



MUSIC PERFORMANCE ANXIETY: INSIGHTS FROM PSYCHOLOGICAL SCIENCE



By

Mr. Wee Hun Stephen LIM

A Thesis Submitted in Partial Fulfillment of the Requirements
for Master of Music MUSIC RESEARCH AND DEVELOPMENT

Silpakorn University

Academic Year 2023

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Music Performance Anxiety: Insights from Psychological Science



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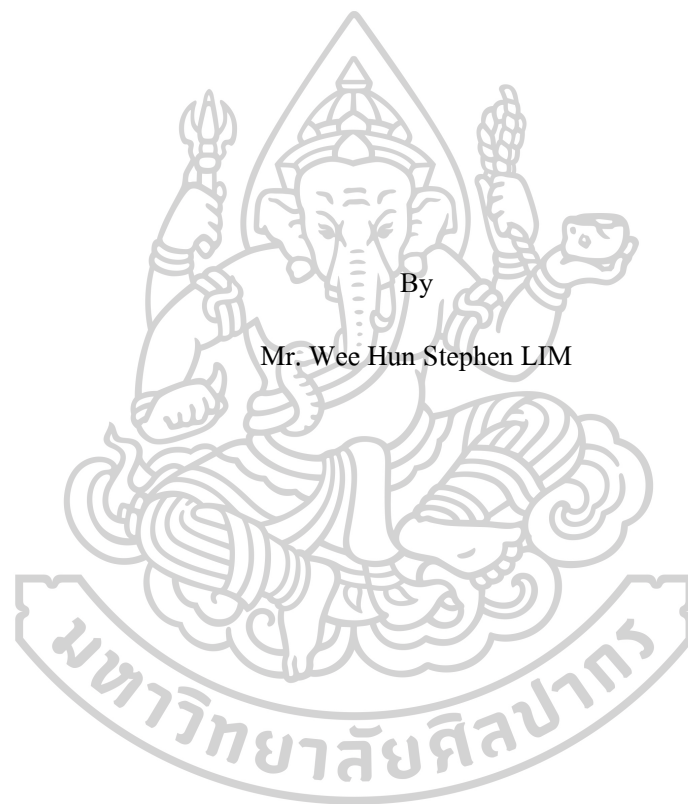
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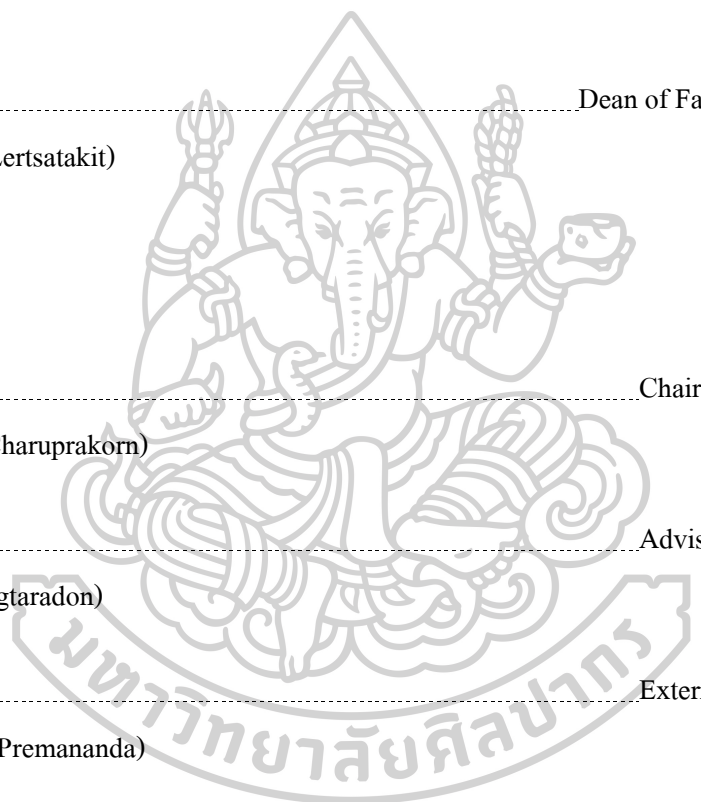
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Music performance anxiety (MPA) is a multidimensional construct that negatively impacts musicians to different extents but presumably across all musical contexts. Here, we review recent literature concerning theoretical conceptualizations of MPA, and discuss extant interventions relating to cognitive-behavioral therapy and multimodal interventions which, we argue, are at best approaches that remedy MPA only peripherally, and not inherently. Drawing on cognitive psychological research: When students are well-prepared for a high-stakes academic exam, test anxiety did not predict exam performance (Theobald et al., *Psychological Science*, 2022). This finding provided the foundation for the current hypothesis: Performance-anxious musicians should not perform worse in high-stakes stressful situations than their preparation (practice) would otherwise allow; where musicians are well-prepared, performance anxiety per se should not interfere with stage performance accuracy and quality. Thus, performance-anxiety interventions ought to promote effective practice—optimal, deep learning—at an early stage during performance preparation, rather than aim to reduce test anxiety only shortly before or during stage performance. How, then, might we enable musicians to achieve such effective learning? A counterintuitive learning and practicing strategy as informed by psychological principles and personal reflections is recommended and discussed.

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Wee Hun Stephen LIM



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PROLOGUE

This thesis serves as an authentic record of my learning journey in the Master of Music (Music Research and Development) (MMus) program at the Faculty of Music, Silpakorn University from 2565 to 2567. Whereas I predominantly worked on classical piano performance with Assistant Professor Jamorn Supapol, I have had the good fortune of also pursuing jazz studies with Associate Professor Dr. Pang Vongtaradon, musicology with Associate Professor Komtham Domrongchareon, as well as composition with Associate Professor Dr. Pang Vongtaradon and Dr. Poumpak Charuprakorn.

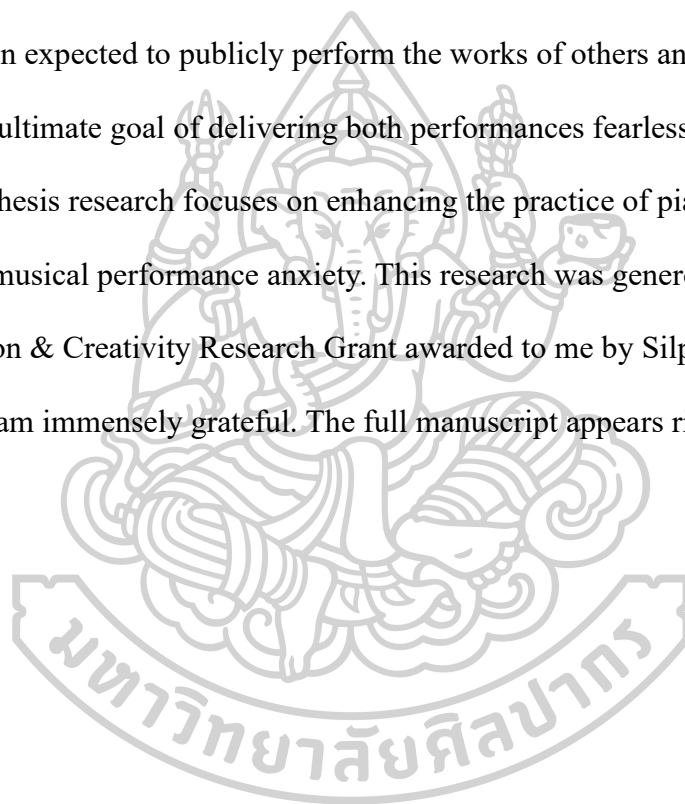
Accordingly, my MMus journey culminates in two solo piano performances. The first 50-min performance took place on 4 April 2567, 6 PM in the Main Auditorium of Silpakorn University (Wang Tha Phra Campus). My musicological reflections on modern-day classical music performance practice appear in the Appendix, while the performance program is as follows:

—Stephen Lim Master of Music Piano Recital—

Wolfgang Amadeus Mozart	Piano Sonata No. 8 in a minor, K. 310 I. Allegro maestoso II. Andante cantabile con espressione III. Presto
Robert Schumann	Papillons, Op. 2
Fédéric Chopin	Ballade No. 1 in g minor, Op. 23
Peter Sculthorpe	Mountains

The second piano performance will take place as part of The 5th Silpakorn International Conference on Sound and Music (SICSAM) on 7 June 2024 at the BACC (Bangkok Art and Culture Center). The performance program is planned to draw on original music composed for solo piano. The full scores are available upon reasonable request.

Like all performing musicians, however, I struggled with musical performance anxiety when expected to publicly perform the works of others and of my own alike. Toward the ultimate goal of delivering both performances fearlessly and successfully, my MMus thesis research focuses on enhancing the practice of piano performance by remedying musical performance anxiety. This research was generously supported by an Innovation & Creativity Research Grant awarded to me by Silpakorn University for which I am immensely grateful. The full manuscript appears right after this Prologue.



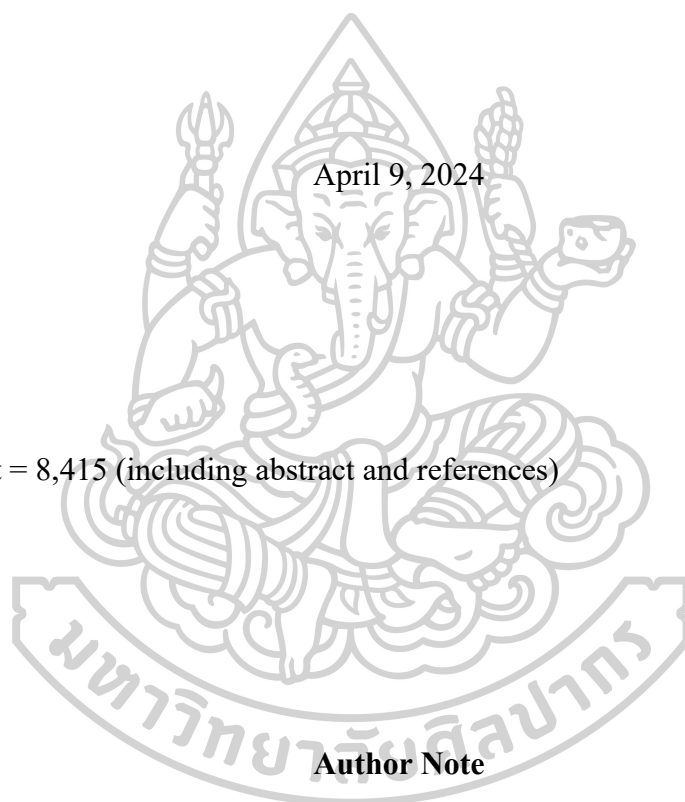
Music Performance Anxiety: Insights from Psychological Science

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Abstract

Music performance anxiety (MPA) is a multidimensional construct that negatively impacts musicians to different extents but presumably across all musical contexts. Here, we review recent literature concerning theoretical conceptualizations of MPA, and discuss extant interventions relating to cognitive-behavioral therapy and multimodal interventions which, we argue, are at best approaches that remedy MPA only peripherally, and not inherently. Drawing on cognitive psychological research: When students are well-prepared for a high-stakes academic exam, test anxiety did not predict exam performance (Theobald et al., *Psychological Science*, 2022). This finding provided the foundation for the current hypothesis: Performance-anxious musicians should not perform worse in high-stakes stressful situations than their preparation (practice) would otherwise allow; where musicians are well-prepared, performance anxiety per se should not interfere with stage performance accuracy and quality. Thus, performance-anxiety interventions ought to promote effective practice—optimal, deep learning—at an early stage during performance preparation, rather than aim to reduce test anxiety only shortly before or during stage performance. How, then, might we enable musicians to achieve such effective learning? A counterintuitive learning and practicing strategy as informed by psychological principles and personal reflections is recommended and discussed.

Keywords: music performance anxiety, performance science, psychological science

Introduction

Music performance anxiety (MPA) is a challenge faced by many musicians across various stages of professional development. Studies estimating the prevalence of MPA among music students and professionals have reported wide-ranging figures from 16% to even 96% (for recent reviews, see Barros et al., 2022; Fernholz et al., 2019; Herman & Clark, 2023). In part, the high variability of these estimates reflects high heterogeneity surrounding the definition and measurement of MPA in extant studies. Despite decades of research, the extensive landscape of MPA literature has been plagued by a lack of clarity and cohesion in the definition of this construct, with different terms used interchangeably (e.g., “stage fright”, “performance anxiety”; Barros et al., 2022). In contemporary studies, though, the definition put forth by Kenny (2010) has been increasingly adopted:

Music performance anxiety is the experience of marked and persistent anxious apprehension related to musical performance that has arisen through specific anxiety-conditioning experiences. It is manifested through combinations of affective, cognitive, somatic, and behavioural symptoms and may occur in a range of performance settings, but is usually more severe in settings involving high ego investment and evaluative threat. (p. 433)

Although MPA has often been viewed as a unidimensional construct, some researchers have proposed and offered evidence that MPA is a multidimensional construct comprising three correlated dimensions: (a) *Somatic and Cognitive Features*, relating to physical manifestations of performance anxiety immediately before and during a performance, and fear of making mistakes, (b) *Performance Context*, relating to performers’ preferences for solo or group performance contexts,

and the nature of the audience, and (c) *Performance Evaluation*, relating to the evaluations that the audience and performer may make of a performance, the consequences of these evaluations, and difficulty concentrating when performing before an audience (Osborne & Kenny, 2005; see also Sârbescu & Dorgo, 2014).

MPA encompasses both adaptive and maladaptive components (Wolfe, 1989; see also Kenny, 2011; Mor et al., 1995; Simoens et al., 2015). Whereas adaptive MPA can have facilitating effects when optimal levels of arousal boost musical performance as in the inverted-U relation described in the Yerkes-Dodson law (1908; see also Wilson, 2002), maladaptive MPA has been associated with debilitating effects that may manifest as a constellation of autonomic (e.g., skin resistance), affective (e.g., anxious feelings), cognitive (e.g., catastrophizing), and behavioral (e.g., trembling hands, poorer musical performance quality) responses (e.g., Craske & Craig, 1984; Sokoli et al., 2022). Such debilitating effects have been the predominant focus of much MPA research. Indeed, MPA has often been examined through a pathological lens and described as a “condition”, “disease”, or “disorder” that needs “treatment” (see Herman & Clark, 2023 for a review). For instance, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychiatric Association, 2013), a musician may be diagnosed as having “performance-only” social anxiety disorder when diagnostic criteria are met for a marked and persistent fear or anxiety about a social situation that is restricted to performing in public and that leads to significant distress or impairment in functioning.

Psychological Theories of MPA

To explain the etiology of MPA, psychological theories from psychoanalytic, physiological, behavioral, cognitive, and emotion-based perspectives have been

proposed, although there is currently no widespread consensus in favor of any single theory (Herman & Clark, 2023; Spahn, 2015). According to *psychoanalytic theory*, MPA symptoms are an expression of internal conflicts and defense mechanisms that arise from individual personal experiences such as the development of attachments with caregivers in childhood (Kenny, 2011; Spahn, 2015). Under this view, the performance situation represents a staging of unconscious conflicts from the performer's earlier life experiences, whereby the fear of negative evaluation is tied to the fear of losing the affection of one's caregivers (Nagel, 2004; Spahn, 2015). However, empirical evidence for this view is limited (Brugués, 2019).

Physiological theories view MPA as rooted in an evolutionarily ancient fight-or-flight response triggered by situations that are perceived as threatening (Kenny, 2010; Spahn, 2015). Thus, the physiological symptoms associated with MPA are thought to either facilitate increased performance ("fight") or escape ("flight") in response to the emotional signal of fear (e.g., fear about being viewed negatively by others).

Behavioral theories view MPA as a classically conditioned fear arising from previous negative learning experiences (e.g., Clark, 1989; Spahn, 2015), with genetic factors contributing to variations in individual responses to similar experiences (Kenny, 2011). In comparison, *cognitive theories* of MPA (e.g., Osborne & Franklin, 2002) focus on cognitive distortions such as dysfunctional beliefs and assumptions about the self (e.g., "I'm going to make a fool of myself") and others ("They have a perfect standard which I cannot match"), fears of negative evaluation (e.g., "If I make the slightest mistake, they'll think I'm incompetent and fail me"), and catastrophizing the consequences of negative evaluation (e.g., "My career is ruined"). Under this

view, schemas developed from prior sensitizing negative music performance experiences (Osborne & Kenny, 2008) interact with judgments of low self-esteem and self-efficacy to produce a negative affective state when encountering highly evaluative performance situations. In turn, the discrepancy between one's schema of their ability to perform competently and their expectation of the audience's performance standards leads to rigid survival rules, coping strategies, and safety behaviors that shift attention away from the performance task to the self. This precisely increases the likelihood of performance errors and produces MPA that feeds back dysfunctional beliefs about oneself, reinforcing the vicious cycle (Osborne & Franklin, 2002; see also Chow & Mercado, 2020 for a discussion of the temporal dynamics of interacting processes in MPA).

Emotion-based theories (Barlow, 2000; Kenny, 2010) view MPA as a state of helplessness when one experiences a strong sense of uncontrollability and unpredictability in a performing situation. Such panic-like negative emotions may be false or true alarms (i.e., fear responses that occur in the absence versus presence of a real danger) that have been conditioned in persons with generalized biological and psychological vulnerabilities following direct experience or stress. These alarms provide the propensity for anxious apprehension in performing situations. If the performance is (perceived to be) impaired, the negative emotions that follow may trigger further alarms and exacerbate the anxious apprehension, in turn increasing the likelihood of further performance impairment. This reinforces the vicious cycle until the performance setting itself evokes learned (conditioned) alarms even before the performance (Kenny, 2010).

Extant MPA Interventions

To support musicians in managing MPA, numerous coping strategies and interventions have been developed over the years, in what is now a highly heterogeneous literature marked by inconsistent effects and methodological weaknesses such as small sample sizes and a lack of a randomized (active) control group (for reviews, see Faur et al., 2023; Fernholz et al., 2019; Herman & Clark, 2023; Kenny, 2005; McGinnis & Milling, 2005; Spahn, 2015; Wilson & Roland, 2002). Such diverse interventions include but are not limited to: pharmacotherapy (e.g., James & Savage, 1984), psychoanalytic/psychodynamic therapy (e.g., Kenny et al., 2016), cognitive therapies such as cognitive restructuring to modify dysfunctional thought patterns (e.g., Kendrick et al., 1982; Sweeney & Horan, 1982), behavioral therapies such as repeated stage exposure (e.g., Candia et al., 2023), cognitive-behavioral therapy (CBT; e.g., Kenny & Halls, 2018; Nagel et al., 1989), biofeedback (e.g., Nagel et al., 1989; Wells et al., 2012), yoga and meditation (e.g., Khalsa et al., 2009; Paese & Egermann, 2024; Stern et al., 2012), expressive writing (Tang & Ryan, 2020), improvisation-assisted desensitization (e.g., Kim, 2008), psychological skills training (e.g., Cohen & Bodner, 2019; Hoffman & Hanrahan, 2012), and multimodal interventions that combine treatments such as relaxation techniques, goal setting, and mental imagery (e.g., Braden et al., 2015; Kim, 2008; Spahn et al., 2016). Whereas a comprehensive review of the myriad of interventions is beyond the scope of this article, the following section focuses on CBT and multimodal interventions that meta-reviews have considered the most promising (Braden et al., 2015; Spahn, 2015; Wilson & Roland, 2002).

CBT for MPA aims to modify maladaptive cognitive and behavioral patterns through cognitive restructuring and systematic controlled exposure to performing

situations (Spahn, 2015). For instance, Sweeney and Horan (1982) tested a cognitive-behavioral intervention that included cognitive restructuring and cue-controlled relaxation. Specifically, music majors identified self-defeating thought patterns that occurred during their piano performances, analyzed the consequences of these thoughts, learned “coping” self-statements to facilitate their task attention and reduce debilitating anxiety, and practiced these self-statements while playing music. In addition, the musicians were trained in progressive muscle relaxation, and learned to pair the cue word “calm” with a relaxed state while playing music. This combined treatment was found to reduce self-reported anxiety as compared to a musical analysis training control condition, although not significantly more so than either cognitive restructuring or cue-controlled relaxation alone.

More recently, Kenny and Halls (2018) developed and tested a CBT intervention based on an empirically validated group anxiety treatment, *Chilled* (Rapee et al., 2006). Their CBT intervention included psychoeducation about the nature of music performance anxiety, affect recognition, identifying thinking styles, cognitive restructuring, and learning to develop and implement a step-by-step exposure plan to manage high-anxiety performing situations (e.g., gradually progressing from performing a piece for one’s teacher, then for more supporters, then for a music exam). After the intervention and at a follow-up four to six weeks later, the CBT intervention produced gains in performance quality, although reductions in self-reported state anxiety were not significant and the study did not include a control group.

Overall, a medium effect ($d = 0.535$) of CBT interventions in reducing MPA symptoms has been found in Faur et al.’s (2023) recent meta-analysis of 91 effect

sizes from 14 studies. However, the authors also noted that many of the individual studies had small sample sizes and lacked sufficient statistical power to detect changes. Moreover, CBT interventions did not always lead to changes in performance quality in these studies.

On the other hand, multimodal interventions for MPA target the performer's somatic, cognitive, emotional, and behavioral responses via a combination of various psychotherapeutic methods, which may include relaxation techniques, pharmacotherapy, cognitive restructuring, psychotherapy, stage exposure training, etc. (Spahn, 2015). For instance, to train music students to cope with MPA during auditions, Spahn et al. (2016) evaluated a multimodal combination of behavioral exposure (e.g., video feedback on one's performance, stage exposure via class concerts), exercises for coping with MPA (e.g., cognitive restructuring, body relaxation exercises, mental imagery), and education on the theoretical framework of MPA. The multimodal intervention reduced self-reported anxiety and external judgments of the performer's MPA-related issues during their auditions, relative to a control group that did not receive the intervention.

Cohen and Bodner (2019) further proposed a two-pronged approach to facilitate positive functioning while reducing debilitating MPA. Their multimodal intervention was an 11-week course that included mental skills training (e.g., positive thinking, goal setting, mental rehearsal, concentration and focusing, identifying negative automatic thoughts, performance preparation, resilience), developing physiological awareness (e.g., regulating and reframing arousal as excitement, refocusing attention), enhancing musical communication (e.g., improvisation exercises to focus on musical goals), and simulated performances to implement the

learned skills. Compared to a waitlist control group, the intervention reduced self-reported pre/post-test MPA. In addition, judges rated the intervention group's simulated performance as having improved in quality after the intervention.

Multimodal interventions seem to bear promise for reducing MPA, but the high heterogeneity in their components across studies impedes generalizable conclusions (Herman & Clark, 2023). Moreover, the complexity of tailoring individualized approaches may preclude the accessibility of such interventions to musicians with diverse backgrounds and needs.

Limitations of Extant MPA Interventions

Despite the numerous interventions available and the reported positive effects of some interventions in individual studies, MPA prevalence rates have not substantially changed at the population level over the years, suggesting that extant interventions may have limited impact on overall (Herman & Clark, 2023). Whereas most interventions target MPA symptoms with the aim of lowering self-reported anxiety, some amount of anxiety or arousal could in fact facilitate peak performance (Kenny, 2005).

More importantly, treating the symptoms of MPA does not necessarily resolve its root cause(s). Musicians have reported experiencing anxiety far in advance of their performance, rather than only during their actual performance on stage (Tahirbegi, 2022). The reality is that music performance in evaluative situations carries high demands—whether perceived or actual—on the performer to attain (near) perfection. Such pressures and strivings for errorless performance and perfection may be particularly acute in some genres such as Western classical music, especially in solo performances (Kruse-Weber & Parncutt, 2014; Papageorgi et al., 2013; see also

Perdomo-Guevara, 2014). For instance, musicians face challenges ranging from temporally precise fine motor technique, sustaining attention over long durations, memorizing complex material, to interpretative and musical communication skills (Kenny & Osborne, 2006; Pecun et al., 2016).

Yet, many MPA studies do not screen participants for weak technical musical ability, and for whom anxiety may be a consequence rather than a cause of poor performance (McGinnis & Milling, 2005). As Faur et al. (2023) also note in their review, that extant MPA interventions do not always improve performance quality could be due to their focus on treating anxiety symptoms without targeting the improvement of technical skill (see also Osborne et al., 2007). Indeed, debilitating anxiety could result from inadequate preparation and deficits in musical technique.

Toward a New Cognitive-Psychological Perspective

Do test-anxious persons actually perform worse in evaluative situations than their knowledge or skill would otherwise allow? This commonly held but rarely tested assumption has recently been challenged in a field study. Using log files from a digital learning platform, Theobald et al. (2022) examined data from 309 medical students preparing for a high-stakes exam. The students' test anxiety at the start of the study was negatively associated with their final exam performance, as well as their preparation performance when completing old exam questions over 100 days before their final exam, and their performance on a mock exam 28 days before their final exam. If students' test anxiety (e.g., fears about knowledge deficits or negative consequences of poor exam performance) interferes with their processing and performance during evaluative situations, then high-anxiety students should perform worse on the high-stakes final exam than non-evaluative mock exam, and this

performance decline should correlate with their test anxiety. But this was not the case. Instead, students' test anxiety did not predict a drop in their performance from the mock exam to final exam. Furthermore, when controlling for students' mock exam performance, their test anxiety did not predict their final exam performance.

These findings suggest that highly test-anxious students' lower knowledge levels accounts for the link between their test anxiety and worse final exam performance. In line with this idea, Theobald et al. (2022) found that students with high test anxiety tended to show less knowledge gains during their exam preparation. Moreover, whereas higher state anxiety in the morning did not predict the number of practice questions that students correctly solved on that day during their exam preparation, correctly solving fewer questions predicted students' higher state anxiety the next day. Thus, awareness of one's poorer knowledge may trigger test anxiety. The key implication is that short-term interventions that aim to reduce test anxiety shortly before or during the evaluative situation may have limited impact because they cannot offset long-term knowledge deficits (Theobald et al., 2022). Rather, effective learning strategies that boost and secure actual deep learning are needed to tackle test anxiety at its root.

Whereas Theobald et al.'s (2022) study was conducted in the context of academic exam performance, the findings have important implications for music performance too. Some recent evidence suggests that MPA and performance quality co-develop during practice sessions, such that musicians who improve their playing are subsequently less anxious (Passarotto et al., 2023). Thus, MPA interventions ought to promote effective practice that produces optimal, deep learning at an early stage

during performance preparation, and not merely aim to reduce anxiety only shortly before or during stage performance.

Music students have most commonly reported that increasing their practice time is their main strategy to manage MPA, while developing specific practice techniques to address concerns such as potential memory slips (Tahirbegi, 2022) and difficult parts of the music (Fehm & Schmidt, 2006). Notably, students have ascribed their performance experiences to their level of technical preparedness, which may directly impact their MPA. For instance, interviewed participants in Tahirbegi's (2022) study commented that "My anxiety depends on how secure I feel about the concerts, how well I know the pieces I play" and "I notice that if I am very well prepared, I don't necessarily get that nervous". Indeed, well-prepared performers may experience higher self-efficacy that facilitates their management of MPA (Tahirbegi, 2022). In turn, lower MPA mediates the positive effects of self-efficacy on self-rated performance quality (González et al., 2018). Conversely, more anxious musicians have reported less conviction in their ability to perform the task (i.e., lower self-efficacy) even with their anxiety under control than less anxious musicians (Craske & Craig, 1989). Thus, mastering the musical material and technical skills could boost self-efficacy, which has been found to be the most important predictor of music performance quality in evaluative exams (McPherson & McCormick, 2006).

Clearly, musicians are well-aware of the importance of good preparation for successful musical performance (Ericsson et al., 1993). However, the practice strategies that they use during their preparation may not always be the most effective. For instance, although increasing practice time is a strategy that musicians often use to cope with MPA (Tahirbegi, 2022) and that has been associated with lower self-

reported MPA in some studies (e.g., Biasutti & Concina, 2014; González et al., 2018; Kenny et al., 2013), hours of practice alone do not necessarily predict better music performance quality (McCormick & McPherson, 2003; Williamon & Valentine, 2000). Moreover, state anxiety has been associated with repetitive practice behaviors during longer practice sessions, which may increase the musician's risk of developing injuries from overuse and repetitive strains (Passarotto et al., 2023). Adding insult to injury, mindless repetition and drill during practice may also have limited benefits for deep learning and performance quality (Ericsson et al., 1993; Lehmann & Ericsson, 1997).

Taken together, these findings point to the importance of practice *quality* for achieving musical mastery and managing MPA. How, then, should musicians practice for deep, durable learning? Drawing from the cognitive psychological literature, two potent strategies are: deliberate practice and retrieval practice.

Deliberate Practice

Extended experience and preparation are undoubtedly crucial for gaining expertise. Based on his review of 76 eminent composers' biographies, Hayes (1989) observed that "no one composes outstanding music without first having about 10 years of intensive musical preparation" (p. 297), presumably because "the composer must know the timbres of the various instruments and the sound, look, and feel of chords and key structures" (p. 293). However, experience and sheer quantity of practice alone do not automatically produce peak performance. Rather, *how* one practices matters.

The amount of one's practice time can be divided into "formal" versus "informal" practice time (Sloboda & Davidson, 1996), which have been defined as

practicing with versus without a specific musical or technical goal in mind (Miksza, 2012). For instance, whereas informal practice includes improvisation, playing one's favorite pieces by ear, and messing about with music, formal practice includes practicing technical exercises such as scales, studies and études, and sight-reading (McPherson & McCormick, 2006; Sloboda & Davidson, 1996).

In particular, deliberate practice has been closely associated with formal practice (Bonneville-Roussy & Bouffard, 2015; Platz et al., 2014). *Deliberate practice* involves structured, effortful practice activities that are specifically designed and tailored to improve one's current level of performance, as characterized by: (a) repeated experiences in which the performer attends to the critical task elements, (b) focused attention, (c) intrinsic motivation to improve, and (d) corrective feedback and performance monitoring that enable gradual refinements (Ericsson et al., 1993). Thus, based on their desired performance goal and imagined music experience for their audience, the performer must plan how to execute their performance to achieve this goal, while monitoring the sound produced during their current practice attempt, such that they can refine subsequent attempts to target discrepancies between their produced versus desired sound (Ericsson, 1998; Ericsson & Harwell, 2019). For instance, when monitoring their self-regulated practice in the absence of a teacher's feedback, musicians could use video feedback (e.g., filming one's practice performance, then watching and self-evaluating one's recorded performance before the next practice session) to guide their practice strategies (Boucher et al., 2020).

Many studies have shown that deliberate practice is a necessary and important predictor of higher levels of music performance (e.g., Bonneville-Roussy et al., 2011; Ericsson et al., 1993; Sloboda et al., 1996; see Lehmann et al., 2018 for a review),

even if it may not be sufficient (Hambrick et al., 2014; Meinz & Hambrick, 2010). For instance, Platz et al.'s (2014) meta-analysis of 13 studies found a mean effect size of $r = 0.61$ accounting for 36% of the variance in the relationship between task-relevant practice (including deliberate practice) and music performance (see also Ericsson & Harwell, 2019; Hambrick et al., 2014; Macnamara et al., 2014). Indeed, practice time has been shown to predict musical achievement only through formal practice that includes deliberate practice and self-regulation strategies, goal direction, and focused attention—when formal practice is controlled for, then practice time in fact negatively predicts musical achievement (Bonneville-Roussy & Bouffard, 2015). This suggests that informal practice time may not only be “empty” time, but could impede musical achievement. Thus, to learn effectively and reduce MPA stemming from skill deficits, musicians should engage in more deliberate practice rather than simply increasing practice time.

Retrieval Practice

Besides deliberate practice, testing oneself from memory—*retrieval practice*—is a potent learning technique that decades of research have robustly shown fosters deep, durable learning (Roediger & Karpicke, 2006a, 2006b; see Karpicke, 2017 for a review). Notably, retrieval practice yields reliable memories that are resilient to stress. In a study by Smith et al. (2016), participants studied words and images either by restudying them or practicing retrieval (i.e., recalling as many items as they could after studying them). One day later, half of the participants underwent stress induction in which they were asked to give impromptu speeches and solve math problems in front of an audience. When participants were subsequently tested on their memory of the studied words and images, the retrieval practice group outperformed

the restudying group. Importantly, stress impaired memory in the restudying group, but not in the retrieval practice group. In fact, stressed retrieval practice participants outperformed non-stressed restudying participants, and performed just as well as non-stressed retrieval practice participants. These findings suggest that stress does not always harm memory and performance. Rather, when strong memories are created during encoding by using effective techniques such as retrieval practice, these well-encoded memories are protected against stress.

At the same time, retrieval practice reduces test anxiety. In a study of 1,408 middle and high school students, Agarwal et al. (2014) found that 72% of students reported feeling less nervous for tests and exams for their classes that had implemented retrieval practice (e.g., via low-stakes practice quizzes administered via “clickers”). Presumably, when students engaged in retrieval practice, they learned the course material better and were thus less anxious about facing subsequent evaluative tests.

In the context of music performance, the implication is that practicing retrieval during performance preparation could be a powerful way to lower MPA, while enhancing learning and reducing memory failures during one’s actual performance even when anxious. Indeed, retrieval practice is an effective technique that musicians have reported using when learning and memorizing new pieces, even when their practice time is limited (e.g., Chaffin, 2007; Chaffin et al., 2010). For instance, Chaffin (2007) describes how an experienced concert pianist learned Debussy’s *Clair de Lune* in seven sessions over two weeks by constantly testing herself from memory. Specifically, the pianist attempted to play from memory almost immediately in her first practice session, “muddling through” even when hesitating at various places in

the music, evaluating her progress by listening for mistakes and checking them in the score, and using the musical structure and performance cues (e.g., expressions to be conveyed) to organize her practice and increase the speed and automaticity of her retrieval. Similar practice processes have been observed in case studies of jazz musicians learning new pieces (Noice et al., 2008; see Wellmann & Skillicorn, 2024 for a discussion of applying retrieval practice in jazz pedagogy). Such practice strategies can also be taught and developed in non-expert musicians (Lisboa et al., 2018).

Barriers to Implementing Effective Practice Strategies

Although deliberate practice and retrieval practice are potent techniques for enhancing deep learning and managing MPA, their benefits may be constrained by suboptimal implementation. For instance, rote memorization (e.g., repeating the music until it can be played automatically by “feel”) is a common form of retrieval practice, especially for novice musicians (Hallam, 1997; Williamon, 2004; see Mishra, 2010 for a review of memorization methods). After repeating short sections and playing them from memory without the music score, the musician may link or “chunk” these sections into longer sections, then repeat these longer sections and play them from memory, until the whole piece has presumably been memorized. In this way, retrieving each chunk cues the musician’s recall of the next chunk (Chaffin, 2007), in what is known as associative chaining (Ebbinghaus, 1885/1913) or serial position effects in recall (e.g., Roediger & Crowder, 1976).

Yet, although some degree of automaticity is needed for efficient performance under pressure, procedural memory is unreliable and vulnerable to interference (Beilock & Carr, 2001; Lisboa et al., 2018; Mishra, 2010; Williamon, 2004). When

memory fails during a music performance, serial cuing of recall is disrupted (Chaffin et al., 2023). Thus, if musicians relied only on rote memorization during their performance preparation, they may have no other recourse than muddling along, improvising or, worse still, restarting the piece if a memory lapse occurred onstage (Chaffin, 2007; see also Rubin, 2006).

In fact, expert performance has been conceptualized as a shift of cognitive control to higher-level strategic aspects of performance, rather than being eliminated entirely for full automaticity (Christensen et al., 2016). That is, experts may be able to perform seemingly without thinking because they harness automatic control systems to think in music while sequencing the actions needed (Logan, 2018). For instance, expert musicians form performance cues based on the musical structure of a piece (Chaffin & Imreh, 2002) to create memory that is “content addressable” (Rubin, 2006). Such performance cues include: (a) *structural cues* representing section boundaries of the music (e.g., based on harmonic and melodic properties), (b) *expressive cues* representing the feelings to be conveyed to an audience, (c) *interpretive cues* representing critical interpretive decisions that need monitoring during the performance (e.g., decreasing the dynamics to prepare for a later crescendo), and (d) *basic cues* representing critical technique details such as fingering (Chaffin & Imreh, 2002). In this way, the music’s structure provides a hierarchical retrieval scheme, while performance cues serve as landmarks in a mental map from which the musician can access specific content or locations to recover from a memory lapse, rather than having to restart from the beginning of the piece.

But even performance cues have limitations. Although the musician may be able to recover from a memory lapse by jumping forward and continuing from a

performance cue, recall tends to be highest at the beginning of phrases starting with structural or expressive cues, then declines steadily across the rest of the phrase (Chaffin et al., 2010; Lisboa et al., 2018). One interpretation is that structural and expressive cues provide content-addressable access to memory that is otherwise organized as an action sequence (i.e., in serial order). Thus, later bars in the sequence are recalled less well and memory failure becomes increasingly likely (Chaffin & Imreh, 2002; Lisboa et al., 2018). In contrast, recall tends to be lower at basic cues then increases as serial distance from the cue increases, suggesting that basic cues do not provide direct content-addressable memory access but function as parts of serial associative chains (Chaffin et al., 2010). How, then, can musicians learn the music more intimately on a bar-to-bar basis?

Personal Reflections: Non-serial Learning and Practicing

Consider the following excerpt from Chopin's first ballade:

The image shows a musical score excerpt from Chopin's first ballade. It consists of two systems of piano music. The first system starts at bar 167 and the second at bar 170. The score is in G minor and 3/4 time. The right hand features chords and arpeggiated figures, while the left hand has a steady eighth-note accompaniment. Asterisks are placed below the left hand in several bars to indicate specific cues.

It is commonplace for pianists that bars 170 to 172 form a serial associative chain (Chaffin et al., 2010) so that, relative to bar 170, the content of 171 or 172 is not readily accessible. Instead, the retrievability of bar 171 often hinges heavily, if not

wholly, on first executing bar 170 successfully; likewise, 172 relies on 171. Evidently, where a pianist fails to execute bar 170 successfully, bars 171 and, by extension, 172 also cannot be recovered. One expects the same outcome for Mozart's Sonata in a minor, K. 310. Consider the opening figure of its third movement:

Indeed, such is the severe cost to basic cognitive systems that function in a serial recall manner. Consequently, one cannot successfully start a piece from just anywhere, but must start from the outset or at least at the beginning of a section. For a singer, one cannot directly recall what words in a ballad rhyme with *ee* or even what happens in the last stanza, but has to in fact sing the ballad and listen for *ee* sounds and pay attention to the last stanza when one gets to it (Rubin, 2006). Similarly, a pianist playing the above opening figure often cannot directly pinpoint the exact notes that bars 2 to 4 contain, and would have to “play to know” when he/she gets to each of those bars.

Under this light, the remedy is no longer counterintuitive, but straightforward. One ought to resist the tendency to practice bars 170 to 172 of Chopin's ballade or bars 1 to 4 of Mozart's sonata above serially, and instead dissolve the serial associative chains by practicing in various non-serial combinations: e.g., bars 171–

170–172, 172–171–170; 4–2–3–1, 4–3–2–1, etc. Personally, I would further subdivide each bar into halves during non-serial practice, yielding: e.g., bars 171b–171a–170a–170b–172a–172b; 4a–4b–2b–2a–3a–3b–1b–1a, etc.

Personally, numerous spots from Schumann's Papillons Op. 2 have also benefitted from non-serial learning and practicing. For instance, in No. 4, both phrases in section B hinge strongly on their respective harmonic progressions involving rapid chord changes, so that there is the natural tendency to serially practice bars 90 to 97, followed by bars 97 to 105, which one must resist. Instead, such serial associative chains ought to be dissolved, again by practicing in various non-serial combinations for deep learning and durable memory.

In appreciating the present idea more fully, imagine a story you know very well, or a lecture you attended recently. Summarize it or recall a part of it from the middle. Imagine next a poem or prayer that you know well and which has a clear meaning. Recite any line without cycling all the way through it, or simply try to start that line from its middle. Oftentimes, the same serial processes that enable cuing in serial recall *restrict* access, permitting access only via serial recall. Therefore, when recall is no longer restrictively serial, any to-be-retrieved content can be accessed and addressed with ease, just like our autobiographical memories (Rubin, 2006).

Notwithstanding its usefulness, given the large volume of music that a pianist or musician normally has to cope with for an audition or a performance, it may not be practically feasible to apply the present approach to all of the to-be-learned music exhaustively in a single sitting. Thus, it is commonplace to subject only specific portions of a program needing remedy the most to non-serial learning and practicing. How might we reliably identify these portions?

In working towards an audition or a recital, a day's basic practice might typically be scheduled in the following sequence:

1. Warm-up
2. Practice
3. Record

Whereas recording one's performance can help effectively reveal portions of a program that require attention, first playing ourselves into a good, comfortable place via practice (throughout the day) prior to recording ourselves (at the end of the day) may be counterproductive for this purpose. To this end, a simple inversion is recommended:

1. Warm-up
2. **Practice Record**
3. **Record Practice**

The adjusted sequence—recording without first practicing—illuminates weaknesses in a program with greater fidelity, following which principles of deliberate and retrieval practice can be applied as part of non-serial learning and practice in remedying those portions.

Conclusion

Traditionally, music performance anxiety (MPA) negatively impacts musicians in almost every musical context imaginable. Extant interventions relate to cognitive-behavioral therapy and multimodal interventions but do not cure MPA at its roots. Drawing on cognitive psychological research findings, performance-anxious musicians should not perform worse in high-stakes stressful situations than their preparation (practice) would otherwise allow. Instead, where musicians are well-prepared, performance anxiety per se should not interfere with stage performance accuracy and quality. From this stance, performance-anxiety interventions ought to promote effective practice and optimal learning at an early stage during performance preparation, rather than aim to reduce test anxiety only shortly before or during stage performance. Informed by psychological science and personal reflections, the present non-serial learning and practicing approach is expected to help performers achieve deep, durable learning and flourish on stage, notwithstanding any musical performance anxiety that they may or may not then experience—that's now inconsequential.

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Musicology Reflections on Modern-Day Classical Piano Performance Practice

Piano playing in the 21st century is characterized by an obsession with “the correct sound” and “the correct speed”. In this brief essay, I will argue that such an approach is incorrect and counterproductive for our artistic goals and future.

“The Correct Sound”

Jeremy Denk who stands among America’s most celebrated pianists today judiciously remarked during his masterclass at Juilliard, “Everyone is trying so hard to be a good pianist, a ‘correct’ pianist. To voice well, to pedal right, to play all the notes, to win competitions.” Unwittingly, we have spent all our lives trying to be “that one correct pianist”. But do we want to hear a pianist who is merely “correct”? That is not what art is. None of us would have a distinctive voice.

Consider the following excerpt from Chopin’s first ballade (arrow highlights mine):

Embedded in Chopin’s writing is an alluring counter melody, which we are not always well-poised to hear or willing to sing, owing to pre-conceived expectations of what

the ballade’s “correct” sound ought to be, and the resulting fear—from forfeiting Distinction at an LTCL exam to failing the Preliminary Round outright in Warsaw.

“The Correct Speed”

Another reason we do not hear or sing such hidden gems relates to performance directions, such as tempo. For Chopin, his two-horse carriage would have been charging forward at *presto* already (during his near-fatal accident in Scotland when one of the animals broke loose), whereas we grumble that the *shinkansen* is still too slow for our modern society. Today, the meaning of *presto* is distorted, and performing this section of the ballade (bars 166 to 190) at lightning speed has become commonplace. Another place is of course the Coda, where at least five distinct musical ideas reside, but are all meshed up and completely lost on the listener—exactly like the numerous orchestral and pianistic nuances from Chopin’s first concerto, until one listens to such a well-regulated rendition as [this](#). Psychologists call this phenomenon “cognitive overload”—the brain tries but fails to process lots of information at high speed, so we miss the things we have wanted to see, hear, feel, or taste. Imagine a big feast at the table, which must be consumed in no more than two quick minutes. Chopin should have been quite upset, if he knew pianists are devouring his music today.

Moving Ahead

As an aspiring pianist, I endeavour to re-enact our western classical music heritage with strict fidelity but also with imagination and innovation. By respecting composers’ original intentions, we perform works of music steadily—authentically¹.

By not obsessing with a warped sense of “correctness”, we discover new musical

¹ For further reading: Dodd, J. (2012). Performing works of music authentically. *European Journal of Philosophy*, 23(3), 458–508.

ideas, experiences and enjoyment on our artistic journeys, telling stories of the past as our own in measured, unique ways. Concurrently, as a cognitive-educational psychologist, I have a burgeoning passion in helping musicians combat musical performance anxiety, so that every performer may thrive and flourish on stage where we are meant to be.



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