universität wien

MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

„Effects of Choking Interventions on Performance and Performance Anxiety Symptoms in Musicians"

verfasst von / submitted by

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angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien, 2021 / Vienna 2021

Studienkennzahl lt. Studienblatt / degree programme code as it appears on the student record sheet:	UA 066 840
Studienrichtung lt. Studienblatt / degree programme as it appears on the student record sheet:	Masterstudium Psychologie UG2002
Betreut von / Supervisor:	Ass.-Prof. Mgr. Dr. Peter Gröpel

Acknowledgments

I would like to thank…

…my family and my girlfriend for their support, time and patience.

…Veronika Tief, who supported me with all her knowledge, competencies, feedback, and the time she spent to help me to understand this topic and cope with difficulties this study brought.

…Ass-Prof. Mgr. Dr. Peter Gröpel for his support and feedback to my work.

The data used in this master's thesis were collected as part of a broader research project on choking interventions in the Performing Arts by Veronika J. Tief and Peter Gröpel (University of Vienna), who provided me with the data and recordings of the first phase of this study. Veronika J. Tief is a PhD student supervised by Peter Gröpel, and the data analysed in this thesis were also used by Tief and Gröpel (2020). In particular, Tief and Gröpel tested the effectiveness of choking interventions on performing artists' self-efficacy and performance quality as rated by the participants themselves as well as by expert jurors. For triangulation of performance measures, they then analysed the level of agreement between self-ratings, jury ratings and the ratings by psychology students that I collected for this thesis.

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Abstract

Performing under high pressure is not an easy task, not even for professionals. Students and aspiring professionals are often impacted even more by performance decrements when pressure and anxiety rises. This performance decrement under pressure is called choking under pressure. At the moment, there are several pre-performance routines (PPRs) against choking under pressure which have been proven effective in sports, but still need implementation testing in the field of music. This study tests if music students trained with pre-performance routines like centering, left-hand dynamic handgrip and goal setting show a better performance and fewer behavioural signs of performance anxiety than the control group. 44 violin and viola students and aspiring professionals, assigned to one of the three experimental groups or the control group, performed an excerpt in a low-pressure situation, learned a PPR and then performed in a simulated audition, which was the high pressure situation. Music students performance and behavioural signs of performance anxiety were rated by 20 lay people, who were psychology students, in an online questionnaire. The results showed that there were no significant differences in performance and behavioural signs between the three study groups and the control group. Future studies should test the intervention in a real concert hall with more control over the standardisation in the pre- and post-test.

Keywords: music, choking, anxiety, performance, behavioural signs

Introduction

The job of professional athletes and musicians is to train and practice for a long time in situations with almost no or very low pressure and then show their peak performance in a high-pressure situation like a competition, or, for musicians, an audition or concert. This can be very challenging for professionals who are highly skilled in their task and is even harder for young aspiring professionals (Buma et al., 2015). This is caused by the fact that students and young athletes often lack experience and coping mechanisms for situations with high pressure (Pecen et al., 2018). As it is necessary in an audition or competition to perform at peak, this pressure may lead to a suboptimal physical and psychological state with heightened anxiety and loss of focus, which can decrease the performance output (Osborne et al., 2014). This suboptimal performance in a high pressure situation is called choking under pressure (Baumeister, 1984).

Choking under pressure describes a substandard performance in a pressure situation although the person is highly skilled and trained (Gröpel & Mesagno, 2019). Sport psychologists developed strategies and interventions like pre-performance routines (PPR) and left-hand dynamic handgrip to deal with choking and to perform well under pressure (Gröpel & Mesagno, 2019). These interventions have been tested for effectiveness with musicians because they are in similar low- and high-pressure situations as athletes. Recent studies have shown that a mixture of mental skills training, physiological awareness and the PPR centering has a positive effect on music performance (Cohen & Bodner, 2018) and that PPRs can also affect self-efficacy (Tief & Gröpel, 2020). Another effect of PPRs is that these interventions can reduce behavioural signs of performance anxiety. Cohen and Bodner (2018) reported in their study that the PPRs they used had a positive effect on their participants and that the judge-rated behavioural signs of music performance anxiety were significantly reduced in comparison to the control group. So far, performance and behavioural signs of music performance anxiety have only been evaluated by professional musicians. As they are professionals, they are more likely to notice subtle differences in comparison to lay people, who are in most cases the audience of musicians.

The aim of this study is to check if there is a noticeable difference for lay people in performance and behavioural signs of performance anxiety in music students, who have been taught sport psychological interventions and to find out which pre-performance routine is the most effective for musicians. In the following sections of this thesis the theoretical backgrounds of the study, choking under pressure and its two different models, interventions against choking and performance anxiety, will be discussed.

Choking under Pressure

Choking under pressure (referred to as choking hereafter) was described by Baumeister (1984) as an inferior performance although the person strived for their individual best, as the situation demanded it. Baumeister (1984) stated that choking mostly appears under pressure conditions like competitions. This is based on the fact that anxiety is a crucial factor for choking and as anxiety increases, the attention of the performer rather focuses on unimportant information for the performance, like internal or external distractions. Thereby, the important information for the performance is left unattended (Mesagno & Beckmann, 2017). Gröpel and Mesagno (2019) mentioned that two further aspects need to be fulfilled for a behaviour to be classified as choking. The first one is that the person has the skill to perform better and the second one is the intention to perform better. This implies that choking can only occur to skilled people and not to novices (Gröpel & Mesagno, 2019). In both papers mentioned above (Gröpel & Mesagno, 2019; Mesagno & Beckmann, 2017) the researchers focused on the attentional model with its two parts: the distraction model of choking and the self-focus model of choking.

Distraction Model of Choking and Interventions. Current reviews describe the distraction model as a shift in attention from task-relevant cues to irrelevant cues as the result of heightened anxiety (Gröpel & Mesagno, 2019; Mesagno & Beckmann, 2017). The distractions can be internal or external. Internal distractions are worries, feelings or thoughts about the current situation the person is in and may exceed the attentional span of the person and may limit the capacity available for task-relevant cues (Mullen et al., 2005). External factors like audience or loud noises can also result in a shift in attention to the irritants and have the same negative effects as internal distractions.

The distraction model was the basis for developing interventions that enhance focus on task-relevant cues in performance situations (Gröpel & Mesagno, 2019). The goal of distraction-based interventions is to prevent the shift from relevant to irrelevant internal and external distractions and therefore maintain a high performance (Gröpel & Mesagno, 2019). One of the most used and evaluated interventions in sport psychology for the distraction model are pre-performance routines (PPR; Mesagno & Beckmann, 2017). PPRs are behavioural or cognitive routines that a person can use right before the performance like deep breathing, cue words, centering or countdown to performance (Gröpel & Mesagno, 2019; Mesagno & Beckmann, 2017; Osborne et al., 2014).

Different studies in different sports like in ten-pin bowling (Mesagno et al., 2019), free throws in basketball (Lonsdale & Tam, 2008), and putting in golf (Hill et al., 2011) have proven the effectiveness of PPRs on performance. Mesagno and Mullane-Grant (2010) demonstrated in their study with accurate shooting in football that the combined use of different PPRs can have an even better effect on enhancing performance. The mix of using different PPRs like centering, cue words, deep breathing and releasing muscle tension have been proven to have a stronger effect on performance (Mesagno & Mullane-Grant, 2010) than using only one element of a PPR, for example deep breathing.

One PPR that was used for this study was centering. This pre-performance routine is based on the work from Nideffer (1985) and is a self-regulating technique to maintain control over tension, concentration and pressure and can also be used as a mid-performance routine (Nideffer, 1985; Osborne et al., 2014). This technique has also been adapted for music performance by Greene (2002) to help the musicians refocus their attention and perform a musical piece at a high level, even under high pressure. It consists of five main aspects: (a) finding a focal point, (b) deep abdominal breathing, (c) releasing excess muscle tension, (d) finding one´s centre of mass and distributing one´s body weight around it, and (e) developing a specific cue to which to direct attention after having centered (Greene, 2002, as cited in Tief & Gröpel, 2020).

Most PPRs have been used in sports and there is still the need to do more research in the field of music performance. Existing studies of PPR and its effect on music performance lack in their study design such as no control group, a control group assigned with a less effective intervention, no pressure condition or only used self-reports to measure the outcome variable (Clark & Williamon, 2011; Kinne, 2016; Osborne et al., 2014; Tief & Gröpel, 2020). It is therefore hard to say, if PPRs really have a performance enhancing effect in music and these interventions need further testing.

Self-Focus Model of Choking and Interventions. This model proposes that choking occurs, when the performer focuses their attention to the execution of an automated motor skill as anxiety heightens (Mesagno & Beckmann, 2017). One of the reasons for this is the fact that motor skills are often learned explicitly (e.g., where to stand or how to move the hand and fingers). This explicit knowledge of motor skills can lead to a conscious monitoring and controlling of movement under pressure (Gröpel & Mesagno, 2019). Beilock and Carr (2001) developed the explicit monitoring approach, which proposed that performance is impaired under

pressure because more attention is paid to the step-by-step execution of well-learned behaviour and skills. Beilock and Carr's (2001) approach has been further developed by Jackson et al. (2006) as explicit monitoring negatively effects performance when the performer tries to consciously monitor and control movements. Therefore, it is important for skilled performers to execute their well learned, automated motor skills without monitoring and controlling them, because this behaviour can lead to performance decrements under pressure. Masters (1992) showed with his study that golfers, who learned putting with explicit knowledge, had a performance decrease under pressure, whereas golfers who learned putting implicitly had a constantly improving performance, even under pressure.

In traditional learning theories, motor skills are generally learned explicitly via cognitive processes and produce declarative knowledge to guide the performance of motor skills (Steenbergen et al., 2010). To maintain high performance under pressure, even with explicitly learned skills, sport psychological interventions on base of the self-focus model have been developed. The purpose of these interventions is to minimise the reinvestment of explicit knowledge and the conscious control of automated motor skills (Gröpel & Mesagno, 2019). Some of these interventions are the quiet eye training (QE training), dual task, analogy or implicit learning, process goals and left-hand contractions (Gröpel & Mesagno, 2019; Mesagno & Beckmann, 2017). In this study, left-hand contractions will be used as an intervention, so the focus of the next paragraph will be on them.

Left-hand contraction is a technique, where the athlete or musician has to press a soft ball two times per second for 30 seconds. This technique is used as an intervention in this study, because there is evidence that it can help to minimise reinvestment of explicit knowledge and conscious control of automated motor skills. Beckmann et al. (2013) reported in their study that in the three different sports they used in their experimental pre-post design, football, tae kwon do and badminton, the participants who used left-hand contractions before a pressure situation showed a better performance than the group which used right hand contractions. Except from Beckmann et al. (2013) there are some other studies, which have tested left-hand contractions as an intervention against chocking. Gröpel and Beckmann (2017) used left-hand contractions as an intervention for gymnasts in two studies and in both studies the experimental group had a better performance under pressure than the control group. Another study testing the effectiveness of left-hand contractions on bowlers also found a significant effect on improving the accuracy and the performance in comparison to the control group (Mesagno et al., 2019). The authors Beckmann et al. (2013) thought that the reason behind the performance enhancing effect under

pressure was hemisphere-specific priming induced by unilateral hand contraction. The assumption for this was that the inhibition of the left hemisphere and a shift of activation to the right hemisphere of the brain was linked to executing automated motor skills in golfers (Crews & Landers, 1993) and elite archers (Salazar et al., 1990). Further research has proven that it is not a shift in hemispheric activation but rather a reduced overall cortical activity and higher alpha band amplitude which is enhancing the performance under pressure (Cross-Villasana et al., 2015). Cross-Villasana et al. (2015) stated that the reduction in activity of the cortex and a higher amplitude of the alpha band started as the unilateral contractions ended and it was stronger when the left hand was used for the contractions. Mirifar et al. (2020) also replicated the results of the study of Cross-Villasana et al. (2015) and corroborated their results, although the effects were lower than in the initial study. The performance enhancing effect is presumably due to the fact that left-hand contractions inhibit activity in the left hemisphere and enhanced alpha levels help reduce the task-irrelevant activity in the cortex, which promotes task focus (Mirifar et al., 2020) and helps to eliminate conscious control of automated behaviour (Gröpel & Beckmann, 2017). Overall, left-hand contractions have been proven to positively affect the performance under pressure in different sports. One very positive aspect of left-hand contraction is that it is very easy to learn and simple to include into practice. As for professionals or aspiring professionals free time to learn new things is not always available, such an easy and simple intervention can come in handy.

Another intervention from the self-focus model is goal setting. This intervention is included, as Tief and Gröpel (2020) used goal setting in their study as a control intervention when testing the effectiveness of a PPR. In contrast to their hypothesis, they found no difference between the PPR and goal setting group as their music performance, which was judged by professionals, did not significantly differ. One explanation for this result might be that many music students lack an effective structure for daily practice (Burwell & Shipton, 2013) and that the music students with the goal setting strategy were able to practice more efficiently and had a better track of their progress than those without goal setting. Hence, they were less nervous and anxious before their performance and performed similar to the PPR group. Goal setting is in general a widely used technique to reach a person’s goals. For the purpose of effective goal setting, Kyllo and Landers (1995) found out that goals need to be individual, personal and specific and on the timeline there need to be short, medium and long term goals. These findings are consistent with the study by Hatfield (2016), where music students with general goals had a random and inexact daily practice and often did not know how to handle problems and how to

exactly plan their practice. Additionally, the greatest effect of goal setting on performance could be seen, when the goals were set cooperative and trimmed to the person and not when the goals were just assigned to the person (Kyllo & Landers, 1995). A study by Filby et al. (1999) tested the difference between different methods of goal setting (e.g. process goals, outcome goals and a mixture of them) and found out that students with multiple goals set had a better performance in a competitive situation than the control group or groups with single goals set. Because of these findings goal setting is a viable option to reach one's goals and achieve a good performance in pressure situations. Especially in music performance it is important to be able to practise effectively as a deficit in practice can reduce the musical competency and lower the overall performance and increases the likelihood to develop music performance anxiety (Patston & Osborne, 2015).

Music Performance Anxiety

Anxiety is a normal reaction to perceived danger and helps to enable a fast response to it (Osborne et al., 2014). Anxiety has an effect on different parts in a person: it can cause physical, cognitive, emotional and behavioural changes (Kenny, 2011). These changes are also triggered, when a musician experiences music performance anxiety (MPA) and can occur, if musicians are asked to perform, especially in an audition or in front of audience. The cognitive changes are often complex, as the musicians can worry about not being able to perform well, may fear about making mistakes or being negatively evaluated by others, can overestimate the negative consequences of a bad performance or have a negative self-evaluation in relation to the high performance expectations to themselves (Kenny & Osborne, 2006; Osborne et al., 2014). Typical physical changes in musicians are a racing heart, dry mouth, sweating, trembling etc. which can disrupt the fine motor skills needed for playing an instrument (Yoshie et al., 2009). Some of these behavioural changes cannot be noticed from a bystander, as they are located within the individual, but there are also signs of music performance anxiety which can be observed. Behavioural signs of MPA are nervous movements like tics, twitches, pulling faces and trembling, tense shoulders and body posture, lack of eye contact, breathlessness and can even be things like forgetting the music or lyrics and stopping the performance (Cohen & Bodner, 2018). All these problems can occur if anxiety develops and exceeds the optimal level, which normally has a facilitating effect on performance (Yoshie et al., 2009).

MPA reaches its highest levels right before or during the performance for most of the musicians (Van Kemenade et al., 1995). MPA is not a problem that occurs from time to time for

single musicians, it is a problem for many. Many elite musicians reported that they suffered from MPA when they were students in conservatoire (Pecen et al., 2018) and almost 60% reported that they suffered from MPA at least one time in their career (Krawehl & Altenmüller, 2000). There is also a gender difference when it comes to quantity and quality of experiencing MPA. Women are prone to experience MPA more often whereas men experience MPA stronger than women (Fernholz et al., 2019). Literature pinpoints, that music students are generally more prone to MPA than professionals as they lack in experience and coping mechanisms (Biasutti & Concina, 2014). Fehm and Schmidt (2006) analysed MPA in young music students for their coping mechanisms. Most of them reported rehearsing, positive thinking, praying, smoking, relaxation and using calming substances as short-term coping strategies. In a more recent study, Oudejans et al. (2016) found out that young musicians have more worries and less positive thoughts than professional musicians, which facilitates performance anxiety. These findings match the results of Steptoe and Fidler (1987), where they found a negative correlation in music students between positive thoughts and MPA, and a positive correlation between catastrophizing and MPA. Therefore, coping strategies like positive thinking might not be the most effective coping strategy against music performance anxiety as the performer has to overcome the negative thoughts and worries to think positive. Some other ways to deal with MPA are distal methods like extensive mental skills training, medication, and therapeutic treatment like cognitive behavioural therapy (Brugues, 2011; Kenny, 2005). These strategies are also not optimal, as they may not be applicable right before the performance or may have other side effects. Medication, for example, is by far one of the easiest ways to reduce MPA and individuals normally tend to use easy and quick solutions, but they are not as effective as cognitive behavioural approaches and they can have impactful negative side effects like lowered reaction times and addiction (Kenny, 2004).

Therefore, other simple and easy to use strategies are in need to counter the performance-reducing effect of MPA and help especially young aspiring professionals to perform at peak level when the stakes are high. As the interventions from sport psychology like centering and left-hand contractions help athletes show their best performance even under pressure and high anxiety levels (e.g. Gröpel & Mesagno, 2019; Mesagno & Beckmann, 2017), these interventions should also help musicians to perform under pressure.

The Present Research

Music performance anxiety is for both professionals and music students a big problem (Steptoe & Fidler, 1987). However, music students are often more affected by MPA than professionals, as they lack audition and concert experience and do not have effective strategies to deal with anxiety (Biasutti & Concina, 2014; Pecen et al., 2018). Sport psychologists have developed and successfully applied different interventions like pre-performance routines and left-hand contractions to help athletes to focus on performance and relevant cues in high pressure situations to prevent them from choking under pressure as their anxiety rises (for reviews, see Gröpel & Mesagno, 2019; Mesagno & Beckmann, 2017). These interventions have also been used in the recent years to improve performance and reduce choking in musicians with inconclusive results (e.g. Cohen & Bodner, 2018; Tief & Gröpel, 2020). Another intervention that might help young music students to cope with anxiety, is goal setting. As Tief and Gröpel (2020) have found no difference between the effectiveness between PPRs and goal setting, it is important to test if goal setting has a similar effect on performance for musicians as other PPRs, like centering and left-hand dynamic handgrip have for athletes in comparison to a control group. Another important aspect of music performance is how the musicians are perceived on stage by the audience and how their performance and appearance is judged by them. Up to date, there are no studies on the perception of students trained with sport psychological interventions to reduce choking and behavioural signs of performance anxiety rated by lay people. Thus, I propose the following two hypotheses.

> H1: The three intervention groups – PPR, left-hand dynamic handgrip, and goal setting will show better performance under pressure than the control group under pressure, with the PPR and dynamic handgrip groups showing the best performance.

> H2: The three intervention groups – PPR, left-hand dynamic handgrip, and goal setting will show fewer behavioural signs of anxiety for their performance under pressure than the control group under pressure, with the PPR and dynamic handgrip groups showing the fewest signs.

Method

Design

The study was prospective, randomized and blinded with two different phases. Phase one was used for the pre- and post-test to teach the music students the interventions and gain the video samples for phase two, which was used to elicit assessments of the dependent variables. A G*Power analysis (Faul et al., 2007) was realised a priori to the study. With the medium to large effect size Cohen´s $f = 0.33$ and $\alpha = .05$, a sample size of 32 music students should be sufficient to reach the intended power (.80) and to detect significant differences between the groups. The medium to large effect size was based on the results of prior studies on PPRs in sports (Beckmann et al., 2013; Lautenbach et al., 2015; Mesagno & Mullane-Grant, 2010).

The study was a 2 x 4 (Phase X Group) between-within subjects design. There were four groups: the centering, the left-hand contraction, the goal setting and the control group. In order to collect the video material, two measurements time points were set in the first phase of the study. The music students had to record themselves while performing a classical music piece during a low and high pressure setting. In phase two, psychology students were asked to judge the music performance and the behavioural signs of performance anxiety of the music students in the videos. The two different phases are described below.

Participants – Phase 1

Phase one began with the recruiting of international music students or aspiring professionals in the field of classical string music, specifically, viola and violin. A short video has been made to attract interest and gain a sufficient sample size for the musicians. A total of 46 musicians from 22 nations participated in the study. The videos and data of two musicians had to be completely excluded for phase 2. The reason for the first exclusion was exceptionally bad video quality and the second one had to be excluded because there was important data missing from the pre- and post-test. The data of cognitive anxiety from one participant had to be excluded as the difference between the pre- and post-test for his score was three standard deviations over the mean in contrast to the rest of the sample. The data of performed auditions so far had to be winsorized for another participant, because it was three standard deviations above the mean. Details of the participants of phase one are given in Table 1.

Table 1.
Description of the study sample from phase 1 (N = 44)

Characteristics	Study sample
Age in years, *M* (*SD*)	26.43 (4.46)
Gender, female, n (%)	36 (81.82)
Skill level, n (%)	
Undergraduate (1st/2nd year)	6 (13.63)
Undergraduate (3rd/4th year)	12 (27.27)
Graduate	13 (29.55)
PhD	13 (29.55)
Played instrument, n (%)	
Violin	37 (84.09)
Viola	7 (15.91)
Years playing the instrument, *M* (*SD*)	19.14 (4.44)
Practice (hours/week), *M* (*SD*)	20.32 (7.24)
Performed auditions so far, *M* (*SD*)	8.61 (6.94)
Chosen piece, n (%)	
Mozart KV218	13 (29.55)
Mozart KV219	24 (54.55)
Stamitz	5 (11.35)
Hoffmeister	2 (4.55)
Trait Anxiety *M* (*SD*)	3.08 (0.97)

Participants – Phase 2

The participants for the second and actual phase of the study were recruited with the LABS-system of the University of Vienna. The applicants had to fulfil several criteria in order to be allowed to participate in this study. They needed excellent written and spoken German skills, had to be active students of the Faculty of Psychology of the University of Vienna and they had to be undergraduate students. Also, only students who met the criteria above and were registered to one of the following courses were allowed to participate: STEOP: Psychologische Forschung erleben (Experience Psychological Research), a social psychology course and voluntary participation in social psychology studies. For completing the study in the lab, the participants were granted four LAB-Credits which they needed to complete their courses. Overall, 20 participants were needed for this study as two evaluations of every video were needed.

Psychology students were chosen for the evaluations, as they should be able to recognise behavioural signs of performance anxiety better than the general population.

Due to technical problems, 23 people needed to be recruited, but only 20 evaluations were selected for the analysis. From the videos which were evaluated by three participants, one out of the three was randomly outlined with random numbers (Microsoft Excel; Microsoft, Redmond, WA, USA). Detailed descriptions of the participants from Phase 2 are in Table 2.

Table 2.
Description of the study sample from phase 2 (N = 20)

Characteristics	Study sample
Age in years, *M* (*SD*)	20.90 (2.75)
Gender, female, n (%)	15 (75.00)
Education, n (%)	
Matura	19 (95.00)
Realschule	1 (5.00)
Music instrument played, n (%)	
Yes, actively playing	5 (25.00)
Yes, not actively playing	10 (50.00)
No, never played	5 (25.00)
Years played, *M* (*SD*)	6.60 (3.78)
How often listening to classical music, n (%)	
Several times per week	3 (15.00)
Several times per month	5 (25.00)
Once per month or less	9 (45.00)
Never	3 (15.00)
Knowing classical music pieces, n (%)	
A lot	2 (10.00)
Many	4 (20.00)
Some	3 (15.00)
Few	10 (50.00)
None	1 (5.00)

Procedure

Phase 1. The music students were randomly assigned to the three different experimental groups (PPR, left-hand contractions, goal setting) or to the waitlist control group. There were two measurement time points, one with low pressure and one with high pressure to test the effectiveness of the interventions. All sessions were held via videocall (Zoom; Zoom Video Communications, San Jose, CA, USA). At first, the participants had to choose two excerpts they wanted to perform in the sessions. They had to choose out of four classical pieces, each of them being a standard repertoire for orchestra auditions to ensure ecological validity. The four pieces were: Mozart KV218, Mozart KV219, Stamitz op. 1 and Hoffmeister, concerto for viola and orchestra in D major. A pre-test was conducted to get the baseline performance with low pressure. The music students had to fill in several questionnaires regarding self-efficacy, trait anxiety and cognitive and somatic state anxiety before they started playing. They had to record themselves while playing and share the videos with the researchers. After the low-pressure performance, the music students had to rate their own performance. Then, the participants learned their intervention in one-on-one sessions on Zoom from a psychologist over a period of four weeks. Each participant had at least three weeks to train the intervention and practise their chosen excerpt. The last part of phase one was the post-test with a simulated high-pressure situation. There were overall six meetings on Zoom, where between seven and eleven music students participated. These sessions were moderated and there were several methods used to induce pressure. At first, there were three professional musicians who were also lecturers at music universities in the call acting as jurors and giving feedback on the student's performance. The participants got a randomly assigned start number, which defined the order of introducing themselves, could start their performance and receive feedback. The participants had to upload their videos on Youtube (Google LLC, San Bruno, CA, USA), so that the jurors could watch their performance and give feedback. Before the music students were allowed to play and record their chosen excerpt, they had to fill in the same questionnaires from the pre-test again. Directly after they performed the excerpt, the music students again had to rate their own performance, like in the low-pressure setting. When the music students received their feedback from the jurors, they were allowed to leave the session. In the following two weeks after the post-test the music students were debriefed by the psychologist who trained them in the first place.

Phase 2. The second phase of the study was conducted with the online questionnaire software UniPark (Questback, Oslo, Fylke, Norway) in a laboratory at the University of Vienna. In phase two, the videos from the pre- and post-test of the music students were shown to the psychology students. The structure of the questionnaire was as follows. There were overall ten quotes. A quote can be seen as a group of videos and each participant completed only one quote with overall twelve videos. At the beginning of a quote the participants gave consent regarding data protection and had to fill in the first demographic variables (age, gender, and education). This was followed by a detailed description of the tasks the participants had to do in the questionnaire and the opportunity to ask questions before the initial study started. At the beginning the students were shown two videos from two different professional musicians, one performing a different classical music piece than the music students from the quote and one performing the same classical music piece as the students. The two videos of the professional musicians were used to get the psychology students familiar with classical music, how professional musicians behave and perform and to get familiar with the questions regarding performance and behavioural signs of music performance anxiety. After the two videos of the professional musicians, the participants saw the pre- and post-test videos from the music students. There were overall ten videos from five music students and the pre- and post-test videos were presented alternatingly to the participants to prevent them from guessing which video was from pre- and post-test. After the videos, the participants had to answer questions regarding their musical skills and knowledge. After this part, they had the option to give feedback to the study. The last part was the debriefing of psychology students which was conducted by the study author.

Measurements

All questionnaires were provided in German, as the target population were German speaking undergraduate students from the Faculty of Psychology in Vienna.

Music Performance. Music performance was evaluated with one item in German: “Wie schätzen Sie die musikalische Leistung des Musikers / der Musikerin ein?”. The participants could answer on a 6-point scale from 1 (*very bad / sehr schlecht*) to 6 (*very good / sehr gut*).

Behavioural Signs of Performance Anxiety. Behavioural signs of performance anxiety were evaluated with the adapted scale of Cohen and Bodner (2018). Five behavioural signs were evaluated with the following question at the beginning: "Wie stark hat der/die Musiker/-in die folgenden Verhaltensweisen gezeigt?". Afterwards, the five behavioural signs of performance anxiety should be rated: nervous movements (e.g., trembling), tense appearance (e.g., tense shoulders), technical problems (e.g., unstable rhythm, loss of fluency), breathlessness / lack of air and forgetting / stopping music on a 7-point scale from 1 (*very weak / sehr schwach*) to 6 (*very strong / sehr stark*). The seventh option was "*nicht bewertbar*" (*non-evaluable*). This evaluation of the behaviour was interpreted in the way that the behavioural sign was not observable and therefore counted as the value 0. The mean of each participant was calculated over all five items for the pre- and post-test to get the mean score for the behavioural signs of performance anxiety.

Results

The data has been analysed with IBM SPSS Statistics 27 (IBM, Armonk, NY, USA).

Homogeneity of the Groups

A chi-square test was conducted to test if there were any differences between the four groups from phase one regarding the proportion of men and women and showed no significant differences, $\chi^2(3) = 3.86$, $p = .277$, $\varphi = 0.29$. Furthermore, a one-way analysis of Variance (ANOVA) was conducted to test for differences between the different variables of the groups. There were no significant differences between the groups regarding age, skill level, practice hours per week, years playing the instrument and trait anxiety. In Table 3 the details and results of the one-way ANOVA of Phase 1 are presented.

Table 3.
Description of the study groups: means (standard deviations), F test, significances and effect sizes.

	PPR (n = 11)	LHDH (n = 12)	GS (n = 11)	WLC (n = 10)	F	Significance	η^2
Age (years)	26.18 (3.71)	26.17 (5.24)	25.91 (4.68)	27.60 (4.45)	0.29	.832	0.02
Auditions	10.64 (8.52)	7.58 (5.96)	7.09 (5.91)	9.30 (6.94)	0.59	.624	0.04
Years playing the instrument	19.82 (3.68)	17.75 (5.05)	18.82 (4.60)	20.40 (4.40)	0.75	.527	0.05
Practice (hours/week)	19.18 (7.53)	18.92 (7.74)	21.55 (7.58)	21.90 (6.42)	0.49	.624	0.04
Trait anxiety	3.22 (1.25)	2.96 (0.74)	3.19 (0.94)	2.93 (1.00)	0.25	.862	0.02

Note: PPR = Pre-Performance Routine, LDHD = Left-Hand Dynamic Handgrip, GS = Goal Setting, WLC = Wait List Control Group, df = 3, 40

State Anxiety

A 2 X 4 (Phase X Group) repeated measures ANOVA was conducted for cognitive and somatic anxiety. There was a statistically significant effect of the test phase on cognitive anxiety $F(1, 39) = 5.44$, $p = .025$, $\eta_p^2 = .12$, but not a significant main effect of Group $F(3, 39) = 0.88$, $p = .458$, $\eta_p^2 = .06$ and there was also no significant interaction $F(3, 39) = 0.75$, $p = .529$, $\eta_p^2 = .05$. Because of higher cognitive anxiety levels in the post-test compared to the pre-test, the pressure manipulation was effective.

For somatic anxiety, there was no significant main effect of Phase $F(1, 40) = 0.51$, $p = .479$, $\eta_p^2 = .01$ or Group $F(3, 40) = 0.55$, $p = .649$, $\eta_p^2 = .04$ and there was also no significant interaction $F(3, 40) = 1.01$, $p = .398$, $\eta_p^2 = .07$. The means and standard deviations for both cognitive and somatic anxiety are displayed in Table 4.

Table 4.
Means (standard deviations) of cognitive and somatic anxiety from the pre- and post-test.

	Centering (n = 11)	LHDH (n = 12)	GS (n = 11)	CG (n = 10)	Significance		
					Group	Phase	Interaction
			Cognitive Anxiety				
Pre	45.00 (29.92)	41.09 (15.21)	49.00 (19.84)	42.00 (23.56)	.458	**.025**	.529
Post	51.09 (29.48)	58.00 (21.90)	64.55 (24.68)	43.40 (27.86)			
			Somatic Anxiety				
Pre	44.00 (28.13)	53.25 (20.92)	49.18 (23.85)	56.90 (29.72)	.649	.479	.398
Post	49.27 (28.48)	53.33 (20.61)	65.45 (25.87)	49.30 (26.50)			

Note. LHDH = Left-Hand Dynamic Handgrip; GS = Goal Setting; CG = Control Group.
p values below .05 are marked in bold.

Music Performance

A 2 X 4 (Phase X Group) repeated measures ANOVA was conducted on the evaluation of music performance by the lay people from phase two. There was no significant main effect for Phase $F(1, 40) = 0.17$, $p = .683$, $\eta_p^2 < .01$ and Group $F(3, 40) = 1.55$, $p = .216$, $\eta_p^2 = .10$ and there was also no significant interaction $F(3, 40) = 1.41$, $p = .254$, $\eta_p^2 = .10$, showing no support of H1. The means and standard deviations for music performance are displayed in Table 5.

A one-way random effects intra-class correlation (ICC) was calculated for the agreement between the two raters of each quote. For both, the pre- and the post-test, the intra-class correlations are poor. The results for the intra-class correlation for performance from the pre-test and the post-test are shown in Table 6.

Table 5.
Means (standard deviations) of music performance from the pre- and post-test.

	Centering (n = 11)	LHDH (n = 12)	GS (n = 11)	CG (n = 10)	Significance		
					Group	Phase	Interaction
Pre	5.22 (0.52)	4.42 (0.90)	4.77 (0.47)	5.00 (0.74)	.216	.683	.254
Post	5.09 (0.83)	4.75 (0.62)	4.77 (0.82)	4.95 (0.83)			

Note. LHDH = Left-Hand Dynamic Handgrip; GS = Goal Setting; CG = Control Group.

Table 6.
Intra-class correlation (ICC) for the pre- and post-test measures of music performance over all raters using one-way random effects.

	ICC	95% Confidence Interval		F Test With True Value 0			
		Lower bound	Upper Bound	F	df1	df2	p
Pre-test	.48	.05	.71	1.91	43	44	.017
Post-test	.28	-.323	.60	1.38	43	44	.146

Behavioural Signs of Performance Anxiety

A 2 X 4 (Phase X Group) repeated measures ANOVA was conducted on the evaluation of behavioural signs of performance anxiety from the lay people from phase 2. There was no significant main effect for Phase $F(1, 40) = 1.81$, $p = .186$, $\eta_p^2 = .04$ and there was also no significant interaction $F(3, 40) = 1.05$, $p = .381$, $\eta_p^2 = .07$. But there was a significant main effect for Group with $F(3, 40) = 3.50$, $p = .024$, $\eta_p^2 = .21$.

The significant difference between the groups was further analysed with a one-way ANOVA. It revealed that there were significant differences in the pre-test between left-hand dynamic handgrip group ($M = 2.06$, $SD = 0.61$) and the control group ($M = 1.48$, $SD = 0.16$), (0.60, 95%-CI[0.19; 1.18]), $p = .045$ and between the goal setting group ($M = 2.12$, $SD = 0.66$) and the control group ($M = 1.48$, $SD = 0.16$), (0.64, 95%-CI[0.04; 1.24]), $p = .032$ with $F(3, 40) = 4.14$, $p = .012$, $\eta^2 = .24$. All of these results show no support of H2.

A one-way random effects intra-class correlation (ICC) was calculated for the agreement between the two raters of each quote. For both, the pre-test and the post test, the intra-class correlations are poor. The results for the intra-class correlation for behavioural signs of performance anxiety from the pre-test and the post-test are shown in Table 8.

Table 7.
Means (standard deviations) of behavioural signs of performance anxiety from the pre- and post-test.

	Centering (n = 11)	LHDH (n = 12)	GS (n = 11)	CG (n = 10)	Significance		
					Group	Phase	Interaction
Pre	1.65 (0.43)	2.08 (0.61)	2.12 (0.66)	1.48 (0.16)	.024	.186	.381
Post	1.75 (0.60)	1.98 (0.52)	2.25 (0.70)	1.74 (0.58)			

Note. LHDH = Left-Hand Dynamic Handgrip; GS = Goal Setting; CG = Control Group.

Table 8.
Intra-class correlation (ICC) for the pre- and post-test measures of behavioural signs of performance anxiety over all raters using one-way random effects.

	ICC	95% Confidence Interval		F Test With True Value 0			
		Lower bound	Upper Bound	F	df1	df2	p
Pre-test	.49	.07	.72	1.95	43	44	.015
Post-test	.23	-.41	.58	1.29	43	44	.200

Discussion

The goal of this study was to test if the pre-performance routines centering and left-hand dynamic handgrip are effective against choking under pressure and help to reduce behavioural signs of performance anxiety and maintain a high performance level under pressure. Lay people judged the videos from the pre- and post-test regarding performance and the behavioural signs of performance anxiety. Centering and left-hand dynamic handgrip have been proven as effective interventions against choking under pressure as prior evidence suggests from bowling (Mesagno et al., 2019), football (Mesagno & Mullane-Grant, 2010) and even longer tasks like the performance of artistic gymnasts (Gröpel & Beckmann, 2017). Although there are several studies which prove the effectiveness of PPRs in sports, there recently is only one study by Tief and Gröpel (2020) which tested specifically PPRs on music students. The results of the study from Tief and Gröpel (2020) were consistent with the results from this study, where the intervention had no significant effect on performance. One possible explanation for this might be the different video and audio quality of the videos. The music students received an exact explanation on how to film themselves for their performance but not all of them followed the instructions. The results were varying light situations, different fields of view, varying distance to the camera, varying sound quality and different volume. Some music students wore for the pre-test video casual clothes and nice dresses or shirts for the post-test with the jury feedback, although they were instructed to wear the same clothes for both videos. Let alone this difference in the appearance of the music students could have led to different assumptions by the participants in phase two. A more standardised situation would be necessary to diminish the influence by these factors. For example, when all the music students are recruited from one university, the pre-test could take place in a practice room of this university, where distance, lighting, sound and video quality is standardised for all music students. Also, the post-test should take place in a concert hall to mimic the audition situation even better and standardised settings for all music students should be used.

This study also tested if centering, left-hand dynamic handgrip and goal setting had an effect on behavioural signs of performance anxiety. The results revealed that there was no significant difference between pre- and post-test and no interaction but a significant difference between the groups in the pre-test. As there was no difference between the behavioural signs of performance anxiety between pre- and post-test, hypothesis two was not supported by the data. These results are different from the findings from Cohen and Bodner (2018), where they found

that a mixture of different PPRs and mental skills lead to less behavioural signs of performance anxiety in the second pressure situation in contrast to the first pressure situation. Kenny (2004) stated that generally the most effective interventions against music performance anxiety are methods like progressive muscle relaxation, mental rehearsal, or attention-focussing techniques. From this point of view, the methods used in this study should have been generally effective against choking under pressure, although there was no evidence found for it in this study. One of the reasons could that somatic state anxiety did not significantly increase from pre- to post-test. As somatic anxiety did not rise as much as cognitive anxiety, the music students did not show many behavioural signs and the participants from Phase 2 were therefore not able to detect significant changes from pre- to post-test.

The intra-class correlation from the participants in this study is also rather interesting. In most studies judges are evaluating the performance of musicians or athletes, who are themselves expert in the field they are judging. Therefore, the intra-class correlation is generally high with values about .70 to .90 (e.g. Cohen & Bodner, 2019; Tief & Gröpel, 2020), but in this study, the intra-class correlation between the lay people was poor for performance and behavioural signs of performance anxiety and for both measures in the post-test not even significant. This implies that the ratings in the post-test are very different from each other and the congruence from both psychology students in each quote is very low. One reason for the low ICC could be the different knowledge and musical background of the participants. From 20 people, five had no musical experience and five were still playing an instrument. The rest played an instrument in the past. Another possible explanation could be that the study was perceived as monotone because the psychology students had to watch videos of the same music piece eleven times and they had to put a lot of effort into detecting even small differences in behavioural signs of performance anxiety. Another reason for low intra-class correlation for behavioural signs of performance anxiety may be that they were very subtle and hard to detect on the videos. Therefore, each person may lay a different focus on a behavioural sign, which leads to the low intra-class correlation.

The participants of phase two, the psychology students, can be seen as a strong point but also a weak point of this study. One reason why psychology students were chosen was that they should be able to notice subtle differences and changes in behaviour as it is part of their studies and future profession to observe behaviour and rate it. Therefore, they should be able to notice even small changes in the behavioural signs of performance anxiety and assess them more precise by the given scales than the average population. The downside of this choice of

participants was that three quarters of the participants had experience in music. Their prior knowledge of music could potentially affect the rating on music students and therefore distort the results. For further research it could be interesting to see if there are differences in the ratings between lay people with and without musical knowledge and competencies.

In general, the study has an overall high ecological validity with the standard audition repertoire, an effective pressure manipulation via video taping (DeCaro et al., 2011), feedback from professional musicians and a simulated audition setting with a random order in which the music students had to introduce themselves and perform via Zoom. The whole study was conducted via video-calls due to the corona crisis which was the best available option but a live setting in a concert hall would have been better. The videos of the music students were all rated by undergraduate psychology students in a laboratory in a controlled setting with headsets and the possibility to ask questions during the experiment. Although the study was well planned and set up, there were no differences found between the three experimental groups and the control groups regarding the effectiveness of PPRs, left-hand dynamic handgrip and goal setting against the performance decrements from choking under pressure and the behavioural signs of performance anxiety.

Conclusion

This study gives insight to the use of pre-performance routines, left-hand dynamic handgrip, and goal setting against choking under pressure and its negative consequences. The results did not support the hypotheses and the used interventions had no effect on the evaluation of performance and behavioural signs of performance anxiety of the music students. Further research should be conducted to gain more insight, if PPRs could be effective interventions against choking under pressure. The study design was already well planned, but the implementation should be done in a real concert hall and not via video calls.

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Appendix

Appendix A – Unipark Questionnaire

Ihre Aufgabe

Sie werden in dieser Studie insgesamt 12 Videos von verschiedenen Musikern/-innen sehen und hören. In den ersten beiden Videos wird Ihnen die Aufnahme von professionellen Musiker/-innen gezeigt, in den restlichen 10 Videos sehen Sie Musikstudenten/-innen. **Sehen Sie sich bitte jedes Video vollständig an**. Nachdem Sie ein Video vollständig angesehen haben, füllen Sie bitte die unter dem Video angeführten Fragen zu der musikalischen Leistung und verschiedenen beobachtbaren Verhaltensweisen aus. Es gibt hier keine richtigen oder falschen Antworten, es soll eine Einschätzung von Ihnen sein. Wenn Sie ein Verhalten nicht beobachtet haben oder nicht bewerten können, verwenden Sie im Fragebogen bitte die Option "Nicht Bewertbar".

Ablauf:
1. Video: dieses Video dient dazu, ein Gefühl für eine sehr gute musikalische Leistung zu bekommen und wie sich professionelle Musiker/-innen bewegen und verhalten. Beantworten Sie im Anschluss den Fragebogen.
2. Video: dieses Video zeigt das nachher zu bewertende Musikstück von einem Profi gespielt. Achten Sie hier auf alle Feinheiten der musikalischen Leistung und des Verhaltens. Beantworten Sie im Anschluss den Fragebogen.
3. - 12. Video: hier sollen Sie die musikalische Leistung und die betreffenden Verhaltensweisen der Musikstudenten/-innen bewerten.
Falls Sie hier noch Fragen zu dieser Studie haben, wenden Sie sich bitte jetzt an Ihre Testleitung. Wenn es keine Fragen mehr gibt, fahren Sie bitte mit dem Fragebogen und dem ersten Video fort.

Wie stark hat der/die Musiker/-in die folgenden Verhaltensweisen gezeigt?

	Sehr Schwach					Sehr Stark	Nicht Bewertbar
Nervöses Verhalten (z.B. Zittern)	O	O	O	O	O	O	O
Angespanntes Auftreten (z.B. angespannte Schultern)	O	O	O	O	O	O	O
Technische Probleme (z.B. instabiler Rhythmus, Spiel/Bewegung nicht mehr fließend)	O	O	O	O	O	O	O
Kurzatmigkeit bzw. angehaltener Atem	O	O	O	O	O	O	O
Anhalten der Musik bzw. Unterbrechungen	O	O	O	O	O	O	O

Appendix B – Zusammenfassung

Leistung unter hohem Druck zu erbringen, ist selbst für Profis keine leichte Aufgabe. Studenten und angehende Profis sind oft noch stärker von Leistungsabfällen betroffen, wenn der Druck und die Angst steigen. Dieser Leistungsabfall unter Druck wird als Choking under Pressure bezeichnet. Derzeit gibt es mehrere Pre-Performance-Routinen (PPRs) gegen Choking under Pressure, die sich im Sport als wirksam erwiesen haben, aber im Bereich der Musik noch der Implementierungsprüfung bedürfen. Diese Studie testet, ob die Pre-Performance-Routinen Zentrierung, linker dynamischer Handgriff und Zielsetzung zu einer besseren Leistung und weniger Verhaltensanzeichen von Leistungsangst führen als eine Kontrollgruppe. 44 Geigen- und Bratschenmusikstudenten und angehende Profis wurden einer der drei Versuchsgruppen oder der Kontrollgruppe zugeteilt, spielten einen Ausschnitt in einem simulierten Vorspiel in einer Situation mit geringem Druck, lernten eine PPR und traten dann in einer Situation mit hohem Druck auf. Die Leistung und das Verhalten der Musikstudenten, die Anzeichen von Auftrittsangst zeigten, wurden von 20 Laien, die Psychologiestudenten waren, in einem Online-Fragebogen bewertet. Die Ergebnisse zeigten, dass es keine signifikanten Unterschiede in der Leistung und den Verhaltensanzeichen zwischen den drei Studiengruppen und der Kontrollgruppe gab. Zukünftige Studien sollten die Intervention in einem realen Konzertsaal mit mehr Kontrolle über die Standardisierung im Prä- und Posttest testen.