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Stress and Anxiety Interventions for Classical Musicians

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ABSTRACT

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This meta-analysis looks at the results of performance anxiety related interventions with musicians. This meta-analysis results from all found studies on computerized databases including National Library of Medicine's PubMed, Dissertations and Theses (ProQuest), PsycINFO, and Oxford Journals Database. They range from cognitive interventions, behavioral interventions, mediation, and biofeedback. The results are primarily drawn from participants’ self-report before and after the intervention. They were coded for length of intervention, number of participants, level of participant (students or professionals), type of intervention, self-report measures used, and the effect size of the intervention. The overall effect of all 17 studies involved in the meta-analysis was (Hedge’s *g* -0.627, 95% CI [-0.926, -0.384], p<.000). The interventions were significantly different, with largest effect sizes in combination interventions (Hedges *g* = -0.813, 95% CI [-1.171, -.456], p>.000), followed by physiological interventions with an effect of (Hedges *g* = -0.638, [-1.111, -.164], p=.008), and purely cognitive interventions having the smallest effect size (Hedges *g* = -0.455, 95% CI [-0.757, -.153], p=.003).

Keywords: meta-analysis, musicians, anxiety

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"I have had a very difficult time with stage fright; it undermines your well being and peace of mind, and it can also threaten your livelihood" – Renee Fleming

Renee Fleming, one of the highest paid professional opera singers in the last thirty years, and the majority of classical musicians experience stage fright, the negative cognitive and physiological experiences associated with performing (Kenny, 2011). Classical musicians, from students to professionals, express high levels of stress and anxiety related to both their personal and professional lives (Goren, 2015). Anxiety refers to negative cognitions and physical symptoms (shaking hands, sweating, biting nails) around performance and stress refers to the effects of the negative cognitions or the situation on the activation of the sympathetic nervous system (Kuan, 2013). Performance anxiety is pervasive and seen in musicians as early as middle school, with young female musicians between ages 12-18 reporting significant symptoms of anxiety related to performance (Thomas & Nettelbeck, 2014). The most significant predictor of performance anxiety in the young adult time period is trait anxiety, with most of the reported performance anxiety having a social anxiety quality (Thomas & Nettelbeck, 2014).

This relationship continues to be seen as these musicians begin seriously studying music in college and continues from the beginning stages until the end stages of their professional careers (Kenny, Driscoll, & Ackermann, 2014). While the specific challenges musicians face in their careers may change, the response to these challenges tends to be high levels of anxiety, particularly related to performance. College age musicians report fear of negative evaluation on all aspects of their music performance, including group performances, individual performances, and even personal music practice where they are not being monitored by others (Nicholson, Cody, & Beck, 2015). Professional orchestral musicians report an interesting relationship of being both overwhelmed and bored by their careers, feeling they are not often challenged or given new opportunities, but then when these opportunities are given, they do not have adequate resources to cope with these new situations (Kenny et al., 2014).

A recent study of more than 2,000 musicians in the United Kingdom found that previous studies showing elevated rates of depression and anxiety might be underestimating their prevalence among musicians, especially among freelance musicians with less dependable sources of income and more socio-economic pressure. The survey, published November 1, 2016, asked musicians various questions around the theme, “Can music make you sick?” More than 70% of the respondents reported symptoms they thought were indicative of a panic attack, and 65% reported suffering from depression (Help Musicians UK, 2016 Survey). Additional problems reported in the survey dealt with working late hours, having unreliable income, and an inability to plan their future. The majority of these respondents were between the ages of 18-35, showing that the upcoming generation of professional musicians and music students are struggling with these issues. Another recent survey of Brigham Young University music students revealed a similar pattern of high reported levels of depression, stress, and anxiety (Brigham Young University School of Music, 2016). These two studies might reflect higher rates of depression and anxiety than other populations of musicians due to the career instability reported by the respondents, which tends to result in higher self-reported rates of depression, anxiety, and stress than in populations of musicians with salaried jobs (Pilger et al., 2014).

However, even in populations of musicians with career security and advanced degrees, the rates of anxiety and depression are many times higher than the national average. In one study on a respected professional orchestra in Vienna, members reported elevated rates of social phobias, generalized anxiety, and depression (Kenny et al., 2014). The orchestral members were highly educated and trained, with most having a master's degree and several additional years of professional training, which have been shown to be a protective factors against anxiety (Manturzewska, 1990; McLaren, Szymkowicz, Kirton, & Dotson, 2015). Even with these favorable and protective conditions, 32% of the orchestra endorsed clinically significant symptoms of social phobia, compared to between 4.5-9.5% in a German sample of the general population (Kessler, Stang, Wittchen, Stein, & Walter, 1999). Thirty-two also met criteria for generalized anxiety according to an anxiety screener (Nicholson et al., 2015). Again, this is greater than the 9% lifetime prevalence reported in the DSM-5 (DSM-5). Elevated rates of depression are also reported, with 33% meeting criteria for a depressive disorder (Kenny et al., 2014) compared to 7% prevalence rate reported by the DSM-5 (DSM-5). These rates are more than twice the amount reported fifteen years ago, and almost four times higher than surveys taken more than thirty years prior (Piperek, 1981).

Even higher rates of depression and anxiety are reported when asked about performance specific symptoms (Kenny et al., 2014). In studies conducted in the 1980s, more than 40% of musicians endorsed symptoms of performance anxiety or physical arousal negatively impacting performance (Brandfonbrener, 1986; Fishbein, Middlestadt, Ottati, Strauss, & Ellis, 1988). When Kenny et al. (2014) surveyed performers, students, administrators, and music faculty about performance anxiety, all reported that performance related anxiety negatively affects most of the work of their performers or the work of the organization.

Along with elevated rates of anxiety and depression, musicians experience high levels of chronic stress and distress. Professional musicians have been found to have elevated cortisol levels during performances (Felger, 2014). While elevated cortisol levels are adaptive in time limited circumstances, chronic activation of the HPA axis, which results in chronic elevations in cortisol, can create an allostatic load, which is maladaptive and leads to negative health outcomes such as lowered immune functioning, increased risk of disease, and inflammation (McEwen, 2004; Yehuda & McEwen, 2004). This is problematic considering how often musicians perform. In addition to measuring cortisol, the researchers also had all musicians rate their social interactions during the performance. Those with higher cortisol levels rated their social interactions as consistently more negative than those with lower cortisol levels. For those who are stressed, their work, and likely personal, relationships are perceived as more negative and less supportive for several hours following a performance. This will likely increase the amount of stress and anxiety they feel at work, creating a negative feedback loop. In addition to having elevated stress responses in performances, musicians report feeling that they do not have the necessary resources to successfully meet their personal and professional challenges (Parasuraman & Purohit, 2000).

Results of Stress

The distress, stress, anxiety, and depression reported by musicians are associated with functional impairment both in performance and every functioning (Kenny & Ackermann, 2015). Stress and anxiety levels are correlated with both social and physical symptoms. For example, clinically significant symptoms of anxiety are correlated with inflammation and muscle pain, which impair performance, and in some cases, can compromise careers (Kenny & Ackermann, 2015). The inflammation and muscle pain can result in forced sick days, where musicians are not able to physically perform, which can result in loss of income. This is even more problematic for women, who report more of the physical symptoms of anxiety (Kenny & Ackermann, 2015). During performance, many artists complain of dry mouth, rapid heart rate, sweating, and poor concentration. In one sample of several hundred musicians, more than 16% reported their careers had been compromised because of performance anxiety. More than 50% reported having significant amounts of anxiety as a result of performance (Wesner, Noyes, & Davis, 1990). In addition to health difficulties, most musicians work on a freelance basis, and are only paid when they perform. Missed days of work, or lack of playing well due to physical limitations will create additional negative feedback loops, where the loss of work will lead to significantly more stress, and therefore less work in the future.

Comorbid Conditions

In addition to specific performance stress and anxiety, musicians also report overall high levels of distress in general, both in biological measures, such as high cortisol levels, and in self report stress and anxiety measures (Felger, 2014; Kenny et al., 2014). Musicians also report high levels neuroticism and maladaptive perfectionistic traits in both state and trait anxiety measures (Gilman, Adams, & Nounopoulos, 2011; Stoeber, & Eismann, 2007; Thomas & Nettlebeck, 2014). Musicians experiencing elevated levels of negativity also report greater levels of performance related anxiety (Sadler & Miller, 2010). As seen in the earlier studies of younger musicians, dispositions such as neuroticism or trait anxiety increase the risk of developing an anxiety disorder both related to general functioning and performance. As a result, interventions will likely be most effective earlier on in their schooling and careers.

These negative styles of interacting with the world also have a negative impact in other high stress professions, such as business or law, that share the same experience of intensive training periods at the beginning of careers (Gramstead, Gjestad, & Haver, 2013). In studies with these populations, personality traits also have been correlated with higher levels of depression, which may be especially elevated in a population that is already more prone to depression than the general public. The combination of the tendency towards depression and anxiety and the pattern of anxiety and stress development in holding a high stress position is likely fueling these increasing rates of self-reported psychopathology.

Coping Strategies

The recommended treatment for social phobia, generalized anxiety, specific and chronic anxiety, and depression involve treatment with qualified mental health practitioners and doctors (Barlow, Conklin, & Bentley, 2015). The treatments often include therapy and pharmacological interventions.

The majority of musicians do not seek help with these symptoms. In the most recent UK survey, 53% of UK based musicians did not know where to go for help with psychological symptoms, even with government provided mental health services (Help Musicians 2016 Survey). However, in Dews and Williams (1989), while 90% sought help, the most widely used sources were friends and social networks. Another often used coping mechanism found in Kenny et al. (2014) was excessive use of alcohol. These coping styles continue to be used, even when not successful at resolving problems (Langendörfer, Hodapp, Kreutz, & Bongard, 2006). In these studies, the types of coping strategies were insufficient to provide clinically significant changes in symptoms.

Interventions

While the majority of performers do not report either seeking help or knowing where to get help for their difficulties, there has been an increase in performance anxiety interventions in the last thirty years.

Medicinal Interventions

Previous interventions have involved pharmaceutical interventions, such as using beta blockers, which have been shown to lower heart rate and stage fright while performing (Neftel et al., 1982). However, there are side effects from the medications, and there can be interactions with other prescribed medications. Several studies of musicians and public speaking have noted side effects from medications that occur during performances. These included delayed recall, decreased energy, and in some cases, greater perception of anxiety and physiological responses (Bourgeois, 1991). Taking beta blockers can also be associated with an increase in the beta-adrenergic receptors, resulting in withdrawal after people stop taking the drugs (Bourgeois, 1991).

Psychological Interventions

Perhaps as a result of these complications, psychological interventions have been studied as either an adjunct or alternate to medication. These psychological interventions include treatments that are both cognitive, such as exposure and response therapy, as well as interventions aimed at addressing physical symptoms, such as yoga and biofeedback. These treatments are adapted from standard treatments for anxiety and major depressive disorder, with a focus on performance behaviors. While the results from these studies have been promising overall, the majority of these studies were intended as lower powered pilot studies, aiming to follow up on the results in a more comprehensive manner with more participants.

Cognitive. Cognitive interventions, which intend to change thoughts that either increase anxiety or depressive symptoms or contribute to the maintenance of these thoughts, involve processes such as guided imagery, systematic desensitization, exposure through virtual training, increased preparation, music therapy, cognitive restructuring, and short term mental skills (Hofmann, Asnaani, Vonk, Sawyer, & Fang, 2012). Performance interventions using cognitive techniques are similar to the anxiety treatments and theory used at that time point when the interventions are created. Early performance anxiety interventions using cognitive techniques looked at changing automatic behaviors that were conditioned with earlier performance (Appel, 1974). They hypothesized that early performances were likely an anxiety provoking experience, and that as the performers continued to perform, their bodies would continue to experience the same emotional and physiological responses. The focus of these interventions were to train new responses and extinguish old responses (Appel, 1974). Later interventions looked at using exposure in various formats to help performers habituate and lower the anticipatory arousal to performances (Bissonnette, Dube, Provencher, & Moreno, 2015). The most recent cognitive treatments for performance anxiety are looking at avoidance behavior and thought processes that continue this avoidance (Clark & Williamon, 2011). In these, the researchers intervene to help prevent pre-performance avoidance behaviors, including what they describe as intentional self-sabotage through lack of preparation, with the aim of making the performance a more positive experience.

Physiological. Physiological interventions aim to change the physiological processes that increase the stress response, using interventions such as meditation, yoga, biofeedback, breathing, and progressive muscle relaxation. Many performers report feelings of shallow breathing, increased heart rate, sweaty and dry mouths, and shaky hands during performance (Help Musicians UK, 2016 Survey). These symptoms are characteristic of the stress response, in which an initial stress response or alarm reaction activates the hypothalamus and sympathetic nervous system to prepare the body to respond to the stressor (Buchanan, al'Absi, & Lovallo, 1999). This stimulates the adrenal gland, which releases epinephrine, norepinephrine, as well as adrenal steroids. The adrenal steroids release hormones, including cortisol. These interventions look at reducing the amount of physiological arousal in response to the stressor by either promoting parasympathetic nervous system activity (such as in progressive muscle relaxation) or balance in the autonomic nervous system (as in biofeedback).

Combination. The majority of studies have found that both cognitive and physiological symptoms of stress are present and often impairing in musical performance (Appel, 1974; Braden, Osborne, & Wilson, 2015; Kenny & Ackermann, 2015; Stern, 2012). In addition, cognitive and physiological symptoms are likely to interact. The lack of preparation, whether due to a conditioned avoidance response or another cause, will likely influence the amount of physiological arousal prior to the performance. These negative physical states will then reinforce the thought that the performance was an experience to be feared and avoided, and increase the avoidance and continue the cycle. As a result, many performance interventions look at addressing both the physical and cognitive symptoms and causes of performance anxiety. These interventions can either be primarily cognitive, with an element of teaching coping strategies to help with increased body arousal prior to performance, or primarily physiological, addressing the maladaptive stress response while helping address negative cognitions that likely lead to this response.

Current Study

Music performance anxiety is reported by the majority of musicians, with rates only continuing to increase. Musicians report experiencing clinically significant physical and cognitive symptoms of both anxiety and depression, throughout all time points researched. While there are a variety of interventions based off of current research in both anxiety and chronic stress, these interventions have yet to be widely disseminated. The aim of this paper is to look at the characteristics of the studies included in the meta-analysis, the overall effects of different types of interventions, and the relationship between different aspects of the interventions and the overall effects of the interventions. This information can then be used to help design the most effective studies to address the problem of stress and anxiety in musicians.

Method

Search Strategy and Study Selection

We searched computerized databases including National Library of Medicine's PubMed, Dissertations and Theses (ProQuest), PsycINFO, and Oxford Journals Database. We used the search terms: *music, anxiety, depression, performance anxiety, anxiety and musicians, stress reduction in musicians, anxiety reduction in musicians, and performance anxiety reduction interventions in musicians*. Once studies were found, we searched the reference lists from these studies and also all studies that cited them. Because there are differences between the challenges, stress levels, and personalities of classical and popular/rock musicians, we restricted the search to interventions involving classical musicians (Papageorgi, Creech, & Welch, 2013). All studies needed to meet the following inclusion criteria: 1) Studies must be experimental in nature, requiring a control group and an intervention, though randomization was not required, 2) Studies must be with classical musicians, and 3) studies must publish enough information from which to calculate an effect size. Studies were excluded when they lacked experimental manipulation or did not publish results.

Extraction

Three trained independent coders extracted demographic characteristics, including sample size, condition group sizes, number of conditions groups, length of study, type of study (whether cognitive, physiological, or both) as well as the means and standard deviations to calculate effect sizes. Cognitive interventions were defined as using techniques to help correct maladaptive thought patterns and schemas, as well as correct avoidance behaviors (Beck, Emery,

& Greenberg, 2005). Physiological interventions were defined as techniques aimed at reducing the amount of maladaptive physiological arousal present around performance (Manocha, Black, Sarris, & Stough, 2011). Several studies included both cognitive aspects and physiological aspects. They were coded as a combination of both if they included significant elements of both types of intervention.

If the study published multiple effect sizes and results, such as both state and trait anxiety, the state condition was used, as the majority of studies published only state anxiety. We also chose state anxiety as it reflects how the research participant felt at the time of the performance, as opposed to measuring general “anxiety proneness” (Julian, 2011). Initial agreement between coder one and two was 96% andcoder one and three was 65%, though agreement was in the acceptable range for the third coder after clerical errors were corrected. The group then met to resolve all discrepancies, resulting in a final coding sheet, which was used for the analysis.

Comprehensive Meta-Analysis 2.0 (Biostat, Englewood, New Jersey) was used to calculate and compare the overall effect sizes for the studies, using Hedges and Olkin’s random-effects model, which weights the studies by their sample size, as well providing more conservative effect sizes than fixed-effects models. Additionally, it assumes that all studies were drawn from samples with differing effect sizes (Borenstein, Hedges, Higgins, & Rothstein, 2009). Means, standard deviations, and sample sizes were used to calculate standardized differences between the effects of different studies. Several studies used more than one intervention, so a meta analysis for the results of the individual study was conducted to give one effect size. As the effect sizes for these studies were not independent, this method prevented overrepresentation of single studies (Borenstein et al., 2009).

Analysis

Effects sizes were compared for all studies, and then for studies by intervention category. Interventions were categorized by whether they were cognitive, physiologically based, or both. Mean effect sizes were considered significant ($p<.05$) if the 95% confidence interval did not include zero. Effect sizes were considered .20 being weak, .50 being moderate, and .80 for strong effects (Cohen, 1988). To estimate how unpublished null results could lower the effect sizes, we used a fail N- analysis to estimate how many unpublished studies would be needed to have an effect size of below our criterion to lower the overall found effect. The Rothenthal's failsafe N test shows how many missing studies with statistically insignificant results are needed to reduce the statistical significance in the meta-analysis to be nonsignificant (Borenstein et al., 2009). Orwin's fail safe N was used to calculate how many missing studies below an a priori effect size would change the overall effect size of the meta-analysis. We used the lowest effect size we could find in the general anxiety treatment literature.

Additionally, we will use a power analysis to see whether there were enough studies to power the tests used in the meta-analysis using a procedure described by Baldwin and Shadish (2011).

Results

We identified 30 articles in English published between 1974 and 2015 that potentially met inclusion criteria (see Figure 1 for studies meeting inclusion criteria).

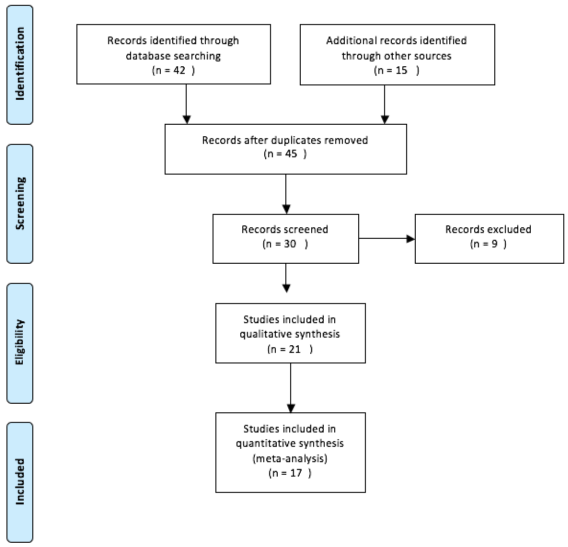


Figure 1. Flow Chart of the Systematic Review Process.

in several cases where data was either missing or unclear, study authors were contacted. However, as these studies were more than 20 years old, study authors have not returned any correspondence.

Six studies were immediately excluded because they were correlation research, and did not do any experimental manipulation. We were unable to use one study because the authors did not report separate results for each group. Two more were also excluded because while they reported they found a significant effect, one did not report any results and other reported the results of both groups together. All 21 studies meeting the first two criteria (experimental design and use of classical musicians) were used to describe the types of studies. Statistics involving effect sizes were calculated using the 17 studies that met full inclusion criteria, requiring adequate statistical information to calculate effect sizes (see Table 1 for comparison of the two groups and Table 2 for summary of studies meeting full inclusion criteria).

Table 1

Comparison of Studies Included in Descriptive Studies (21 Studies) and Full Statistical Analysis (17 Studies)

Category	21 Studies	17 Studies
Average sample size	32	30
Length (mode)	6 weeks	6 weeks
% Cognitive	53%	47%
% Physiological	18%	29%
% Combination	29%	24%

Descriptive Statistics

Sample size. The average sample size was 32 participants, with a range between 14-66 participants. The majority of the studies were done with college-aged musicians currently attending music school (62%). One study used exclusively professional musicians, and the remaining used a combination of students and professionals.

Recruitment. The studies all described similar recruitment processes, with flyers being hung in areas frequented by student musicians as well as emails to music departments and music festivals. It is likely this recruitment technique could result in a biased sample, with higher rates of anxiety than other musicians. Two studies tried to have more homogeneity in their samples by restricting participation to specific instruments. However, both eventually included all classical instruments and voice due to insufficient sample size with only one instrument. One study published results separately by all instruments and piano to see if results were different.

Exclusion/inclusion criteria. Common exclusion criteria included use of medications that affected mood and central nervous system functioning, including beta blockers. Participants were often required to have a certain level of instrumental or vocal proficiency in order to participate. This was determined by either number of years playing the instrument, professional employment as a musician, or music major status.

Methods. There were a range of between two and five groups for the studies, with most studies having two groups. One study (Khalsa, Shorter, Cope, Wyshak, & Sklar, 2009) intended to have random assignment, however; due to lack of interest in their project, they requested participants who were interested and willing to be a no-contact control group.

Types of intervention. Types of interventions were categorized by cognitive interventions, which intended to change thoughts that would either increase anxiety or depressive symptoms or contributed to the maintenance of these thoughts. These interventions involve processes such as guided imagery, systematic desensitization, exposure through virtual training, increased preparation, music therapy, cognitive restructuring, and short term mental skills.

Table 2

Summary of Studies Meeting Full Inclusion Criteria

Study and Year	Sample Size	Type of Intervention	Length	Outcome Measures
Appel (1974)	29	Cognitive	6 weeks	Pulse Rate, Performance Errors
Bissonnette et al. (2011)	17	Combination	6 weeks	Pulse Rate, SUDS, State Anxiety
Chang et al. (2003)	19	Combination	8 weeks	Performance Anxiety Inventory, State Anxiety Inventory
Deen (1999)	39	Physiological	6 weeks	Performance Anxiety Inventory, State Trait Anxiety Inventory Performance Errors
Esplen*	21	Cognitive	unreported	State Trait Anxiety Inventory
Gladys (1982)	49	Cognitive	6 weeks	Behavioral Index of Anxiety Pulse Rate
Grishman (1989)	41	Physiological	3 weeks	State Trait Anxiety Inventory Heart Rate
Hoffmann et al. (2012)	33	Cognitive	3 weeks	Heart Rate State Trait Anxiety Inventory
Kendrick et al. (1982)	53	Cognitive	3 weeks	Heart Rate State Trait Anxiety Inventory
Khalasa et al (2009)	45	Combination	8 weeks	Profile of Mood States Performance Anxiety Questionnaire
Kim (2008)	30	Combination	6 weeks	Finger temperature Music Performance Anxiety Questionnaire
Montello (1989)	21	Cognitive	14 weeks	State Trait Anxiety Inventory
Nageyama (2007)	18	Cognitive	2 weeks	State Trait Anxiety Inventory
Nagel et al. (1989)	20	Combination	6 weeks	State Trait Anxiety Inventory Music Performance Anxiety
Roland (1993)	33	Cognitive	4 weeks	Heart Rate State Trait Anxiety Inventory
Thurber (2006)	14	Combination	3 weeks	Heart Rate State Trait Anxiety Inventory
Williamon et al (2011)	23	Cognitive	9 weeks	State Trait Anxiety Inventory

These interventions involve processes such as guided imagery, systematic desensitization, exposure through virtual training, increased preparation, music therapy, cognitive restructuring, and short term mental skills. A second type of intervention was aimed at changing physiological processes that increase the stress response, such as meditation, yoga, mindfulness, biofeedback, breathing, and progressive muscle relaxation. Some interventions combined both a physiological intervention with cognitive skills, such as guided imagery plus relaxation, mental skills plus relaxation, or a Cognitive Behavior Therapy framework with increased relaxation skills.

Length. The shortest experiment involved a single 30-minute visit and the longest intervention was 15 weeks. The mode, or most common intervention length was 6 weeks.

Outcome measures. Most interventions involved a pre and post self-report measure of anxiety, using general anxiety measures such as the State Trait Anxiety Inventory, as well as more performance specific measures, like the Performance Anxiety Inventory. In addition to self-report measures, the majority of the studies (60%) also measured biological measures, such as heart rate, skin conductance, and skin temperature. While several studies included performance elements (e.g. mistakes made, expert perception of improvement) this was excluded in this study as an outcome measures because of the unreliability of these measures and because external factors, such as attractiveness and performance outfits, influence these decisions (Wapnick, Campbell, Siddell-Strebel, & Darrow, 2009). In addition, these are also not measuring performance anxiety.

Common confounds. These studies were primarily created to be exploratory or pilot studies, showing the effectiveness of the interventions prior to starting large scale studies. As a result, there were several problems across studies due to the exploratory nature of the studies, as well as unexpected confounds that arose when looking at the analysis. The small number of participants in studies, especially as the effect sizes were only expected to be moderate, may have resulted in non-significant findings. When conducting a power analysis bases of the average or mean effect size found in the study, a minimum of 100 participants would be needed across two groups.

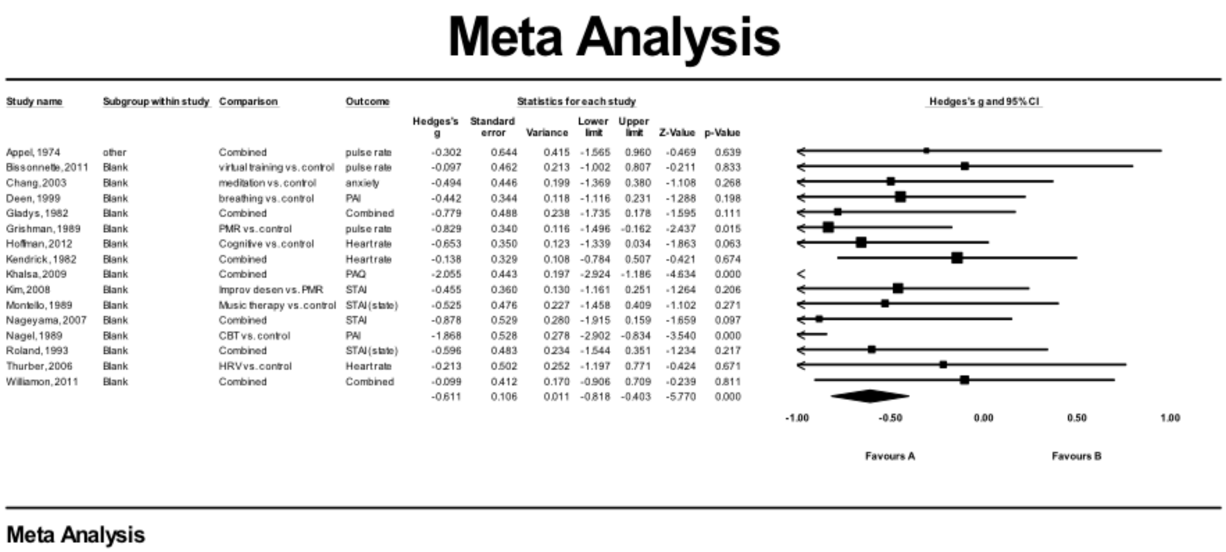
There were unexpected confounds found within studies that resulted in equal groups, particularly as there were a small number of participants in many groups. There was a trend of higher neuroticism among musicians in many of the studies, and as a result, some treatment groups were much higher in this personality trait. Groups with higher neuroticism scores tended to not make the same level of improvement as those low in these traits. These studies reported in their discussions they would carefully control for this personality trait, and perhaps give a measure and randomized groups after this assessment. Larger amounts of participants would likely even out this problem and have more equal groups. Performances were created artificially for the purposes of all the experiments, which might affect the results as well.

Effect of Interventions

The effect of interventions was calculated using 17 studies which met full a priori criteria, including sufficient effect-size information. The self-report anxiety measure and heart rate were used to determine the effect size using the means and standard deviations for both the experiment and the control group.

The overall effect of all 17 studies involved in the meta-analysis was (Hedge's g -0.627, 95% CI [-0.926, -0.384], $p<.000$) in a random-effects model. The samples involved in all interventions were heterogeneous, with the effects more likely to be accounted for by chance than by the intervention (I^2=35.650). This measures the ratio of true heterogeneity to the total variance across effect sizes found in these interventions. This merits a rating between low and moderate as determined by Higgins (Borenstein, Higgins, Hedges, & Rothstein, 2017). Results of these interventions should be interpreted with caution, as all of the experiments likely had insufficient power due to small samples, and many results coded and used in the analysis were not statistically significant, and more likely due to chance variation in the data set than to changes from the interventions.

Effect sizes appear to be consistent across type of intervention (see Figure 2 for forest plot of effect sizes).



Study name	Subgroup within study	Comparison	Outcome	Statistics for each study						
				Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Appel, 1974	other	Combined	pulse rate	-0.302	0.644	0.415	-1.565	0.960	-0.469	0.639
Bissonnette, 2011	Blank	virtual training vs. control	pulse rate	-0.097	0.462	0.213	-1.002	0.807	-0.211	0.833
Chang, 2003	Blank	meditation vs. control	anxiety	-0.494	0.446	0.199	-1.369	0.380	-1.108	0.268
Deen, 1999	Blank	breathing vs. control	PAI	-0.442	0.344	0.118	-1.116	0.231	-1.288	0.198
Gladys, 1982	Blank	Combined	Combined	-0.779	0.488	0.238	-1.735	0.178	-1.595	0.111
Grishman, 1989	Blank	PMR vs. control	pulse rate	-0.829	0.340	0.116	-1.496	-0.162	-2.437	0.015
Hoffman, 2012	Blank	Cognitive vs. control	Heartrate	-0.653	0.350	0.123	-1.339	0.034	-1.863	0.063
Kendrick, 1982	Blank	Combined	Heartrate	-0.138	0.329	0.108	-0.784	0.507	-0.421	0.674
Khalsa, 2009	Blank	Combined	PAQ	-2.055	0.443	0.197	-2.924	-1.186	-4.634	0.000
Kim, 2008	Blank	Improv desen vs. PMR	STAI	-0.455	0.360	0.130	-1.161	0.251	-1.264	0.206
Montello, 1989	Blank	Music therapy vs. control	STAI (state)	-0.525	0.476	0.227	-1.458	0.409	-1.102	0.271
Nageyama, 2007	Blank	Combined	STAI	-0.878	0.529	0.280	-1.915	0.159	-1.659	0.097
Nagel, 1989	Blank	CBT vs. control	PAI	-1.868	0.528	0.278	-2.902	-0.834	-3.540	0.000
Roland, 1993	Blank	Combined	STAI (state)	-0.596	0.483	0.234	-1.544	0.351	-1.234	0.217
Thurber, 2006	Blank	HRV vs. control	Heartrate	-0.213	0.502	0.252	-1.197	0.771	-0.424	0.671
Williamon, 2011	Blank	Combined	Combined	-0.099	0.412	0.170	-0.906	0.709	-0.239	0.811
				-0.611	0.106	0.011	-0.818	-0.403	-5.770	0.000

Figure 2. Forest Plot of Effect Size by Study.

The largest effect sizes were found in combination interventions (Hedges g = -0.813, 95% CI [-1.171, -.456], p>.000), with purely cognitive interventions having the smallest effect size (Hedges g = -0.455, 95% CI [-0.757, -.153], p=.003). The physiological interventions had a moderate effect size, with (Hedges g = -0.638, [-1.111, -.164], p=.008). However, the differences between these effect sizes were not statistically significant (Q(2) = 2.271, p =0.321, i2 = 11.928), which shows a more homogenous distribution of effect sizes between the three types of studies.

Significantly larger effects sizes were seen in the longest four studies (ranging between 8-14 weeks) with an overall effect of Hedges' *g* -0.776 than the five shortest studies (ranging between 2-3 weeks) with an effect size of Hedges' *g* -0.528. A meta-regression was then conducted to see the relationship between the length of the intervention (dose) and the effect of the intervention. The results of this meta regression showed that each intervention reduced anxiety by -.33, and that each additional week of intervention resulted in a small but continued reduction in anxiety of -0.04, although this finding is nonsignificant as the 95% confidence intervals contain zero (95% CI [-0.089, 0.004]).

Publication Bias

Rothenthal's failsafe N tests determined that 128 missing studies with nonsignificant p values would be needed to for the overall effect size of the 17 studies to no longer be statistically significant. Orwin's fail safe N was used to see how many missing studies with an effect size of 0 to bring the effect below a level of clinical significant. Two recent meta-analyses of medication, cognitive treatments, and physiological treatments reported the lowest effect size for a type of clinically significant anxiety treatment to be Hedges' $g = 0.63$ (Hofmann et al., 2012). 6 studies would be needed with smaller effect sizes to have the effects found in this meta-analysis below this amount.

Power Analysis

Meta-analysis has the advance of pooling together findings from various studies that lack enough power to have statistical significance. Factors such as sample size in the individual studies, similarity of effect sizes, number of studies, and population effect size all influence the statistical power (Borenstein et al., 2009). Power is based on both the population effect size in the studies, with an inverse relationship to the size needed in studies. High population effect sizes can reach high power with both a relatively small number of studies and a small amount of subjects in each study (Liu, 2015). The power of the meta-analysis is also related to using either a fixed or random model, with fixed effect models tending to have more statistical power (Liu, 2015). The statistical power of the overall effect in the random effects model was between .974 and 1.00, based on the average effect size found in the studies with unequal groups and unbalanced designs (Liu, 2015).

Discussion

The main finding of the meta-analysis was a moderate overall reduction in performance anxiety in intervention groups compared to control groups (Hedges' g -0.627, 95% CI [-0.926, -0.384], p<.000). There was a statistically significant difference between the three types of interventions, with combination interventions having a larger effect on performance anxiety reduction. The next most efficacious interventions were physiological interventions, though purely cognitive interventions also had moderate effect on anxiety reduction.

This pattern of most effective types of interventions is consistent with a recent meta-analysis looking at anxiety treatments in the general population. A recent meta-analysis found a similar relationship between physiological and cognitive interventions for anxiety (Bandelow et al., 2012). Physiological interventions, including mindfulness and yoga, had slightly higher effect sizes than cognitive treatments. This meta-analysis categorized the treatments as discrete categories, and did not provide an overall effect size for interventions using more than one type of intervention.

While there was meaningful change in both the amount of self-reported anxiety and physiological signs of anxiety (such as increased skin conductivity and heart rate), the effect sizes were much smaller than in studies involving the general population. Two recent meta-analyses of anxiety treatments found effects that ranged between large sizes of (Cohen's d = 2.02 and Cohen's d = .78), with the majority of treatments having effect sizes of Cohen's d greater than 1 (Bandelow et al., 2012; Cuijpers et al., 2014). Placebo effect sizes were Cohen's d = 1.29 for placebo pills and Cohen's d = .83 for psychological placebos. Based on these results, the interventions in the meta-analysis do not compare to the standard of treatment for the general population. In fact, placebo conditions for the general population are more effective. Such a result exposes some limitations of performance specific treatments. In surveys and correlational research, musicians reported anxiety not only in all aspects of their performances, but also most aspects of their daily functioning. It is likely interventions aimed only at reducing performance anxiety do not have a significant enough impact on their daily functioning to change the behaviors and thoughts that continue their anxiety.

The lower effect sizes could also indicate that there are floor effects in these studies. One explanation could be that musicians are not experiencing as much stress or anxiety as the general population. This is an unlikely explanation considering the responses to questions about every day anxiety being very similar to their performance anxiety (Help Musicians UK Survey, 2016). However, this question should be explored using research measures of stress and anxiety, such as the DASS, in addition to asking general questions about every day functioning. A more likely explanation if there are floor effects is that the performance settings in the studies did not elicit the same amount of anxiety as a performance. All of the studies used an artificial performance situation for the pre- and post-performance measures. It is possible that musicians react differently to high stakes performances than to these artificial performances. This again should be considered when designing and measuring further interventions. Williamon (personal correspondence) are exploring virtual reality performance paradigms, where a video recorded audience, capable of being manipulated by the researchers, interact with the performers. in addition, many music schools have standard performances at the end of semesters. These could be used to measure differences between intervention groups in a high stake situation.

Additionally, there also appears to be a dose-response relationship between effect size and the interventions. In comparing the four longest and the five shortest studies, longer studies had a larger effect size. However, when further analyzing this relationship with a meta-regression, the dose-response was very small and statistically insignificant. Due to the number of studies and number of participants within each group, this meta-regression was likely underpowered. There is also the possibility a dose-response interaction with type of intervention. Certain types of interventions might require a longer time period to be maximally effective. These questions require more interventions and larger samples to answer.

This meta-analysis provides several strengths. The first is the statistical power to calculate an overall effect size. The major limitation noted by the individual studies is that due to the exploratory nature and small sample sizes, the results might have been due to chance. Combining them into an overall effect size provides a more accurate representation of the effects of the interventions and justification for them to be pursued at a larger level. The second strength is that this is the second meta-analysis done in this area. Goren (2015) found a similar effect size of Hedges' g = -.64 using slightly different criteria and analytic processes. This meta-analysis used only experimental research, requiring a comparison group for all interventions, rather than using pre and post measures for only one group. In addition, instead of using one intervention measurement, a mini meta-analysis was performed for studies reporting both biological data and self-reported measures, allowing both to be represented without violating assumptions. A meta-regression was added to look at potential factors, such as the dose, which may impact the intervention. This study also included an additional study that had been published between the times of the two analyses.

There were limitations in the questions that could be answered due to the sample sizes of the studies and the number of studies. The power needed for the meta-regression and interaction in the meta-regression require many more studies. These limitations will require more studies to be done in the field.

Conclusion

While there are still unanswered questions about the best intervention for performance anxiety, this meta-analysis provides useful information on the next steps needed in the field. To be more effective, studies should include both a cognitive and physiological component. They are also likely to be more effective if they are longer than 6 weeks. In addition, adding components addressing nonperformance stress and anxiety will likely produce effects more similar to anxiety treatments for the general public. Information from larger studies applying these principles can then be used to find more specific relationships about optimal time needed, best method for measuring outcome variables, and the right combination of performance specific techniques and every day functioning interventions.

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