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Effectiveness of a short Yoga Nidra meditation on stress, sleep, and well-being in a large and diverse sample

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Abstract
Previous studies have shown that meditation-based interventions can have a significant impact on stress and well-being in various populations. To further extend these findings, an 11-min Yoga Nidra meditation that may especially be integrated in a busy daily schedule by people who can only afford short time for breaks was adapted and analyzed in an experimental online study design. The effects of this short meditation on stress, sleep, well-being and mindfulness were examined for the first time. The meditation was provided as audio file and carried out during a period of 30 days by the participants of the meditation group. A Structural Equation Model (SEM) was used to analyze the data with Full Information Maximum Likelihood (FIML) in order to cope with missing data. As expected, the meditation group ($N = 341$) showed lower stress, higher well-being and improved sleep quality after the intervention (very small to small effect sizes) compared with a waitlist control group ($N = 430$). It turned out that the meditation had a stronger impact on the reduction of negative affect than on the increase of positive affect and also a stronger effect on affective components of well-being. Mindfulness, as a core element of the meditation, increased during the study within the meditation group. All effects remained stable at follow-up six weeks later. Overall, a large, heterogeneous sample showed that already a very short dose of meditation can positively influence stress, sleep, and well-being. Future research should consider biological markers as well as active control groups.

Keywords Yoga Nidra · Meditation · Mindfulness · Stress management · Sleep quality · Well-being

"No time to live?" is the name of a bibliography by Müller (2012) in which he takes the value of time and moment philosophically and in relation to our current performance requirements. Awareness of the present moment is also a nucleus of mindfulness and meditation. The present study examined a short form of Yoga Nidra meditation that was designed to relax without big time investments or prior meditation experience. Yoga Nidra is traditionally carried out while lying down and consists of a systematic sequence of perception exercises, e.g., focusing on the breath or certain parts of the body. It has been increasingly examined in recent years regarding the effects on stress (e.g., Borchardt et al. 2012; Dwivedi and Singh 2016), sleep (e.g., Amita et al. 2009) and well-being (e.g., Bhogaonker 2012; Rani et al. 2011). Extant research seems promising but randomized controlled trials and larger samples are rare (e.g., Deuskar 2011; Rani et al. 2013). In addition, a standard Yoga Nidra session usually takes about 30 min. However, since this is already too long for many people, the meditation has been shortened to eleven minutes for the present study and has been empirically investigated for the first time in this form. The intervention was administered as an audio file which was presented online. Particularly those people who can only afford short time for breaks were addressed in this way. Mindfulness as the main mechanism of the meditation is negatively related to various dysfunctional variables that may emerge due to work-related stress, e.g. burnout or depression (e.g. Roche et al. 2014).

Meditation-Based Interventions and Mindfulness

When we consider the word meditation semantically, it means *reflection*. In everyday life, the word meditation is mostly

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associated with different spiritual practices (e.g., Chiesa and Malinowski 2011). In psychotherapy, meditation is increasingly applied as a method in cognitive-behavioral approaches, especially in a recent approach called mindfulness-based cognitive therapy (e.g., Kuyken et al. 2010). In general, meditation is primarily used to effectively relax patients and to reduce negative thoughts, anxieties or constraints (e.g., Ellis 2009). In Yoga, meditation can be carried out in motion, while sitting quietly or lying down. In addition, a core element of Yoga and many other forms of meditation is focusing on an "object", e.g., the breath, for a certain time. Traditionally, the body is first detached from tensions, the breath consciously steered, the attention directed inwards from the sensory impressions, and finally, through concentration on an object, one reaches a state of meditation, which is characterized by deep insight and centering. An important feature of this condition is associated with an expansion of alpha-waves in the brain that reflects a state of deep relaxation (e.g., Parker et al. 2013). They decrease by visual or mental activity (Prakashananda 2010) and are more intensified when the person is temporarily not active but awake and alert (Desai et al. 2015).

A core component of meditation is mindfulness. It includes an orientation to the present moment and represents a specific form of non-judgemental attention (e.g., Kabat-Zinn 2003). The principle of mindfulness stems from Buddhist philosophy and has not only been used to deliberately relax, but also to develop personal values and an attentive attitude towards life. A mindful person is focused on the present moment without evaluating it and he or she is not distracted by the past and the future. In the words of the Dalai Lama (2012), mindfulness implies *a conscious use of the mind*. As so brilliantly titled and empirically underpinned by Killingsworth and Gilbert (2010), *a wandering mind is an unhappy mind*, even if they are pleasurable thoughts to which it drifts. In recent years, mindfulness has been explored as the key mechanism of meditation-based interventions (Sedlmeier et al. 2012) with mindfulness-based stress reduction (MBSR, e.g., Chiesa and Serretti 2009; Grossman et al. 2004; Kabat-Zinn 2003) being the bestseller-approach in this area. Much of the empirical research in the Western world has examined the effects of meditation on self-regulation (e.g., Shapiro 2009). It is argued that mindfulness promotes self-regulation by interrupting the so-called "autopilot", i.e. automatic thoughts and behavior patterns, and thereby fostering self-determined and flexible reactions (e.g., Brown and Ryan 2003). Furthermore, perceiving the current moment without judging makes it possible to change the perspective and to recognize as well as to adapt important reaction patterns: "Reperceiving is seen as a meta-mechanism that allows meditators to stand back and witness their own thoughts and experiences instead of being immersed in them" (Sedlmeier et al. 2012, p. 1144). Thus, the identification with thoughts and emotions is also to be modified in such a way that they are not perceived as part of the self, but as transitory, mental events (Lou et al. 1999; Satyananda Saraswati 2009). Therefore, mindfulness can promote a salutary treatment of thoughts, feelings and actions (Michalak et al. 2008).

Yoga Nidra

Yoga Nidra was developed by Swami Satyananda Saraswati in 1976 as a relatively easy-to-learn meditation to be used by people of various backgrounds and cultures and independent of previous knowledge (Satyananda Saraswati 2009). The heart of Yoga Nidra meditation is a personal resolution, *Sankalpa* (Sanskrit for "intention, resolution"), that addresses a topic important to the person and that affects him or her in a positive way. This intention is put into a simple, short and positive sentence which will be repeated in the beginning and end of the meditation (e.g., "I am calm and relaxed" or "I am successful"). The purpose of this resolution is to train the unconscious to sustainably achieve the desired state through regular mental repetition. Studies that used such intentions during meditation have shown that cognitive restructuring processes are stimulated (e.g., Sedlmeier et al. 2012). For people who regularly practice Yoga Nidra, the realization of this intention is more important than pure relaxation. However, relaxation is a crucial prerequisite for giving the body and mind the opportunity to resolve underlying tension. For this purpose, Yoga Nidra contains a systematic sequence of body awareness and breathing exercises that can activate the parasympathetic nervous system and increase the amount of alpha-waves in the brain (e.g., Mandlik et al. 2002).

In the U.S., the concept of Yoga Nidra has been further adapted by the psychologist Richard Miller (2005) under the name *iRest* for western practitioners and has been used especially for the improvement of mental well-being. The iRest community has enjoyed increasing attention in recent years and offers an overview of current research on https://www.irest.us/research. Empirical studies on Yoga Nidra confirm positive effects on various physiological and psychological criteria such as insomnia, addictive behavior, chronic diseases, pain therapy, pregnancies, geriatrics, asthma as well as disorders of the cardiovascular system (e.g., Satyananda Saraswati 2009). Not only based on self-reports, but also by imaging techniques such as positron emission tomography (PET) and electroencephalography (EEG), sustained changes in the activation of the brain were recorded (e.g., Lou et al. 1999; Mandlik et al. 2002;). As examples for qualitative studies and case studies Datta et al. (2017) show positive effects of Yoga Nidra on chronic sleep disorders and several others find positive effects on PTSD (posttraumatic stress disorder) for veterans (e.g. Stankovic 2011) and women with sexual assault experience (e.g. Pence et al. 2014). It should, however, be noted that the sample sizes in these studies were partly very small or did not include control groups. In

most cases information on the dependent variables or the intervention was poor or missing.

The Effects of Yoga Nidra on Stress, Well-Being, and Sleep

Yoga Nidra is already prescribed by scholars in several countries because of its potential to activate the parasympathetic nervous system and positively influence stress-related parameters such as skin conductivity and cortisol level (e.g., Kumar and Joshi 2009; Prakashananda 2010). This down-regulation of hyper-arousal may also contribute to increasing positive and decreasing negative affect and thus would also have an impact on the emotional components of well-being (Diener et al. 1999). Furthermore, Kjaer et al. (2002) found out that Dopamine is released whilst practicing Yoga Nidra, which can also stimulate positive affect and increase motivation.

In addition to purely relaxing and emotional effects, cognitive restructuring may occur as well, since a personal intention is used at the beginning and end of the meditation as mentioned above (e.g., Sedlmeier et al. 2012). A personal intention may be compared with positive self-instructions often applied in cognitive-behavioral therapy as well as in stress inoculation trainings (Meichenbaum 1985) in order to counteract the detrimental effects of dysfunctional cognitions. The detachment from such dysfunctional cognitions may also be fostered by the meta-mechanism of reperceiving described above. Potential positive changes on the cognitive level may then also influence life satisfaction and thus the cognitive component of subjective well-being (Diener et al. 1999).

Yoga Nidra was explained by Satyananda Saraswati (2009) as an activity or state of "conscious sleep" and is thus characterized by positively influencing the quality of sleep and – in its standard 30-min length – even said to compensate for lack of night sleep (e.g., Satyananda Saraswati 2009). Schulz et al. (2003) consider that an increased level of arousal is responsible for sleep disorders that have dramatically increased in recent years (e.g., Colten and Altevogt 2006; Lohmann-Haislah 2012). Meditation-based interventions can lower the level of arousal and thus positively affect sleep (e.g., Hülsheger et al. 2015; Klatt et al. 2009; Winbush et al. 2007).

Hypotheses

As has been described above, there are several empirical studies that have already shown positive effects of Yoga Nidra on stress, well-being, and sleep (e.g., Bhogaonker 2012; Borchardt et al. 2012; Rani et al. 2013), some of which, however, only used very small samples or no control group. The present study aims at replicating these effects with a newly developed short form of Yoga Nidra meditation and at extending them to a large and diverse sample, employing a randomized waitlist control study design. The importance of replication and availability of larger samples is highlighted for appropriate generalization. A distinctive feature of our study is the use of an online administered audio file of the 11-min meditation. According to previous studies, interventions with a focus on relaxation reached small to medium effect sizes (e.g., Bhogaonker 2012; Eastman-Mueller et al. 2013; Pence et al. 2014). It is therefore expected that practicing eleven minutes of Yoga Nidra per day over a period of one month will lead to significant changes with at least small effect sizes. Most Yoga Nidra interventions focused on a meditation period of more than one month and emphasized a daily practice with personal training sessions (e.g., Kumar 2010; Rani et al. 2013; for a comprehensive overview see Moszeik 2016, 18–21). As the present study aims to provide results for a period of only one month of practice and even referring to a short form of Yoga Nidra, which was completely administered online, we only expected small effect sizes. These effects should also remain stable over a medium-term period of six weeks. In particular, we tested the following hypotheses: compared to a waitlist control condition, practicing Yoga Nidra meditation eleven minutes a day for one month will…

(1) …reduce stress and negative affect (NA; one of the emotional components of well-being) and
(2) …improve positive affect (PA; the other emotional component of well-being), satisfaction with life (the cognitive component of well-being), sleep quality as well as mindfulness.

The Present Study

This study is the first to examine the effects of a newly developed short-form of Yoga Nidra that was independently conducted by each of the participants using an audio file. Instructions and data collections were carried out via EFS Survey, hosted by Unipark (www.unipark.com); the audio file with the Yoga Nidra meditation was provided via download link. A pilot study was conducted with five volunteers to clarify instructions, feasibility and to optimize the meditation (e.g. pauses and speed). The effect of this short meditation on stress, sleep, and well-being is compared with a randomized waitlist control condition in a large German sample, using a Likelihood Ratio test (LRT) in an ANOVA-style structural equation model.

Method

Participants

There were no eligibility or exclusion criteria for selection of participants, rather the authors made advertising for

participation in the snowball principle. Headline of the study was the slogan "Mind full or Mindful?", anyone who felt addressed by this claim and who was interested in an easy-to-learn and short meditation could sign up for the study. Furthermore, it was highlighted that the time investment for participants would be only eleven minutes daily and no experience with meditation was needed. 859 participants registered on the study's website. Participants were randomly assigned to one of two conditions automatically by Unipark software. In total, the following analyses include 341 participants in the meditation and 430 in the control condition. The age of the total sample of 771 participants ranged from 19 to 71 years ($M = 38$; $SD = 10.59$). 575 participants were female (79.9%), 145 male (20.1%). Most of the participants were employees ($N = 364$, 51.4%), 379 people worked full-time (53.3%), 189 part-time (26.6%). In addition, 187 participants (26%) were active as managers in executive positions. Further demographic details can be found in Table 1. The reduction from 859 to 771 valid cases was due to incorrect email addresses and double answers.

The study was carried out in accordance with the recommendations and ethical guidelines of the German Psychological Society and received a positive ethical approval of the Institutional Review Board of Universität der Bundeswehr München. All subjects participated anonymously and voluntarily and could quit their participation whenever they wanted without any disadvantages.

Procedure

The study was announced as an online and only 11-min mindfulness meditation, free of charge and accessible without prior experience. Over half of the sample (53.6%) were recruited via the online platform Moodle of the department of psychology at FernUniversität in Hagen which is the only state-maintained distance learning university in Germany. The other participants were recruited by flyers and posters, internet forums (e.g., Facebook, LinkedIn), newsletters, yoga studios, universities, cafeterias, shopping centers, fairs and on the street.

Previous studies have shown that one critical feature of successful online-administered studies could be the supply of personal video clips (e.g., Manthey et al. 2016). Therefore, a brief video clip with information on the study (length: 2:20 min) was shown to stimulate adherence. In the clip, the principle of mindfulness was introduced, the intervention presented and the chronological and organizational course of the study explained. It was the aim to motivate and commit subjects to their participation and to help define what really mattered - mindfulness.

The study was conducted in a pre-post-follow-up design with three measurement points. The intervention period between pre-test (t1) and post-test (t2) was 30 days; the follow-up measurement (t3) took place another six weeks later. At t1, participants created their personal, 6-digit pseudonymization code, which was used to anonymously combine the surveys (each the first letter of birthplace, first name, first name of mother and father, second digit of one's own birthday and last digit of the year of birth). Therefore, it was not possible to identify individuals within the two groups.

The experimental group was informed that they will be given access to the audio file after completion of t1. Participants of the control group were given the information that different intervention waves take place between October 2015 and February 2016 and they would be informed in time when the meditation period begins. During the intervention period, participants of the meditation group received a weekly e-mail including information on certain aspects of the 11-min meditation they could particularly focus on (e.g., counting the breath, the role of observation and advice to find a personal intention). Furthermore, they were asked to indicate the days on which they carried out the meditation. In order to do so, they received a sample protocol (Excel file) to take real-time notes on frequency and general remarks which also included practical information on the body position and adequate surroundings.

11-Minute-Yoga Nidra Audio Intervention

The present short form of Yoga Nidra meditation was developed by the first author and recorded by a professional producer. The first author is a trained instructor for Yoga Nidra, performs the meditation almost daily and teaches it since 2012. Typically, the meditation takes about 30 min. In the present study, the effects of an 11-min short form of Yoga Nidra were tested for the first time. The usual length of the meditation was reduced as follows: The perception of individual body parts and the observation of the breath, the personal intention as well as the observation of thoughts and feelings were integrated. The perception of the body parts was limited to the left and the right side of the body, and did not address further repetitions of the front and back side. The breath was observed for about 20 s, in longer versions it is perceived for an average of two minutes. Additional contents such as the perception of contrary sensations as well as visualizations were excluded as those specifically are more difficult to implement for people with less meditation experience. The main reason for shortening the original form was to address people who have a busy daily schedule and who cannot invest more time for a break. Compared to physical yoga approaches, the present intervention could not cause any harm or injuries. The most important ingredient was mindfulness, which was explained in more detail in the video clip mentioned above. We recommended to carry out the meditation preferably once a day during the 30 days intervention period. Nevertheless, this was only a suggestion based on the literature of Yoga Nidra (e.g., Satyananda Saraswati 2009) and we still expected positive effects if carried out less frequently. The only

Table 1 Participant Characteristics

	EG with Yoga Nidra Intervention		CG without treatment	
	N	%	*N*	%
Sex (*N* = 326 EG; *N* = 394 CG)				
Female	262	80.4	313	79.4
Male	64	19.6	81	20.6
Age (*N* = 325 EG; *N* = 394 CG)				
19–35 years	144	44.3	185	47
36–50 years	135	41.5	157	39.8
51–71 years	46	14.2	52	13.2
Marital status (*N* = 322 EG; *N* = 388 CG)				
Single	90	28	127	32.7
In partnership	86	26.7	95	24.5
Married	117	36.3	136	35.1
Divorced	25	7.8	28	7.2
Widowed	4	1.2	2	0.5
Education (*N* = 325 EG; *N* = 390 CG)				
Secondary modern school	5	1.5	–	–
Secondary school	31	9.5	40	10.3
Advanced technical college	34	10.5	44	11.3
University-entrance diploma	124	38.2	142	36.4
University	131	40.3	164	42.1
Employment (*N* = 321 EG; *N* = 390 CG)				
Not employed	30	9.3	42	10.8
Part-time	86	26.8	103	26.4
Full-time	174	54.2	205	52.6
Partial retirement	3	0.9	1	0.3
Mini job	12	3.7	29	7.4
Irregular employed	14	4.4	9	2.3
Military service / Alternative civilian service	2	0.6	1	0.3
Profession (*N* = 321 EG; *N* = 387 CG)				
Jobless	5	1.6	6	1.6
Employed	172	53.6	192	49.6
Official	11	3.4	14	3.6
House wife / husband	10	3.1	19	4.9
Retiree	7	2.2	7	1.8
Pupil	1	0.3	–	
Self-employed	63	19.6	80	20.7
Student	52	16.2	69	17.8
Executive position (*N* = 326 EG; *N* = 394 CG)				
Yes	85	26.1	102	25.9
No	241	73.9	292	74.1

Note. Collection of these sociodemographic data took part at t1. EG = experimental group; CG = control group; changing sample sizes reflect missing information due to voluntariness of demographic data

requirement necessary to perform the meditation accurately was access to any form of audio player. No further experience in meditation was needed but if any questions would come up, participants had the chance to contact the first author via e-mail.

Our primary intention was to provide evidence for the effectiveness of this shortened form of Yoga Nidra. Referring to other short meditation-based interventions (e.g., Banks et al. 2015) we had a promising basis to expect at least small positive effects of the present meditation format.

Frequency of Meditation

At t2, participants were asked how often they actually performed the meditation during the 30 days intervention period (1 = *all 30 days*, 6 = *once*); $M = 3.24$ ($SD = 1.33$, $N = 227$, due to missing values). 24 participants (10.5%) stated they had completed the meditation on all 30 days, 110 participants (48.1%) on at least every second day. 48 participants (21%) used the meditation on 9–15 days and 36 participants (15.7%) on 2–8 days. Nine participants (3.9%) performed the meditation only once. In addition, we asked at t3 whether the meditation was still used after the official intervention period (1 = *yes, almost every day*, 2 = yes, several times a week, 3 = yes, several times a month, 4 = yes, once a month, 5 = yes, less than once a month, 6 = *not anymore*). There was a mean of 4.55 ($SD = 1.69$, $N = 194$, due to missing values), with more than half of all participants (51.5%) actually continuing the meditation: Twelve participants (6.2%) stated they would still use the meditation almost every day, 18 participants (9.3%) several times per week, 32 participants (16.5%) several times a month, and 38 participants (19.6%) once or less than once a month. 94 participants (48.5%) didn't continue using the meditation after the official intervention period.

Measures

Stress To measure the self-estimated levels of stress and any changes in the course of the study, the screening scale for chronic stress (SSCS) of the Trier Inventory of Chronic Stress (TICS; Schulz et al. 2004) was presented before and after the intervention. The twelve SSCS items capture a global means for experienced stress and can be answered in about three minutes (sample item: "experience that everything is too much what I have to do"). The participants answered on a 5-point scale *(1 = never* to *5 = very frequently)* how often they experienced the presented situation. The internal consistency in this study showed very good values with $\alpha = .89$ for t1 and $\alpha = .92$ for t2 and t3. Participants of the present study reported moderate stress levels at t1 which were significantly higher than those of a representative German sample (Petrowski et al. 2012) with $t(3057) = 20.64$, $p < .0001$. Petrowski and colleagues also present confirmatory factor analysis (CFA) to test the psychometric properties.

Well-Being Well-being was assessed by two different scales: First, the two subscales for positive and negative affect of the German version of the Positive and Negative Affect Schedule (PANAS; Watson et al. 1988; German version of Krohne et al. 1996) were presented. The 20 items capture emotional states and can be answered in about five minutes (e.g.: active, enthusiastic, anxious, irritated). Participants answered on a 5-point scale (1 = *not at all* to 5 = *extremely*) how strongly they felt the different emotions in the last four weeks. The internal consistency was very good with $\alpha = .90$ for t1, $\alpha = .92$ for t2 and $\alpha = .91$ for t3. Participants of the present study reported higher positive than negative affect scores at t1, which were distributed in a middle range. The PA scores did differ significantly from scores of a representative German sample (Krohne et al. 1996) $t(1067) = 11.6$, $p < .0001$ and can be interpreted higher than average whereas the NA scores did also differ highly significantly as participants in the present study reported higher NA than the average German sample ($t(1067) = 17.32$, $p < .0001$). Crawford and Henry (2004) present the CFA to further test the psychometric properties and hypothesized dimensionalities of the scales.

In addition, the five items of the German version of the Satisfaction with Life Scale were retrieved (SWLS; Diener et al. 1985; German version of Schumacher 2003), which take about 1–2 min to complete. The SWLS records the overall life satisfaction and serves as the cognitive component of well-being on a 7-point scale (1 = *strongly disagree* to 7 = *strongly agree*). Sample item: "I am satisfied with my life". The internal consistency was excellent with $\alpha = .90$ for t1 and t2, $\alpha = .92$ for t3. Participants of the present study reported moderate-to-high satisfaction with life at t1. These scores differed highly significant compared with a representative German sample (Glaesmer et al. 2011) and showed that participants in the present study had lower mean values of satisfaction with life than the German average ($t(3237) = 6.85$, $p < .0001$). Glaesmer and colleagues also present CFA to test the psychometric properties.

Quality of Sleep To measure the quality of sleep we used the following six subscales of the German version of the Pittsburgh Sleep Quality Index (PSQI; Buysse et al. 1989; German version of Riemann and Backhaus 1996): the subjectively perceived sleep quality, sleep latency, sleep duration, sleep disturbances, drug use and daytime sleepiness. Participants could assess their sleep habits on a 4-point scale (0–3). The wording of the response scale varied depending on the question. The selected six components were assessed with a total of 16 items and can be answered in about five to ten minutes, e.g.: "How long did it usually take during the last four weeks before you fell asleep at night?" (sleep latency; 0 = *less than 15 min* to 3 = *more than 60 min*); "How many times have you slept badly because you woke up in the middle of the night or early in the morning during the past four weeks?" (sleep disturbances; 0 = *not at all* to 3 = *three times or more per week*); "Did you have problems to do the usual everyday tasks with enough drive during the past four weeks?" (daytime sleepiness; 0 = *no problems* to 3 = *major problems*). The total value of the PSQI can range between 0 and 18 points in the present study. The higher the value, the

more chronic the sleep disorders. The internal consistency was reasonable with $\alpha = .74$ for all three measurement points. Participants of the present study reported moderate sleep disturbances at t1. A comparison to a representative sample is not possible as Buysse and colleagues don't compare mean values but only cut-off values derived from the total score for people who don't sleep well. The present version with six subscales cannot be compared with those cut-off norms. Zhong et al. (2015) present the CFA to further test the psychometric properties and hypothesized dimensionalities of the scales.

Mindfulness In addition, we assessed the extent of mindfulness with the German version of the Mindful Attention and Awareness Scale (MAAS; Brown and Ryan 2003; German version of Michalak et al. 2008). The 15 items of the scale are all formulated towards a careless attitude, because according to the authors, states with less mindfulness are more perceptible and less prone to false positive responses. In the sample of the authors, the following three items had particularly high values in the sense of a lack of mindfulness: "I forget the name of a person almost immediately after it was told the first time."; "I notice that I'm lost in thoughts about the future or the past."; "I notice that I listen to someone with little attentiveness while I do something else at the same time." The items are answered on a 6-point scale (1 = *almost always* to 6 = *almost never*) and can be answered in about five to ten minutes. The internal consistency of the scale showed very good values with $\alpha = .90$ for t1, $\alpha = .91$ for t2 and $\alpha = .93$ for t3. Participants of the present study reported moderate-to-high mindfulness at t1. These scores didn't differ significantly compared with a representative sample (Brown and Ryan 2003) and showed that participants in the present study had average values of mindfulness at t1 ($t(768) = .24$, $p = .81$). Brown and Ryan (2003) also present CFA to test the psychometric properties.

Open Ended Question

In addition to the established quantitative measures, participants had the possibility to describe effects and experiences with the Yoga Nidra meditation in their own words at the end of the online questionnaire. It was pointed out to particularly refer to meditation-related changes over the 30-days intervention period.

Statistical Analyses

We used a Structural Equation Model (SEM) to analyze the data with Full Information Maximum Likelihood (FIML) in order to cope with the missing data. The SEM is shown in Fig. 1; it represents a multi-level structure for the repeated measures combined with a two-group model for the two treatment groups. The three measurement points are nested within individuals. This model can be seen as an ANOVA model implemented in a SEM setting. The model was set up using Onyx (von Oertzen et al. 2015). The corresponding structural equation for the *i*th time point of group g is given by

$$X_{g,i} = \beta + \beta_{t1\to t2}\, Z_1 + \beta_{t2\to t3}\, Z_2 + \beta_{treat} Tr + \beta_{treat\times t1\to t2} Z_1 \cdot Tr + \beta_{treat\times t2\to t3} Z_2 \cdot Tr + Y_g + \varepsilon_{g,i}$$

where all β are fixed effects, $Y_g$is a group dependent upper-level random effect, and the residuals ε are independently distributed normally with different variances. The parameter β is the grand mean, $\beta_{t1\to t2}$ the main effect of the training period, $\beta_{t2\to t3}$is the main effect of the follow-up period in addition to the training period, $\beta_{treat}$is the main effect of being in the treatment group, and $\beta_{treat\times t1\to t2}$ and $\beta_{treat\times t2\to t3}$are the two interaction effects. Z_1 and Z_2 are indicator variables which take on the value 1 after t2 and t3 respectively. The interaction effect $\beta_{treat\times t1\to t2}$which describes how much more the treatment group benefits from the training phase compared to the control group is decisive for testing the effect of the Yoga Nidra intervention. We assume theoretically that the missingness is dominantly Missing At Random (MAR), i.e., the missingness itself can be predicted from the variables which are available and components independent from the data; this is likely to be the case since the three variables are correlated, and at least one is always available. For MAR missingness, FIML estimates are unbiased, so we assume that in the current situation the FIML estimates are only minimally biased.

In the model, we represented the six means as a grand mean, main effects for the treatment group, the period from t1 to t2, and the period from t2 to t3 as well as both interaction effects, i.e. t1 to t2 x group and t2 to t3 x group. For each parameter, we report the a-posteriori probability that the true effect is on either side of zero under the assumption of a flat (i.e., diffuse) prior. That is, we assume that before looking at the data, every parameter value is equally likely. In other words, there is no prior information included in the estimation process.[1] Asymptotically, the probability that the parameter is on the other side of zero compared to the estimate coincides with the p value for a one-sided test in a LRT against the null hypothesis that the parameter in question is zero. The LRT is based on the chi-square distribution and compares the effect of the groups in an ANOVA-style model.

[1] As not enough is known about possible effects at this time to justify an informative prior, a flat prior was chosen to not favor any part of the solution space.

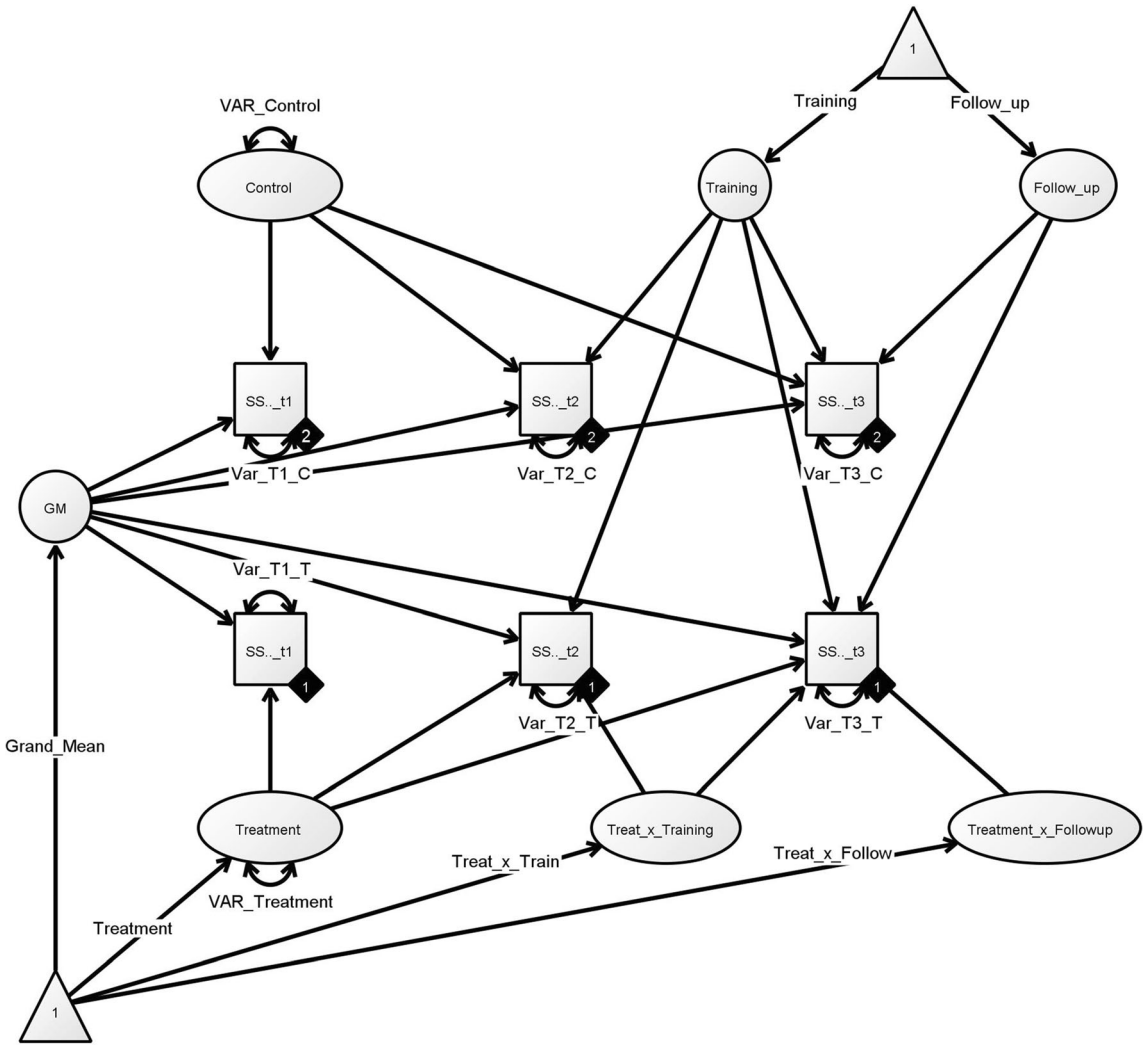

Fig. 1 *S*EM to analyze the data with Full Information Maximum Likelihood (FIML) in order to cope with the missing data. The SEM represents an extended ANOVA design; the latent variables "Treatment", "Training", and "Follow up" describe the main effects, where "Follow up" is added in addition to the training effect. "Treat x Training" and "Treatment x Followup" describe the interaction effects. All these effects are modelled as mean effects only. The "Treatment" variable has a residual variance to model the common variance of the treatment group. An analogous variable "Control" provides the common variance of the control group; this variable has no mean so that the mean of treatment provides the additional effect of treatment on top of the grand mean, represented in the latent variable "GM". Note that all residual variances are allowed to differ between groups and occasion of measurement

Effect sizes are reported as confidence intervals (CI), additionally giving Cohen's *d* (relative effect size) for every parameter. Cohen's *d* of the single parameters was computed as the ratio of effect size over standard deviation, for each parameter separately. For the interaction effect of the follow up and the treatment group, we additionally report the a-posteriori probability that this interaction effect is cancelling out the expected treatment effect in the treatment group, again using a flat a-priori distribution of the parameter. In other words, we give the probability that the dependent variables drop to the pre-treatment level again. The common variance components in both groups reached from 0.3 to 1.25 (roughly 2 to 3 times larger than the residual variances) and are not reported separately for every variable.

Results

Preliminary Analyses

The data were first prepared by correcting input errors and by identifying outlier values. The assumption of normality was supported by the theoretical consideration that the dependent variables are mean scores of multiple items, which in themselves can be assumed to have multiple independent contributors, which via the Central Limit Theorem supports normality. We checked this assumption using histograms and QQ plots as well as the values of skew and kurtosis.

Each dependent variable was analyzed regarding possible pre-test differences. Significant differences were

only found for PA: t (518) = 2.71, p = .007. Participants in the meditation group had a significantly higher pre-test score for PA compared with the participants of the control group. This pretest difference, however, is not relevant for the analyses of the interaction effects because the model explicitly separates the interaction effect from the group effect.

Effects of Yoga Nidra

The descriptive characteristics of the three dependent variables as well as of mindfulness are shown in Table 2 for both groups and for the three measurement points. The variables are listed in the order of presentation in the questionnaire. When considering these raw means, it is already possible to identify changes in favor of the meditation group, which will be explained in more detail in the following analyses. In particular, stress, negative affect and quality of sleep seem to be sustainably positively influenced by the meditation. Furthermore, mindfulness was successfully increased in the meditation group. The following statistical analyses display the effects of the 11-Minute-Yoga Nidra meditation on all dependent variables.

Table 2 *Descriptive characteristics of the dependent variables stress, sleep quality, well-being and mindfulness at the three measurement points*

	t1	*t2*	*t3*
SSCS *M(SD)*			
EG	2.70(.72)	2.49(.76)	2.46(.73)
CG	2.73(.70)	2.72(.74)	2.66(.74)
PA *M(SD)*			
EG	3.32(.63)	3.34(.65)	3.30(.68)
CG	3.20(.68)	3.11(.76)	3.06(.70)
NA *M(SD)*			
EG	2.16(.62)	1.99(.61)	2.02(.64)
CG	2.18(.61)	2.21(.64)	2.15(.67)
SWLS *M(SD)*			
EG	4.62(1.30)	4.75(1.28)	4.72(1.41)
CG	4.57(1.18)	4.59(1.22)	4.59(1.19)
PSQI *M(SD)*			
EG	1.02(.38)	.90 (.40)	.90 (.36)
CG	1.02 (.37)	1.00 (.38)	.98 (.37)
MAAS *M(SD)*			
EG	3.97(.86)	4.23(.83)	4.25(.86)
CG	3.91(.84)	3.91(.83)	3.94(.94)

Note. SSCS = Screening Scale for Chronic Stress, PA = Positive Affect, NA = Negative Affect, SWLS = Satisfaction With Life Scale, PSQI = Pittsburgh Sleep Quality Index, MAAS = Mindful Attention and Awareness Scale; the higher the scores the higher stress, affect, satisfaction and mindfulness, except for sleep quality - lower scores indicate a better sleep quality and less sleep disturbances; t1 = before intervention, t2 = after intervention, t3 = follow-up, EG = experimental group with meditation (N = 341), CG = control group (N = 430)

As can be seen in Table 3, the interaction effects Treat x Train were in the hypothesized direction with at least 96% a posteriori probability under a flat prior (Bayes coefficient > = 37) for all dependent variables. In particular, all effects were significant in a one-sided LRT against the null hypothesis of no effect (Note that the a-posteriori probabilities for negatively coded constructs, e.g. stress, are close to zero, which means that there is a high probability for decrease). This means that the Yoga Nidra intervention led to substantial increases regarding PA, satisfaction with life, sleep quality and mindfulness and to substantial decreases regarding stress and NA compared with the waitlist control condition. The effect sizes indicate an improvement of roughly 10% of the respective SD in most cases except for mindfulness (20%). The 95% CIs (coinciding 95% Bayesian intervals) of the effect sizes are all completely above and below zero respectively except for the CI of the satisfaction with life effect size [−0.001; 0.233].

For all dependent variables other than satisfaction with life, the probability that the follow up effect cancels the treatment effect was below 2.37%, and even for satisfaction with life, it was only 14.04%. Thus, it can be concluded that the effects of Yoga Nidra were maintained at follow up (see Table 4). In particular, no interaction effect of follow up with treatment group was significantly different from zero at p = 0.05 at a one-sided test.

We checked that all residual variances on the upper level were substantially larger than on the lower level, and significantly different from zero at p = 0.05. This supports our earlier theoretical assumption that the data is dominantly MAR. The RMSEA for the model was close to 0.01 for most dependent variables, although model fit is irrelevant in this situation with saturated means and enforced covariance structure.

Open Ended Question

We derived open feedback of 95 participants at t2 and 45 participants at t3 to add qualitative data to our quantitative analyses. The following three remarks were most frequently named:

- Relaxation, positive affect, satisfaction (40% at t2, 42.2% at t3)
- Positive effect on sleep quality (13.7% at t2, 6.7% at t3)
- Positive body awareness (11.6% at t2, 6.7% at t3)

Particular answers to this open format question indicate that for some participants, the intervention seemed to be particularly helpful in acute stress situations as before

Table 3 Effects of Yoga Nidra on all dependent variables at t2

Measure	Estimate Grand Mean (Std.error)	Estimate Treat x Training (Std.error)	Evidence Treat x Training	*d*	95% *CI* Lower	Upper	*p* in %	Bayes Factor
SSCS	2.74 (0.04)	−0.20 (0.05)	−3.92	−0.14	−0.29	−0.10	0	22,100.50
PA	3.20 (0.03)	0.01 (0.05)	2.32	0.08	0.02	0.21	98.98	97.28
NA	2.18 (0.03)	−0.19 (0.04)	−4.63	−0.17	−0.27	−0.11	0	535,623.33
SWLS	4.57 (0.06)	0.12 (0.06)	1.94	0.07	−0.001	0.23	97.39	37.28
PSQI	1.02 (0.02)	−0.10 (0.03)	−3.50	−0.13	−0.16	−0.04	0.02	24,119,931.43
MAAS	3.91 (0.04)	0.25 (0.05)	5.36	0.20	0.16	0.34	100	4199.84

Note. SSCS = Screening Scale for Chronic Stress, PA = Positive Affect, NA = Negative Affect, SWLS = Satisfaction With Life Scale, PSQI = Pittsburgh Sleep Quality Index, MAAS = Mindful Attention and Awareness Scale; Estimate = Maximum Likelihood Estimate (coincides with Bayesian point estimate under flat prior), Std.error = Standard error (coincides with Bayesian a-posteriori standard deviation under flat prior), Evidence = Estimate/Std.error, *d* = Cohen's *d* was calculated as Evidence / square root *N*, *CI* = confidence interval, *p* = posteriori positive, a posteriori probability that the population parameter is above zero under flat prior (coincides with the *p* value of a one-sided Likelihood Ratio test against the null hypothesis that the parameter is zero), Bayes Factor = ratio of the likelihoods under the two competing hypotheses (effect >0 vs. effect <= 0)

exams, during relationship problems or other critical life events: "[I] must confess that at first I did not believe I would see any changes. But I'm much more quiet driving the car, my girlfriend says." Negative feedback was most frequently connected to feelings of boredom as the meditation was always the same, difficulties to integrate the meditation into the daily schedule and to get used to the speed of perception exercises. Participants who then stuck with the meditation also reported improvement: "[I] found the change of body parts initially too fast, towards the end rather positive, so there was no time to think about something else and the concentration worked better".

Discussion

This study aimed at developing a short form of Yoga Nidra meditation and at examining its effects on stress, sleep, and well-being in a large and diverse sample. Overall, we found preliminary support for the effects of the 30-days meditation-based intervention regarding these variables. The intervention showed the expected effects on all dependent variables and these effects remained stable at follow-up after six weeks. As already pointed out, the meditation considerably reduced NA more than it increased PA. This result pattern replicates findings from previous studies that also showed a stronger effect

Table 4 Effects of Yoga Nidra on all dependent variables at t3

Measure	Estimate Grand Mean (Std.error)	Estimate Treat x Follow Up (Std.error)	Evidence Treat x Follow Up	*d*	95% *CI* Lower	Upper	*p* in %	Bayes Factor (posterior follow up cancels treatment)
SSCS	2.74 (0.04)	0.03 (0.06)	0.61	0.02	−0.08	0.14	72.83	2.68 (0.18%)
PA	3.20 (0.03)	0.01 (0.06)	0.18	0.01	−0.10	0.12	57.22	1.34 (1.45%)
NA	2.18 (0.03)	0.09 (0.05)	1.76	0.06	−0.01	0.19	96.08	24.48 (2.37%)
SWLS	4.57 (0.06)	−0.04 (0.07)	−0.58	−0.02	−0.18	0.10	28.21	2.55 (14.04%)
PSQI	1.02 (0.02)	0.02 (0.03)	0.65	0.02	−0.04	0.08	74.22	2.88 (1.29%)
MAAS	3.91 (0.04)	0.01 (0.04)	−0.01	−0.00	−0.10	0.10	49.62	1.02 (0.00%)

Note. SSCS = Screening Scale for Chronic Stress, PA = Positive Affect, NA = Negative Affect, SWLS = Satisfaction With Life Scale, PSQI = Pittsburgh Sleep Quality Index, MAAS = Mindful Attention and Awareness Scale; Estimate = Maximum Likelihood Estimate (coincides with Bayesian point estimate under flat prior), Std.error = Standard error (coincides with Bayesian a-posteriori standard deviation under flat prior), Evidence = Estimate/Std.error, *d* = Cohen's *d* was calculated as Evidence / square root *N*, *CI* = confidence interval, *p* = posteriori positive, a posteriori probability that the population parameter is above zero under flat prior (coincides with the *p* value of a one-sided Likelihood Ratio test against the null hypothesis that the parameter is zero), Bayes Factor = ratio of the likelihoods under the two competing hypotheses (effect >0 vs. effect <= 0)

on NA (e.g., Agency for Healthcare Research and Quality 2014; Deuskar 2011). One possible explanation for this result pattern may be the fact that Yoga Nidra primarily regulates hyperarousal that is addressed in many items of the short NA-scale. As the meditation effect is more relaxing than activating in its present short form, several participants answered to an open-format question that they used the meditation to be able to fall asleep and were thankful that it did indeed work. For the authors it was also valuable to read about the sustainable use of the meditation and that about 10% of the sample integrated the meditation into their everyday routine. Furthermore, it is important to consider that the stability of the effects from post-test to follow-up presumably are attributable to the fact that many participants still used the meditation after the actual 30-days intervention period. On the other hand, participants in the meditation group might have benefitted from the good news of being selected first and therefore might have shown higher initial PA values as a sign of motivation.

General life satisfaction, the cognitive component of well-being, was also significantly increased by meditation in the study at hand compared to the control condition. Since the CI of the effect size for this dependent variable included zero, this effect has to be interpreted with caution. Altogether, the short form of Yoga Nidra seems to influence affective and cognitive components of well-being in the short and medium run. The present short form of Yoga Nidra focused on relaxing components such as the perception of the body and the breath and not on cognitive components such as the perception of contrasting sensations and visualizations that are present in the long form of Yoga Nidra. This issue could be addressed in future studies that compare the long and the short form to further analyze differences between affective and cognitive effects. Furthermore, the Sankalpa or personal resolution could also be considered in more detail in future research. As a cognitive component, such resolutions will differ more or less between Yoga Nidra practitioners and could be associated with different effects.

The present work is consistent with previous studies that have shown the positive effect of meditation- and mindfulness-based interventions on sleep quality (e.g., Hülsheger et al. 2015). This positive effect might also be explained with the reduction of hyperarousal through Yoga Nidra. Since Schulz et al. (2003) have shown that the cognitive component of worry is the critical determinant of sleep disorders, future studies could investigate in more detail whether Yoga Nidra may have an explicit impact on worry-related sleep disturbances. Finally, the study showed the strongest but still small effect (in terms of Cohen's conventions) regarding the increase in mindfulness for participants of the meditation group. Thus, Yoga Nidra as a specific form of mindfulness meditation in fact does increase mindfulness.

Strengths, Limitations and Implications for Future Research

There are four core strengths regarding (the design of) our study: (1) This study has investigated the effects of Yoga Nidra in a randomized controlled trial and (2) includes a large sample of participants holding a broad range of jobs. (3) The entire Yoga Nidra intervention was very economic and cost-saving since it could be successfully administered online and thus reached a wide range of participants that (4) only had to invest eleven minutes per day in order to increase their well-being and sleep quality and to reduce stress.

Although the effects of the Yoga Nidra meditation were only very small to small (between 10% and 20% *SD* of the distributions of the respective variables), they may be considered important in terms of public health that aims at promoting health in large populations using cost-saving and low-threshold interventions. In terms of adherence, eleven minutes are easier to invest for employees who have to cope with a tight schedule. Furthermore, importance may also be defined as a function of "how minor the manipulation of the independent variable is and how resistant a dependent variable is to change" (Prentice & Miller, 1992, cited according to Manthey et al. 2016, p. 334). As the intervention was highly economic, unlikely to produce harm and only took eleven minutes a day, it can be considered a minor manipulation. The significant results are supported by the high power the tests have due to the large sample size. The changes in statistics are supported by the participants' personal responses to the optional open-format question through which the authors received diverse positive feedback about the intervention.

The shortness of our Yoga Nidra intervention may be criticized in terms of a currently inflationary use of mindfulness meditations that was accurately termed "McMindfulness", first coined by Buddhist psychotherapist Miles Neale (Fisher 2010). Neale warns against the myopia of McMindfulness while advocating for a meditation practice that considers moral responsibility within our global interconnectivity. McMindfulness also means that big effects should be reached with small or fast meditation-related expenditure. These critical comments on the wide dissemination and sometimes probably superficial use of mindfulness, however, may also help to give the construct more pointedness. With regard to future studies it will be particularly interesting to compare the short form with the standard length to analyze a possible gain of effect sizes. Furthermore, real-time monitoring of Yoga Nidra meditation using mobile sensing (Harari et al. 2017) or other experience sampling technologies that enable to unobtrusively collect data would decisively improve the validity of the study. Through these new technologies, it is also possible to assess physiological indicators of stress like heart rate or skin conductance level (Ollander et al. 2016).

Referring to dropout rates, further techniques to increase motivation and self-efficacy could be introduced in future studies. Lederer and Middlestadt (2014) showed that the intention to meditate is related to attitudes, norms and behavioral control, and that this knowledge can be used to motivate individuals to take advantage of the positive effects of meditations. Furthermore, the present sample is very educated and doesn't represent individuals with a lower educational background who should be included in future studies.

Probably most critical is the fact that we only used a waitlist control instead of another active control condition. For now, it cannot be said for sure if the intervention effect is caused by the meditation and not also by the fact that participants in the intervention group do something different in their routine, the fact that participants are maybe just happy that they have been sorted to the intervention first, or the effect that is created by just giving attention to their well-being and stress. Thus, future studies should include active control groups, e.g., other interventions like progressive muscular relaxation or autogenous training to further validate the specific effects of Yoga Nidra. Furthermore, one could argue that our results are due to social desirability since we only used self-report data and probably also because participants randomized to the intervention can have the intention to please the researcher and to comply with the expectations. In a similar vein, information on possible positive effects of mindfulness and meditation that were provided in a clip shown to all participants in the beginning of the study, might have influenced the participants' answers. On the other hand, it would have been difficult with regard to the principle of informed consent to leave the participants in the dark with regard to these possible effects. A further limitation is the only short- and medium-term consideration of the effects; future studies could also examine the long-term effect of the 11-min meditation. Future studies should also include biological parameters, e.g., cortisol and heart rate variability, in order to further validate the promising effects of our short form of Yoga Nidra. Referring to the general population, it must be considered that participants of the present study reported significantly higher stress, NA and PA as well as lower SWLS than those of a representative German sample at t1. Therefore, the results cannot be generalized without caution.

Finally, the entire intervention was completely administered online without any real-life contact to a Yoga Nidra teacher. On the one hand, this is a big advantage in terms of costs and coverage. On the other hand, studies have shown that "blended interventions" which include real life contacts may foster adherence and thus the effectivity of a treatment (e.g., Goyal et al. 2014; Pracht and Renner 2016). Future studies could therefore integrate presence phases with personal and individualized instructions that could reinforce the effects of Yoga Nidra. There could also be introductory or in-depth training on the method of Yoga Nidra, e.g., for enterprises, which afterwards support the self-administered implementation with audio files.

Conclusion

It is true that meditation-based interventions can never be the same for all people and situations, as Pawson (2006, cited according to Biron et al. 2012, p.1) emphasized: "Interventions are fragile creatures. Rarely, if ever, is the 'same' program equally effective in all circumstances." Nevertheless, they can be further adapted so that people who are not yet inclined to meditation can also experience positive effects. Perhaps more people will be able to help themselves effectively, whether at home, at work or on the road, to relax and focus their lives on personal growth and satisfaction. In the end, this can be refined from seminars and workshops or even through short meditations such as the present one and may lead to an enduring mindful attitude. For this purpose, it would be particularly interesting to include different personality variables such as openness for experience to further understand and optimize the fit between person and intervention. Maybe it even gives insight about the fit of a short form versus standard length Yoga Nidra and personality traits. It would also be important to understand why more women approach similar interventions and how men could be increasingly and successfully addressed.

This experimental study showed small effects of a short audio-guided and online administered Yoga Nidra meditation on stress, sleep, and well-being in a large and diverse sample. Especially in stressful working days and in order to promote work-life balance, the meditation can be used easily to experience the positive effects of yoga without prior knowledge and without use of more or less difficult body-related exercises. Our study shows that it is not always essential to run costly day programs with a large structural, personnel and time effort, in order to be able to reduce stress and to promote well-being and sleep quality. Even this short form of Yoga Nidra seems helpful to interrupt the autopilot of thoughts in order to perceive the excellent moment in which reality takes place – now.

The dataset generated and analysed during the current study is available from the corresponding author on reasonable request.

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Compliance with Ethical Standards

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