktoren konzentrieren, die die Wirksamkeit von Behandlungen psychischer Krankheiten beeinflussen, und SSD-spezifische Maßnahmen entwickeln, die in erster Linie auf die Verbesserung der Lebensqualität abzielen.

Appendix C: Study Designs

Figure C1: Study Design SoMi

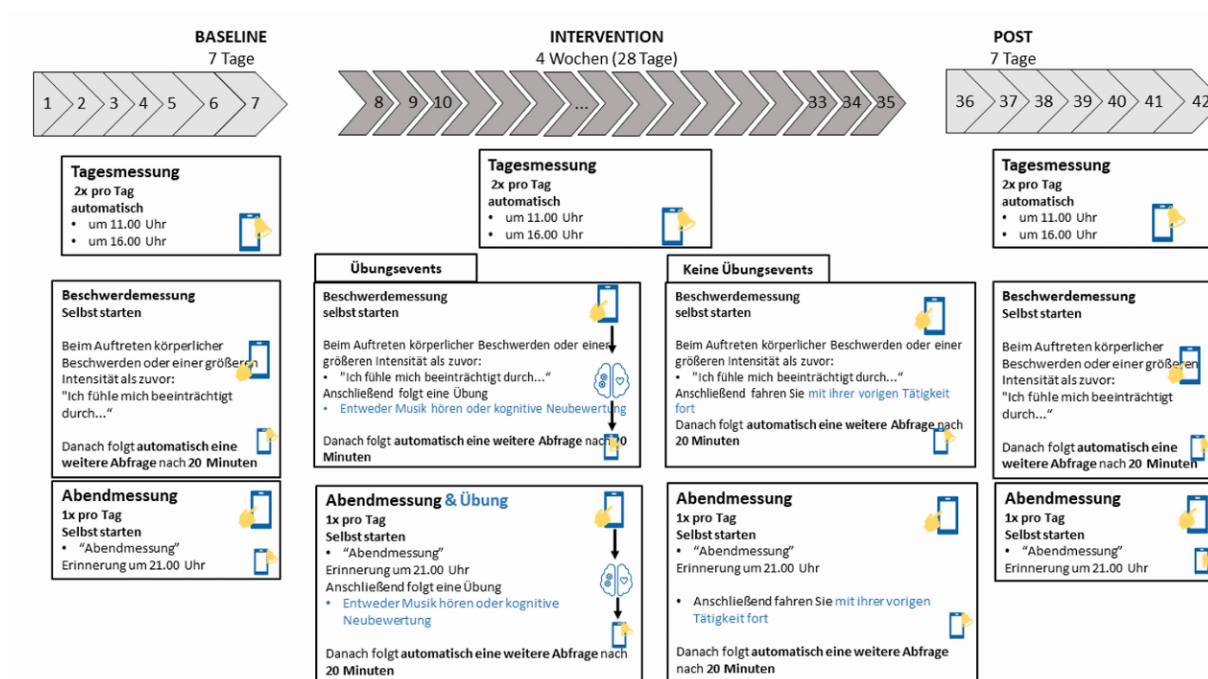


Figure C2: Study Design EPIGRAM 2

