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Distraction-focused interventions on examination stress in nursing students: Effects on psychological stress and biomarker levels. A randomized controlled trial

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Abstract

Background: Nursing students all over the world experience high levels of stress with negative impacts on their health, emotional state and performance.

Aim: This study aimed to investigate the effects of distraction-focused interventions on examination stress and anxiety in nursing students.

Methods: A randomized controlled, parallel trial design was conducted from January to June 2016. After baseline measurement, 72 participants were randomized to one of the following groups (n = 18 each): (i) animal-assisted therapy; (ii) music therapy; (iii) mandala painting; (iv) control group. Outcomes of all groups in terms of stress-reduction were compared by measuring self-reported perceived stress (STAI-State and visual analogue stress scale) and salivary biomarker levels (Cortisol and Immunoglobulin A).

Results: Fifty-seven complete data sets (n = 12-16 for each group) were analysed. All distraction-focused interventions showed stress and anxiety reduction in everyday school situations. By contrast, on days with examinations, stress reductions did not reach statistical significance in regard to self-reported psychological stress. At the same time, interventions resulted in significantly decreased levels of stress biomarkers ($P < .001$).

Conclusions: Our preliminary findings suggest positive but situation-dependent effects of distraction-focused interventions in academic settings. Further research should investigate the complex relationship between physiological and psychological stress parameters.

KEYWORDS
anxiety, distraction, nursing, physiological stress, psychological stress, randomized controlled trial

SUMMARY STATEMENT

What is already known about this topic?

- Academic stress in nursing students is a highly prevalent, international phenomenon, and numerous studies have reported the negative impacts of stress on students' health, emotional state and performance.
- Distraction-focused coping strategies are able to regulate emotions and anxiety. Several studies showed positive effects of distraction on pain and anxiety in health related settings.
- However, little is known about the effects of distraction on examination stress and test anxiety in students.

What this paper adds?

- This paper shows that examinations are outstanding stressors, indicating rising stress on psychological as well as physiological levels.
- The applied distraction-focused interventions showed stress and anxiety-reduction in everyday school situations.
- In exam situation, distraction-focused interventions reduced physiological stress as measured by salivary biomarker levels. At the same time, effects on self-reported psychological stress did not reach statistical significance.

Implications of this paper:

- Distraction-focused coping strategies can be integrated into existing stress management programs in academic settings.
- Further research should investigate the complex relationship between biological stress parameters and psychological stress. As both parameters do have a great influence at health outcomes, the investigation of their interdependencies could be a key for a better understanding of stress related diseases.

1 | INTRODUCTION

Stress in nursing students is a cross-cultural phenomenon and numerous, international studies have reported about the negative impacts of stress on students health, emotional state and performance (Cho, Ryu, Noh, & Lee, 2016; Crego, Carrillo-Diaz, Armfield, & Romero, 2016; Delaney et al., 2015; Kötter & Niebuhr, 2016). Academic stress has negative impacts on quality of life and well-being of students and may lead to delay and dropout (Bedewy & Gabriel, 2015). Moreover, academic stress has been associated with decreasing self-control and health-related behaviours like increased smoking and substance use, eating disorders and even suicidal behaviour (Oaten & Cheng, 2005; Schaefer, Matthess, Pfitzer, & Köhle, 2007).

Given a global shortage of nurses, the increase of graduation rates is of high interest (Bowden, 2008; Oulton, 2006). Hence, investigating and applying successful coping strategies are important prerequisites for promoting nurses during their training and preparing them for a stressful and challenging profession.

Examinations are the top worry of most students and a predominant cause of academic stress and anxiety (Bedewy & Gabriel, 2015; Lyndon et al., 2014; Pulido-Martos, Augusto-Landa, & Lopez-Zafra, 2011; Putwain, 2007). Evidence suggests that greater levels of stress and anxiety may impair academic performance and emotional wellbeing (Lyndon et al., 2014; Schaefer et al., 2007; Struthers, Perry, & Menec, 2000). Moreover, acute stressful events like examinations are capable of causing physiological response in humans, including changes in the nervous, cardiovascular, endocrine and immune systems (Murphy, Denis, Ward, & Tartar, 2010). A recent study related examination stress to negative impacts on graduate students' brain plasticity (Concerto et al., 2017).

Differences in the individual responses to stress can be explained by the contextual, cognitive coping model presented by Lazarus (1966). He defined coping as 'thoughts and behaviours that people use to manage the internal and external demands of situations that are appraised as stressful' (Folkman & Moskowitz, 2004). Lazarus and Folkman also made the theoretical distinction between problem-focused coping and emotion-focused coping (Folkman & Moskowitz, 2004). Although problem-focused coping strategies aim to solve or tackle the problem causing stress, emotion-focused coping strategies address the negative emotions associated with the problem. Other authors enhanced this dualism by more detailed distinctions and made up new, supplementary categories, for example, meaning focused coping (strategies to manage the meaning of the situation), social coping (seeking for help), positive cognitive restructuring (positive reinterpretation, humour and acceptance) and avoidance (Folkman & Moskowitz, 2004; Kapsou, Panayiotou, Kokkinos, & Demetriou, 2010).

Performance situations are mainly marked by the components anxiety and emotionality. Anxiety already occurs in the phase of anticipation, increases during the confrontation and then slowly decreases again. Emotionality begins with the confrontation, rises steeply and disappears after this phase (Krohne, 1985). Cognitive strategies mainly address the component 'anxiety', and they may fail in controlling fear responses in acute stress situations (Raio, Orederu, Palazzolo, Shurick, & Phelps, 2013). In performance situations, the successful regulation of emotions is crucial, and emotion-focused strategies,

like distraction, can be useful then (Doulougeri, Panagopoulou, & Montgomery, 2016; McRae et al., 2010; Suls & Fletcher, 1985). Although distraction-focused strategies do not have any impact on the source of stress, they are capable of creating some kind of break and may help students feel better. This could be an additional, short-term solution with an immediate effect on the emotional state of students in stressful exam situations.

Although in stressful performance situations like examinations, the successful regulation of emotions is crucial; the effectiveness of distraction-focused coping strategies on examination stress and test anxiety has not been evaluated yet. Reported interventions for stress management in academic settings mostly include cognitive, problem-focused and meaning-focused coping strategies such as learning strategies, time management, positive reappraisal or relaxation (Galbraith & Brown, 2011; Kötter & Niebuhr, 2016; Quinn & Peters, 2017).

Until now, research on distracting coping strategies has focused on pain and anxiety in health-related settings. In experimental studies, positive effects of distraction or avoidance on pain sensation were found (Bantick et al., 2002; Birnie et al., 2014; Suls & Fletcher, 1985). Numerous studies investigated the effects of distraction on anxiety when waiting for or undergoing medical treatment (e.g. Haddad, Saleh, & Eshah, 2018; Hudson, Ogden, & Whiteley, 2015). Results show heterogeneous and small but overall positive effects of interventions like aromatherapy or audiovisual presentations, and there is reasonable evidence that listening to music significantly reduces waiting-anxiety in adults (for an overview, see Biddiss, Knibbe, & McPherson, 2014).

2 | METHODS

2.1 | Aim

This study aimed to investigate the effects of three different distraction-focused interventions on examination-stress and anxiety in nursing students.

2.2 | Study design and setting

A randomized controlled, parallel trial design was used. The design of the study did not allow blinding of participants or data collectors, but all outcome adjudicators and data analysts were blinded to subject allocation.

The study was conducted at AZW nursing school (Ausbildungszentrum West für Gesundheitsberufe der Tirol Kliniken GmbH), which is the only nursing school in Tirol/Austria. AZW nursing school educates about 1300 nurses, assistant nurses, medical support professionals and massage therapists at different levels and provides advanced and specialist education for nurses and doctors. The 'diploma-program' was the highest qualification in general nursing in Tirol/Austria until the introduction of bachelor's degree in autumn 2018. Training comprised 3 years full-time study including practical training. Students must have had a minimum age of 17 years. There were no academic entry criteria, but candidates had to pass the entrance exam to start their studies. Diploma students frequently complained about high levels of stress, and the dropout-rate in the first year of education usually exceeded 30%.

2.3 | Sampling and group allocation

We invited all first-year students of the 2015/2016 'diploma-classes' (n = 102) of AZW nursing school to participate voluntarily in our study. We did not define any exclusion criteria for participation as we wanted to give all diploma-students the possibility to participate in our interventions. However, students could deselect an intervention in advance (e.g. reported fear of dogs). As there were few male participants, we considered sex for group allocation. A researcher, not involved in the interventions, generated the randomization sequence using a stratified random sampling approach based on tables of random numbers. The sample size calculation was performed using nQuery Advisor Version 7 and under the assumption of a detectable difference of 0.4 μg/dl in cortisol level.

2.4 | Description of the interventions

Each intervention lasted for about 45-60 min. Interventions were carried out simultaneously in the morning (9 AM) in different classrooms of the nursing school. Music therapy was performed in the school gym to provide enough space to move and not to disturb other classes.

2.4.1 | Animal assisted therapy: Interaction with therapy dogs (TD)

Animal-assisted therapy is widely used in different settings. It aims to raise the quality of life and well-being of patients and may serve as complementary treatment for trauma (O'Haire, Guérin, & Kirkham, 2015). There is evidence that interaction with trained dogs reduces anxiety and stress (Barker, Knisely, McCain, & Best, 2005; Barker, Pandurangi, & Best, 2003; Delago, Toukonen, & Wheeler, 2018).

In the present study, dog intervention was carried out in small groups by four trained therapy dogs and their handlers to ensure direct contact with a dog for each participant. The intervention comprised a therapy program with different tasks, playing and interacting with the dogs, as identical as possible for each group.

2.4.2 | Music therapy: Body percussion (BP)

Favourable effects of passive (listening) and active (performing) music interventions on stress, tension and well-being are widely recognized,

and various studies demonstrate the impact of music therapy in stressful situations like examinations (Bittman et al., 2001; Lai & Li, 2011; Laohawattanakun et al., 2011).

In this study, a professional music therapist conducted a body percussion session. The participants created rhythmic design without instruments, only by means of voice (syllables speaking), hands (clapping) and feet (pounding and walking). Easy rhythms got more and more complex, combining and mixing all three dimensions. In this way, synchronization effects arose on psychological and group levels. Meanwhile, participants were invited to reflect changes in their body ('bodyscan').

2.4.3 | Mandala painting (MP)

Mandalas are geometric shapes around a centre point. Mandala painting is said to have stress-reducing effects; creativity and concentration may be encouraged, and the flow of thoughts calms down. Scientific evidence for these beneficial effects is rare, but a study with students demonstrated the reduction in anxiety and examination stress by mandala painting as determined by heart rate variability (Sandmire et al., 2016).

The participants in the mandala painting intervention group got a choice of several mandala templates and different colours. We asked the students to paint the mandalas as they liked, concentrating on this task, not chattering or walking around in the room.

2.4.4 | Control group (CTR)

Participants of the control group spent an uninstructed free-hour. Students were allowed to spend their time in whatever way they liked, but we asked them not to smoke or to leave the building. About half of the students stayed in the classroom, talking to each other or discussing questions concerning the exam. The others showed up in the classroom only for salivary collection and psychological stress assessment.

2.5 | Measurement instruments

In addition to the assessment of psychological and physiological stress, as detailed below, the following sociodemographic data were collected: sex, age, personal status and educational background. Additionally, participants were asked to indicate their preferred intervention and provide an estimation of the effectiveness of the received intervention. To control for external effects on the cortisol level, they were asked about smoking (yes/no), periodic medication and medication in the last 24 h (yes/no— which one?) and the time when they got up in the morning.

2.5.1 | Psychological stress

Psychological stress was assessed using the well-validated State Anxiety Inventory (STAI-State) from the Spielberger State-Trait Anxiety Inventory, which is the most commonly used self-report to measure current anxiety (American Psychological Association, 2011).

The STAI-State is a 20-item, 4-point scale ranging from 0 (*not at all*) to 4 (*very much so*). Higher scores (range 20-80) indicate greater levels of anxiety (Laux, Glanzmann, Schaffner, & Spielberger, 1970). Considerable evidence attests to the construct and concurrent validity of the scale; the internal consistency coefficient is α = 0.90; test-retest reliability of the STAI-Trait Inventory (over 63 days interval) ranged from r = 0.77 to r = 0.90; as expected, the test-retest coefficients for the STAI-State Inventory (measuring a momentary state) were lower, r = 0.22 to r = 0.53 (Laux et al., 1970).

Additionally, we used a visual analogue stress scale (VASS) for self-assessment of acute stress. The scale consisted of a horizontal line of 10 cm length; 0 cm represented 'no stress', and 10 cm represented 'most stress imaginable'. Underneath the line, six faces supplemented the scale from broad smile on the left (0 cm) to crying face on the right end (10cm) of the scale. VAS scales are frequently used in clinical practice to assess pain and has been shown to reliably measure self-perceived stress (Lesage, Berjot, & Deschamps, 2012). Significant correlation (P < .001) between VASS and STAI-State has been shown in a cohort of 80 nursing students (r = 0.614 in everyday situations and r = 0.805 in exam situations; n = 70) (Buchberger et al., 2019).

2.5.2 | Physiological stress

The hypothalamic-pituitary-adrenal axis is the main physiological stress response system in the body and is frequently assessed by measuring salivary cortisol levels. Cortisol production has a circadian rhythm, with the highest levels in the morning and lowest values at night. However, levels rise in response to stress; cortisol levels rise independently of the circadian rhythm.

Psychological stress is likely to impair mucosal immunity and thus increase susceptibility to infectious diseases. Secretory immunoglobulin A (IgA) is crucial for mucosal immunity and forms the first line of defence against pathogens. Salivary IgA levels vary in a complex fashion in response to stress and emotionality, whereby its concentration typically increases in response to acute stress whereas protracted stress in associated with decreased levels (Bosch, De geus, Ring, & Nieuw Amerongen, 2004; Engeland et al., 2016). Consistently, it has been shown that higher perceived stress is related to lower salivary IgA levels (Engeland et al., 2016).

Multiple studies suggested that cortisol and IgA are fairly reliable biomarkers to measure physiological responses in stress situations, including examinations (Campisi, Bravo, Cole, & Gobeil, 2012; Clutter, Potter, Alarbi, & Caruso, 2017; Hellhammer, Wüst, & Kudielka, 2009; Murphy et al., 2010; Tsujita & Morimoto, 1999; Weekes et al., 2006).

Salivary samples were collected directly prior to and approximately 15 min after distraction-focused interventions using Salivette® Cortisol (Sarstedt) sampling devices. To account for circadian rhythm-dependent changes in biomarker levels, all interventions took place at comparable time points (between 8:30 and 10:00 AM). Saliva samples were stored at −20°C until assayed. Samples were thawed and subsequently centrifuged for 10 min at 3000 x g. Salivary cortisol and IgA levels were determined in duplicates using Cortisol Saliva ELISA and IgA Saliva ELISA (IBL international) according to manufacturer's instructions. These commercially available products were specifically designed for the reliable determination of the analyses in human saliva. The standard ranges for the cortisol and the IgA assay were 0.4-82.8 nmol/L and 6.9-400 μg/mL, respectively. The Cortisol Saliva ELISA had inter- and intra-assay coefficients of variation (CV) of 11.4% and 4.4%, respectively. Inter- and intra-assay CVs for the IgA Saliva ELISA were 9.1% and 4.0%.

2.6 | Data collection and procedure

Data collection took place between January and June 2016 on four different dates.

To provide baseline scores for self-reported psychological stress under everyday as well as under stressful conditions, participants were asked to answer the questionnaire including STAI-State and VASS on a normal school day (first survey date) and a couple of weeks later again prior to a written examination (second survey date).

Thereafter, randomization was performed. In order to familiarize participants with the interventions, we carried them out once, without stress assessment.

On the third survey date, the interventions were carried out on a normal school day. We measured biomarker levels as well as self-reported psychological stress. We collected salivary samples twice, immediately before as well as after the intervention. Psychological stress was assessed once after the intervention to avoid burden and socially accepted answers because of repeated inquiry within a short period of time.

On the last survey date, interventions and measurement took place right before a written examination. Again, salivary samples were collected before and after the intervention, and the self-reported psychological stress was assessed after the intervention.

2.7 | Ethical considerations

According to local regulations, no formal ethical scrutiny was required and undertaken. Students received oral and written information, and all participants signed an informed consent. Students did not receive any financial incentives, but they did receive ECTS credit-points for participation. They were assured that participation was voluntary and that they could withdraw from the study at any time without any consequences. Confidentiality was guaranteed by pseudonymization of data. The study was conducted in line with the principles of the Declaration of Helsinki.

2.8 | Statistical data analysis

All statistical analyses were performed using SPSS Version 24 (IBM Corp. Released SPSS Statistics for Windows). In order to test for normal distribution, the Lilliefors-corrected Kolmogorov-Smirnov test was used. As the majority of parameters were not distributed normally and the number of participants in the intervention subgroup analyses was low, data are presented as median and interquartile range (IQR). Data of participants who did not show up for all four measure units were excluded from the analysis (listwise deletion). Other missing data were scarce. Statistical evaluation was performed using Wilcoxon signed-rank tests, whereby missing data were handled by pairwise deletion (available-case analysis). P values < .05 were considered statistically significant.

3 | RESULTS

After baseline measurement of psychological stress in situations with and without examination, the remaining 72 participants were randomly assigned to three intervention groups and one control group (n = 18 for each group). No participant had to be excluded because of a change in smoking habits or any kind of medication that may influence the biomarker levels. In total, 14 participants did not show up on the survey Days 3 and 4, and one saliva sample could not be analysed due to limited saliva volume. In the end, 57 participants completed the study: n = 12, therapy dogs; n = 14, body percussion; n = 16, mandala painting; and n = 15, control group. The flow of participants is shown in Figure 1.

The participants ranged in age from 17 to 49 years with a median age of 20 years (IQR: 19-22); 13 (23%) participants were male. There were no significant differences between the groups regarding demographic characteristics. Distribution of age and sex and number of included participants for each intervention group are summarized in Table 1.

3.1 | Overall effects of interventions on stress levels

The impact of distraction-focused interventions was analysed initially on a normal school day (no examination) in the total study cohort. Self-reported psychological stress levels of the study participants were significantly reduced on days with interventions compared with days without interventions (VASS: median: 1.1 cm vs. 3.4 cm; P < .001; STAI-State score 35 vs. 39; P < .001). Moreover, salivary cortisol levels were significantly reduced after interventions (9.7 nmol/L vs. 14.2 nmol/L; P < .001), whereas salivary IgA levels were elevated (19.8

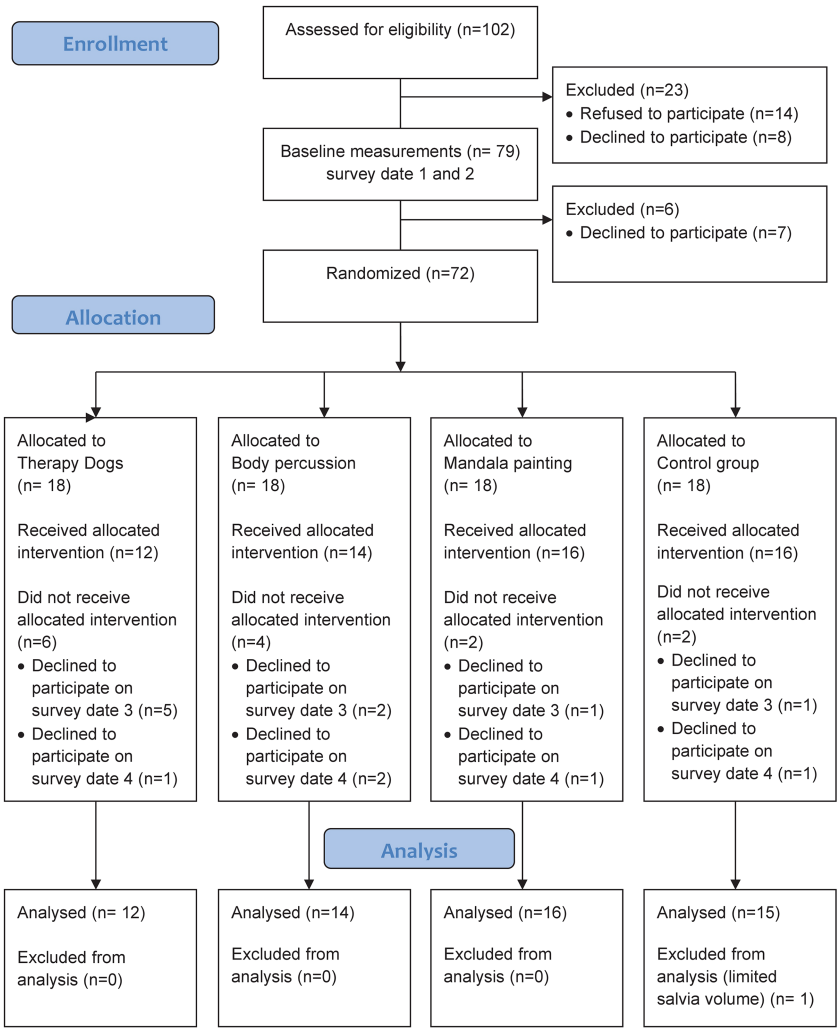

FIGURE 1 CONSORT flow diagram

TABLE 1 Sample characteristics

	Therapy dogs		Body percussion		Mandala painting		Control	
Participants (*N*)	12		14		16		15	
Age (years)								
Median	20.0		20.0		20.5		20.0	
IQR	19.0–20.8		19.8–25.8		19.0–22.0		19.0–22.0	
Sex (N (%))								
Male	3	(25)	3	(21)	4	(25)	3	(20)
Female	9	(75)	11	(79)	12	(75)	12	(80)

μg/mL vs. 16.8 μg/mL; $P < .001$), thus representing declining stress levels after interventions in everyday setting.

In contrast, on days with examinations, interventions did not significantly affect self-reported psychological stress levels (VASS: 5.2 cm vs. 6.1 cm; $P = .16$; STAI-State 56 vs. 55; $P = .83$). However, interventions prior to a written examination resulted in significantly decreased salivary cortisol levels (11.0 nmol/L vs. 15.5 nmol/L; $P < .001$) and increased salivary IgA levels (24.0 μg/mL vs. 20.0 μg/mL; $P < .001$). Overall effects of interventions on stress levels are summarized in Table 2.

3.2 | Effects of specific distraction-focused interventions on self-reported perceived stress levels

In everyday situation (no examination), VASS scores were significantly lower on days with interventions in all groups, including the control group (Figure 2A). This beneficial effect strongly diminished in exam situations. Although median VASS values were still reduced on days with interventions in the therapy dogs, body percussion and mandala painting groups but increased in the control group, these differences did not reach statistical significance (Figure 2B).

STAI-State scores indicated significantly reduced psychological stress in the therapy dog group and to some extent in the body percussion group (not statistically significant; $P = .07$; Figure 2C) in

TABLE 2 Overall effects of interventions on self-reported perceived stress and salivary biomarker levels

		No examination						Examination					
	Intervention	N	Median	IQR			*P*	N	Median	IQR			*P*
VASS	No	55	3.4	0.9	-	5.2		55	6.1	4.0	-	7.9	
	Yes	55	1.1	0.1	-	1.9	< .001	55	5.2	3.9	-	7.8	.159
STAI-State	No	57	39	33	-	48		57	55	41	-	66	
	Yes	57	35	29	-	40	< .001	57	56	42	-	63	.827
Cortisol [nmol/L]	Before	56	14.2	8.7	-	22.0		57	15.5	11.2	-	23.2	
	After	57	9.7	5.1	-	14.2	< .001	57	11.0	7.4	-	16.2	< .001
IgA [μg/mL]	Before	56	16.8	12.4	-	22.9		57	20.0	13.6	-	29.4	
	After	57	19.8	15.3	-	31.2	< .001	56	24.0	15.3	-	40.1	< .001

everyday situation. Prior to the examination, we did not observe significant changes in STAI-State scores in any intervention group (Figure 2D).

3.3 | Effects of specific distraction-focused interventions on salivary biomarker levels

On days without examinations, the applied distraction-focused interventions led to significantly decreased salivary cortisol levels in all groups, including the control group (Figure 3A). However, the effect on cortisol was lowest in the control group, with a decline in the median cortisol level by 1.9 nmol/L compared with 4.6 nmol/L to 6.8 nmol/L in the other intervention groups. Consistently, salivary IgA levels were significantly elevated after interventions but not in the control group (Figure 3C).

In contrast to self-reported psychological stress, cortisol levels were significantly decreased in all groups after interventions prior to written examination (Figure 3B). Similarly, salivary IgA levels were significantly elevated after intervention prior to written examination in the therapy dogs and body percussion groups, and there was a tendency toward elevated IgA levels in the mandala painting group (*P* = .12) but not in the control group (Figure 3D).

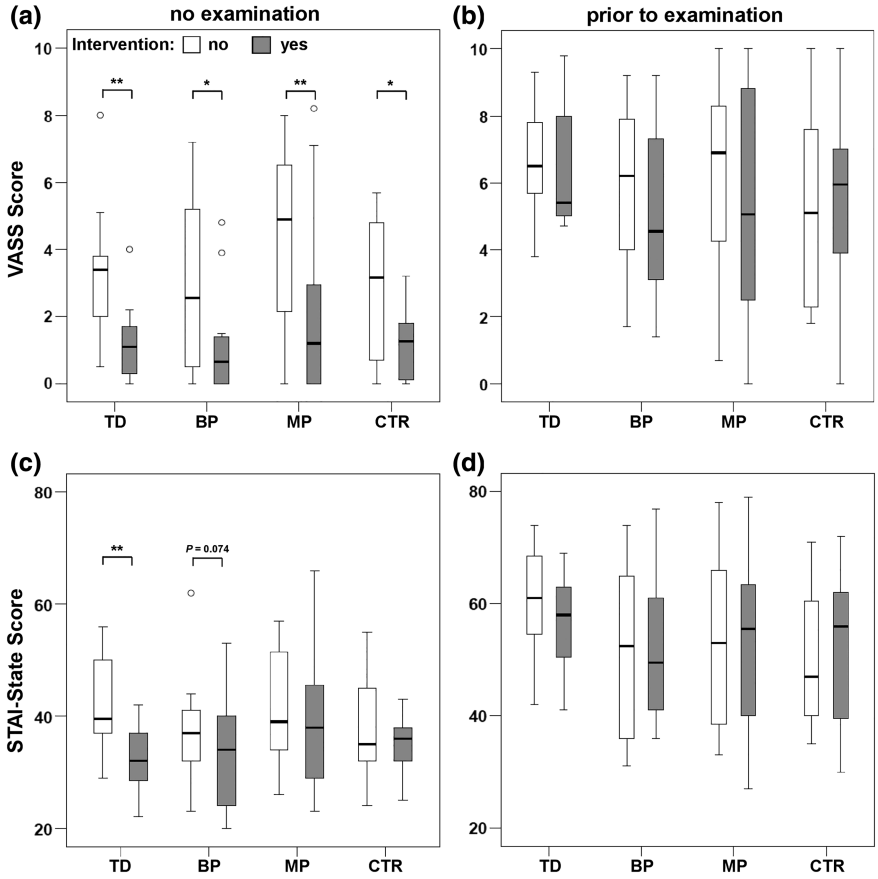

FIGURE 2 Effects of distraction-focused interventions on self-reported psychological stress levels. Psychological stress levels were determined by (A and B) Visual Analogue Stress Scale and (C and D) the STAI-State inventory on days (A and C) without examination stress or (B and D) prior to written examination. Stress levels were reported by participants on days without intervention (white boxes) or after distraction-focused interventions (grey boxes) and stratified by intervention groups (TD: therapy dogs, *N* = 12; BP: body-percussion, *N* = 14; MP: mandala painting, *N* = 16; CTR: control group, *N* = 15). Statistical significance was determined by Wilcoxon signed-rank tests (**P* < .05; ***P* < .01)

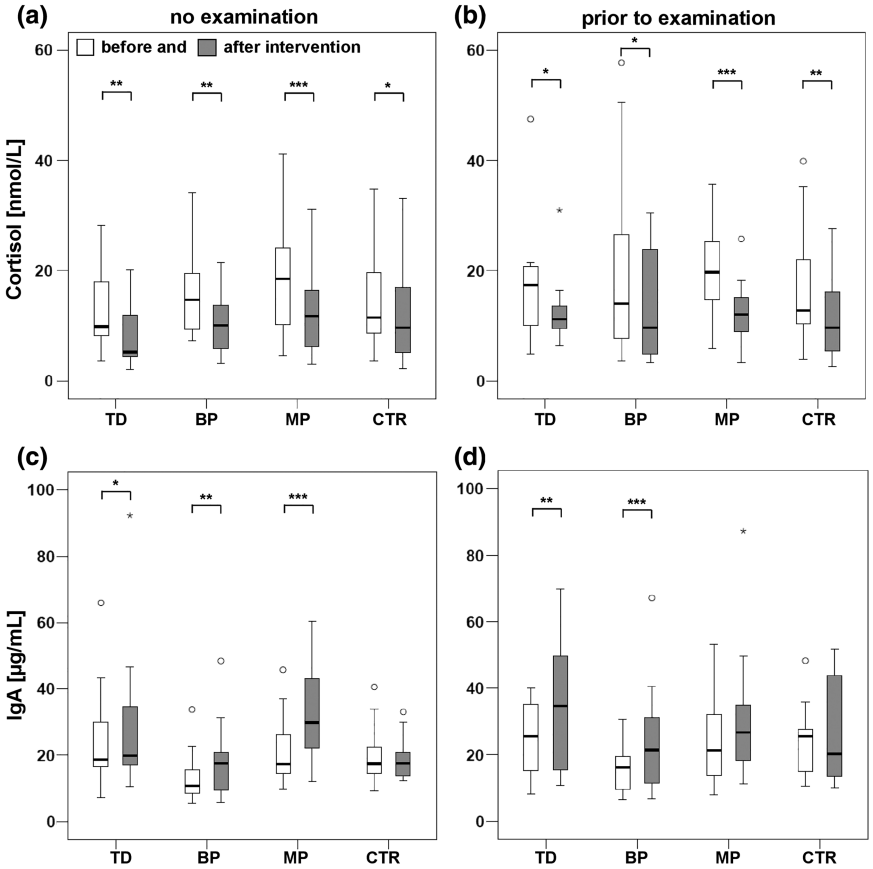

FIGURE 3 Effects of distraction-focused interventions on salivary biomarker levels. Salivary (A and B) cortisol and (C and D) IgA levels were determined by ELISA on days (A and C) without examination stress or (B and D) prior to written examination. Saliva samples were collected from participants prior (white boxes) and after (grey boxes) distraction-focused interventions and stratified by intervention groups (TD: therapy dogs, *N* = 12; BP: body-percussion, *N* = 14; MP: mandala painting, *N* = 16; CTR: control group, *N* = 15). Statistical significance was determined by Wilcoxon signed-rank tests (**P* < .05; ***P* < .01; ****P* < .001)

3.4 | Salivary biomarker levels were unaffected by individually perceived intervention effectiveness

VASS scores did not show a relationship between perceived effectiveness of the applied intervention and the students' stress levels. However, participants who perceived the interventions as effective (yes/rather yes) also showed significantly reduced STAI-State scores in everyday situations. This was not the case for participants who assessed the interventions as ineffective (no/rather no). This indicates that psychological stress might be impacted by perceived intervention effectiveness (Table 3). In contrast, salivary biomarker levels were significantly affected by distraction-focused interventions irrespective of the participants' assessment of intervention effectiveness (Table 3).

4 | DISCUSSION

Our findings indicated that distraction-focused interventions are suitable to reduce academic stress and anxiety, but effects were limited in exam situations.

Using STAI-State and VASS, we determined elevated psychological stress in all students in examination situations compared with everyday situation. In addition to psychometric assessments, we complemented our study with biomarker measurements. Both parameters of cortisol and IgA indicated elevated physiological stress prior to examinations. These results confirm and extend previous publications underlining good applicability of examinations as a short-term outstanding stress model (Lyndon et al., 2014; Pulido-Martos et al., 2011; Putwain, 2007).

Interestingly, the individual interventions showed different outcomes on the measured stress parameters. Therapy dog intervention and body percussion showed strong effects on cortisol and IgA levels in the everyday situation as well as in exam situations. Psychological stress parameters—as stated before—did not indicate significant stress reduction for any of the three interventions prior to examination. In everyday-situation, only therapy dog intervention showed significant stress reduction in VASS scores as well as STAI-State scores.

Intervention effects on psychological parameters seemed to be more explicit in the VASS as observed differences on the VASS scores were bigger than those of the respective STAI-State scores. However, both assessment tools showed comparable trends, and significant correlation between VASS and STAI-State has been shown previously (Buchberger et al., 2019).

The most interesting finding of our study was that the applied interventions showed different effects on psychological compared with biological stress parameters. Moreover, prior to exams, we observed significant stress-reduction on biological levels only.

These findings could be explained by the cognitive stress model of Lazarus, who highlights the appraisal of the situation as the relevant factor for the feeling of psychological stress (Lazarus, 1990). For the study-participants, the examinations seemed to be outstanding stressors, which negatively affected their appraisal of the situation

TABLE 3 Effects of interventions on self-reported perceived stress and salivary biomarker levels stratified by perceived intervention effectiveness

Perceived effectiveness of intervention			Yes/rather yes						No/rather no					
	Examination	Intervention	N	Median	IQR			*P*	N	Median	IQR			*P*
VASS	No	No	24	3.3	0.8	-	4.8		17	5.0	1.6	-	6.3	
		Yes	24	1.0	0.1	-	1.9	< .001	17	0.9	0.0	-	2.7	.010
	Yes	No	24	6.2	4.5	-	7.8		17	7.9	4.0	-	8.8	
		Yes	24	5.0	4.0	-	7.4	*.181*	17	6.0	3.1	-	9.0	*.285*
STAI-State	No	No	24	40	31	-	48		18	38	33	-	48	
		Yes	24	35	28	-	40	.008	18	34	27	-	45	*.107*
	Yes	No	24	56	48	-	63		18	65	36	-	67	
		Yes	24	56	44	-	61	*.403*	18	57	41	-	70	*.653*
Cortisol [nmol/L]	No	Before	23	14.4	9.1	-	22.1		18	16.4	8.3	-	22.3	
		After	24	8.2	5.1	-	13.5	< .001	18	12.6	5.1	-	15.6	.001
	Yes	Before	24	16.5	9.7	-	21.4		18	16.5	13.6	-	31.8	
		After	24	11.1	7.9	-	13.6	< .001	18	11.4	7.3	-	19.6	.002
IgA [μg/mL]	No	Before	23	16.5	9.4	-	24.6		18	15.9	11.2	-	28.7	
		After	24	20.2	16.3	-	31.1	< .001	18	26.9	17.3	-	40.0	< .001
	Yes	Before	24	20.3	13.0	-	30.0		18	18.0	12.7	-	30.5	
		After	24	25.5	16.4	-	37.6	< .001	18	25.9	14.2	-	41.0	.004

and their ability to cope with it. Therefore, irrespective of significantly declining physiological stress-levels, participants did not report these effects with regard to their subjectively perceived stress. Consistently, the participants' evaluation of intervention-effectiveness had an impact on self-reported perceived stress levels but not on physiological stress response (cortisol/IgA levels).

Different effects of distraction-focused interventions on psychological versus biological parameters have also been reported by Bittman et al. for a group-drumming intervention with adults (Bittman et al., 2001). In contrast, Lai et al. report consistency between subjective and objective measurements of stress in a music intervention study with nurses (Lai & Li, 2011). However, comparability of these studies is limited because of different measurement methods and parameters, settings, study-groups, stressors and interventions.

The interpretation of our findings assumes a clear distinction between the components 'stress', 'anxiety' and 'well-being' as well as their relationship towards the tested parameters has to be clarified. Stressful performance situations like examinations are substantially characterized by 'anxiety', and several authors raise reasonable concerns whether physiological measurements, especially cortisol, are appropriate indicators for anxiety or not (Biddiss et al., 2014; Dawe et al., 2016). Following this argument and in consideration of our own findings, we have to conclude that positive effects on biomarker levels do not indicate psychological well-being or declining anxiety in students in exam situations.

On the other hand, we have to consider various linkages between biochemical and psychological parameters. Previous studies showed positive correlation between self-esteem and cortisol (Laohawattanakun et al., 2011). Moreover, there is evidence for an association between IgA and social support and feeling of control, and increased studying seems to have a protective effect against increased cortisol secretion (Murphy et al., 2010). Recent studies also suggest that the relationship between psychological stress and activity of immune cells (natural killers) is among the most consistent (reviewed in Dawe et al., 2016).

These complex interdependencies between psychological and biological parameters remain enigmatic. Inconsistent and contradictory findings may also reflect different methodology and limited comparability of current studies (Biddiss et al., 2014; Dawe et al., 2016; Unger, Busse, & Yim, 2017).

4.1 | Limitations

The current study had several limitations. First, the small sample size of the intervention-groups made it difficult to draw reliable conclusions about the effectiveness of each intervention. Thus, if one intervention was more effective than the other, this would have to be confirmed by further studies. Second, we measured psychological stress only once after the intervention for the reason that two assessments within 1 h of time would exhaust the participants and reduce their willingness to complete the extensive questionnaire, and answers of the second assessment may be affected by memory of the first. Observed differences between these two assessment dates could have been influenced by other, external factors. We asked the participants for major life events, but we could not control for other potential stressors, for example, extensive workload or lack of assessment preparation, which highly influence examination stress (Lyndon et al., 2014). Third, we recruited first year nursing students from one nursing school only, which may affect the generalizability of our

findings. Future research has to demonstrate the validity of our findings in other/representative samples. Moreover, any beneficial effects of distraction-focused interventions on the study-performance of students would have to be shown by longitudinal study designs.

5 | CONCLUSION

Stress is a multidimensional phenomenon leading to various psychological and biological reactions. The present study demonstrates that the self-perceived stress of a person in a certain situation not necessarily corresponds to their stress biomarker levels. For stress assessment, this means that results may differ, depending on the stress parameters used. Thus, multidimensional methodological approaches are required to investigate a complex phenomenon like stress, particularly when scientists want to understand the negative impacts of stress on health, emotional state and performance.

The crucial question is not which single stress parameter, psychological or physiological, is the 'right' one to assess stress but how these parameters intervene. How do they influence each other, in what way and under which circumstances? The investigation of their interdependencies could be key for better understanding of stress and stress-related outcomes, thus representing an important issue and future task of stress and coping research.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

AUTHORSHIP STATEMENT

All listed authors contributed substantially to this manuscript and take public responsibility for the content. CR, SP, VG, WB conception and design of the study. CR, CZ GT, IK, VG data collection, design and preparation of interventions. CZ, SN analysis and interpretation of data. CR, CZ, VG manuscript preparation. All authors revised the manuscript critically and approved the final version for submission.

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