

**THE EFFECT OF MUSIC PERFORMANCE ANXIETY, CONTEXT,
MODALITY AND OBSERVERS' MUSIC EXPERTISE ON
JUDGEMENT OF MUSICAL PERFORMANCES**

Pui Yin KWAN

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<p>Tiivistelmä – Abstract</p> <p>Music Performance Anxiety (MPA) is known to affect musicians at different levels. Recent studies have shown that anxiety can induce changes in non-verbal behaviours, and that non-verbal behaviours could affect perception and production of a musical performance. However, it remains unclear how effectively cues associated with MPA are perceived via different modalities (audiovisual, audio-only & video-only). The present study aims to investigate the impact of MPA, performing contexts and modalities on the observers’ ratings of expressivity, performance quality and inner state, and whether these ratings would be affected by the observer’s level of music expertise. Eight performers completed the revised Kenny Music Performance Anxiety Inventory (K-MPAI) and were also recorded performing a repertoire of their choice in both the presence and absence of an audience. Excerpts of the performances were presented to 53 observers in the three modalities. Observers were asked to rate the excerpts in terms of expressivity, performance quality and the performer’s inner state. The main findings included: 1) Anxiety impaired expressivity and performance quality ratings, especially in the video-only condition; 2) The high-anxious performers were susceptible to trait anxiety, while the mid-anxious and low-anxious performers were effected by the performing context; 3) The high-anxious performers were perceived as being the most anxious in the audiovisual and video-only conditions; 4) The low-anxious performers were perceived as being the most anxious in the audio-only condition, although this finding may have been affected by the acoustic properties of the music; 5) Visual cues seemed to be more dominant in perceiving expressivity and anxiety, while auditory cues played a more important role in performance quality evaluation; 6) Musical training affected assessment of expressivity and performance quality but not the perception of anxiety. The results highlight the importance of visual and auditory cues in performance evaluation, and provide practical implications for online and blind auditions.</p>	
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1 INTRODUCTION

Music Performance Anxiety (MPA) refers to a persistent and stressful experience of the performer which is aroused by the requirement of performing music in public. MPA affects many individuals regardless of their age, gender, experience or hours of practice. Notable sufferers of MPA have included world-class performers such as Frédéric Chopin, Maria Callas, Enrico Caruso, Vladimir Horowitz, Arthur Rubenstein and Sergei Rachmaninoff (Kenny, 2011; Valentine, 2002).

Symptoms of MPA are generally categorized into three groups, namely physiological, cognitive, and behavioural (Valentine, 2002). Physiological responses of MPA can be interpreted as a product of over-arousal of the autonomic nervous system, in which symptoms such as increased heart rate, palpitations, dilation of blood vessels and hyperventilation are manifested. Cognitive symptoms are often associated with subjective negative thoughts about the performance. These include the fear of evaluation by others, catastrophizing, self-handicapping and perfectionism. Behavioural symptoms include shaking, stiffness, trembling and dead-pan expression (Valentine, 2002). These MPA symptoms can either interact with each other or occur separately (Craske & Craig, 1984; LeBlanc, Jin, Obert, & Siivola, 1997; Yoshie, Kudo, & Ohtsuki, 2008). While most of the previous literature focused on the physiological and cognitive aspects of MPA, it seems that the behavioural aspects of MPA have received the least attention (Endo, Juhlbery, Bradbury & Wing, 2014).

The present study attempts to investigate how the severity of MPA, performing context, and modality would prompt differences in ratings of the performers' expressivity, performance quality and perceived anxiety when the performers are evaluated by observers with different level of musical expertise.

To this end, the present research provides an overview of the literature on optimal musical performance, behavioural symptoms of MPA and their assessment, the role of body movement in expressivity, performance quality and emotion perception, as well as effects of musical training on perception of musical performances.

2 LITERATURE REVIEW

2.1 MPA & Optimal Performance

The idiom “practice makes perfect” has been applied to many kinds of learning, including music. It is assumed that 10,000 hours of deliberate practice is needed to master a skill (Ericsson, Krampe, & Tesch-Römer, 1993). To achieve optimal performance, however, it requires more than effort, talent and determination. Previous literature revealed that 83.1% of music university students from a US university experienced performance anxiety (Miller & Chesky, 2004). A high prevalence of MPA is also recorded among professional musicians. Of the 155 professional musicians surveyed from symphonies orchestras in The Netherlands, 59% of them suffered from MPA and claimed that the condition was severe enough to impair performance quality (Van Kemenade, Van Son & Van Heesch, 1995). These figures imply the possible effect of MPA on performing music at peak level.

According to Yerkes-Dodson model, or the inverted-U shape curve (Yerkes & Dodson, 1908), low levels of arousal do not enhance performance. An increase in arousal facilitates performance (adaptive), but only to a certain point, after which increased arousal can elicit deleterious effect on the performance (maladaptive) (Papageorgi, Hallam & Welch, 2007). However, the arousal-performance relationship is not so straightforward.

Making music demands a high level of motor and cognitive skills. One may assume that less arousal is needed for peak performance if a task requires mainly gross motor skills (McAllister, 2012). Oxendine (1970) pointed out that the required level of arousal for optimal performance varies with task complexity. For instance, simple tasks require higher arousal to achieve optimal performance, while complex tasks are performed better with low levels of arousal.

Wilson (1994; 2002) extended the inverted U-shape theory into a three-dimension model (Figure 1). The model suggests that whether anxiety is adaptive or maladaptive to performance is determined by the interplay of three underlying causes, namely trait anxiety, situational stress and task mastery. *Trait anxiety* refers to individual differences in response

to negative emotions across various threatening situations (Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983). Personality characteristics, such as neuroticism or social phobia are related to trait anxiety (Steptoe & Fidler, 1987; Cox & Kenardy, 1993). A number of studies have reported positive associations between trait anxiety and MPA (Hamann, 1982; Kokotsaki & Davidson, 2003; Osborne & Kenny, 2008). Another determinant of performance outcome is *situational stress*. Audience size and the type of the audience are known to have influence on anxiety levels in performers (Wilson, 1997; Miller & Chesky, 2004; Cox & Kenardy, 1993; LeBlanc et al., 1997; Osborne & Franklin, 2002). Finally, the degree of *task mastery* is related to the complexity of the musical work, as well as the amount of preparation for the performance (Wilson, 2002). For instance, highly anxious performers may benefit from choosing a relatively easy or well-rehearsed piece for a demanding situation such as an audition, whereas increased anxiety in experienced performers with high task mastery may facilitate performance (Wilson, 2002).

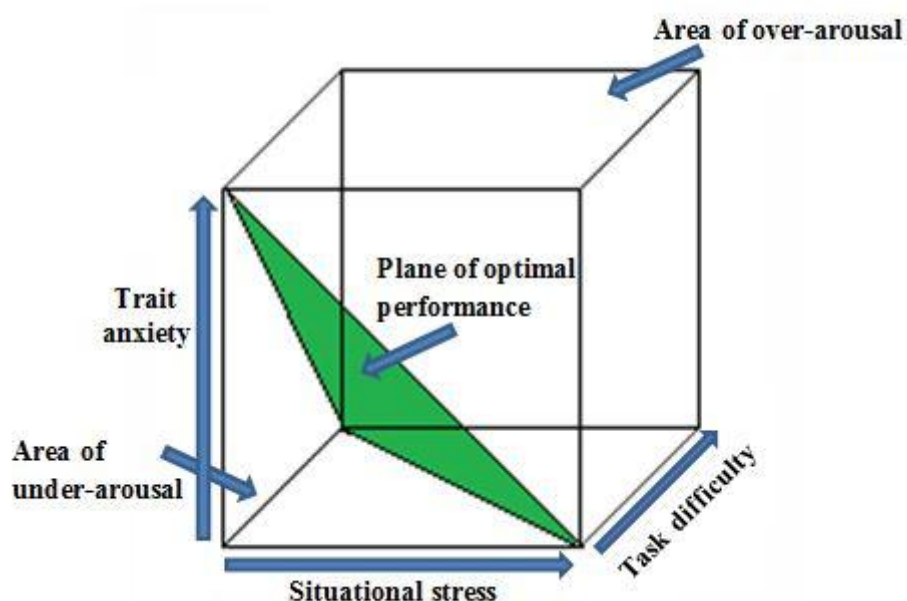


Figure 1. The three-dimension model by Wilson (1994, as cited in Valentine, 2002), with three underlying factors contributing to performance anxiety. Adapted from *The fear of performance* (p.172), by J. Rink (Ed.), 2002, Cambridge, UK: Cambridge University Press.

Over the decades, many studies on performance have been conducted to investigate the combining interaction of these three interdependent factors on performance. For example, musicians who had more musical experience were reported to have performed better under anxiety-induced situations (Harmann, 1982) and received higher performance ratings

(Kokotsaki & Davidson, 2003); Steptoe (1983, as cited in Steptoe, 2001) found an inverted U-shaped relationship between level of tension (of performance context) and performance quality, in which intermediate level of tension results in the best ratings, while impaired performance was recorded in settings related to greater tension, which falls in line with Wilson's (2002) theory. Craske & Craig (1984) found that non-anxious performers received higher score than high-anxious performers regardless of musical experience. Even in sports performance, it was observed that a modest amount of anxiety would have positive effect on performance if an individual's skill level corresponds with the situational demand (Jackson and Csikszentmihalyi, 1999). Conversely, low levels of arousal can provoke boredom and listlessness (Martin, Kuiper, Olinger & Dobbin, 1987).

However, the abovementioned Yerkes & Dodson-based models (Yerkes & Dodson, 1908; Wilson, 2002; Papageorgi et al., 2007) were criticized by Kenny (2011) for not taking into account of other factors influencing the arousal-performance relationship, such as task efficacy, working memory capacity and previous experiences of the performers. Besides, Stephenson and Quarrier (2005) claimed that anxiety sensitivity serves as a better predictor than trait anxiety of MPA.

Besides the models mentioned above, there are numerous existing performance-based theories, such as distraction and self-focus theory (Wan & Houn, 2005), reversal theory (Apter, 1982), and attention control theory (Eysenck, Derakshan, Santos, & Calvo, 2007), where interdependence of the suggested components can be found in these theories. However, much work is required to build a theory that can fully explain the interactions between the interdependent factors and the arousal influenced optimal performance.

2.2 Behavioural Symptoms of MPA and their Assessment

Most of the behavioural symptoms of MPA are overt; they include shaking, stiffness, trembling, dead-pan expression (Valentine, 2002), difficulty in maintaining posture and awkward body movements (Steptoe, 2001). Through these behavioural symptoms, performers may signify to the audience that they are nervous. This can potentially impair the performer's efficiency in communicating with the audience, or cause deterioration to the performance quality (e.g. through the trembling of a violinist's bow arm) (Williamson, 2004).

Wynn Parry (2003) commented that anxious musicians tend to have poor postures and practice techniques. Chronic pain, fear and anxiety are often associated with fear-avoidance behaviour and may lead to reduced activity and postural changes (Leeuw et al., 2007; Vlaeyen & Linton, 2000). From this perspective, it is possible for anxious musicians to exhibit postural changes when performing in front of an audience, such as ‘freezing’ behaviour (Azevedo et al., 2005), tensed facial expression and rigid posture, (Gregersen, 2005) and a change in body movement behaviour (Bögels & Mansell, 2004).

The behavioural element of MPA has been evaluated by way of observational studies, performance quality assessment, anxiety behaviour checklist, and video analysis (Brotons, 1994; Craske & Craig, 1984; Endo et al., 2014; Yoshie, Kudo & Ohtsuki, 2009). Craske & Craig (1984) asked two professional judges to rate the performance quality of conservatory piano students based on various dimensions such as touch, phrasing, dynamics and rhythm. The judges also reviewed the video recordings of the performance and completed a timed-checklist that measures overt and observable behavioural symptoms related to MPA such as stiff postures and limbs tremble. The results showed that anxious pianists behaved differently and they received a lower rating in performance quality in comparison to that of non-anxious pianists when performing before an audience of five judges. Similar results were observed even when the judges rated the performance quality solely based on the sheet music and audiotape recordings. However, Fredrikson and Gunnarsson (1992) reported that the anxious musicians received a higher quality rating based on auditory cues. When audiovisual cues were available, the performance was perceived to be less favourable. This suggests that body posture in anxious musicians may have a negative effect in audience perception of the overall performance.

Brotons (1994) reported that there were significant increase in the performers’ heart rate and self-reported anxiety when they performed under the open jury and double-blind jury settings than under the practice condition, but the type of jury did not affect performance quality ratings or changes in non-verbal behaviour. He argued that the performers’ movements under open and blind jury conditions were a part of music interpretation rather than anxiety. However, he only made behavioural comparisons between the two jury conditions but not between jury and non-jury conditions. Another limitation to Broton’s study is that their

participants played instruments from 5 different categories, thus the behavioural movements measured were strongly dependent on the characteristics of the instruments.

Recent studies in behavioral aspects of MPA have utilized advance technology in analyzing performer's body movements. For example, Endo et al. (2014) used motion capture technology to obtain data from the performer's body movements. It was revealed that cellists with self-reported MPA who performed under anxiety-induced conditions had a more flexed elbow than the non-anxious cellists. Although such method is practical in analysing body movements objectively, it may not be the best tool to study perceived MPA-related behaviour because some roughness will remain in the point-light animation after the clean-up process that may lead to "extraneous perceptual effects" (Platz & Kopiez, 2012). Broughton (2015) obtained the video recordings of the two recital performances (lunchtime recital and evening recital) and the self-reported anxiety ratings prior to and after the recitals from a classical vocalist. The non-verbal body movements of the vocalist were analysed using ELAN computational software. It was found that the vocalist displayed almost doubled the duration of musically expressive nonverbal behaviours in the recital condition that she claimed to be less anxious, demonstrating that the "vocalist's personal experience of MPA may "leak" through his/her performance presentation and be evident in his/her nonverbal behaviours" (p.3). From this perspective, anxiety-related gestures can potentially lead to impairment of performance quality and communication between the performer and audience, although performance ratings were not recorded in the two recitals.

While observational studies, behavioural checklists and computational technology have proven useful in identifying possible behavioural differences between high-anxious and non-anxious individuals under different performing contexts (Craske & Craig, 1984; Brotons, 1994; Endo et al., 2014; Broughton, 2015), it is more likely that concert-goers will evaluate a performance as a whole. For this reason, this thesis will not measure specific body movements.

2.3 Perceiving Expressivity, Performance Quality and Experienced Emotion

The role of body movement in expressive performance has received increased attention in the recent years. However, studies regarding how behavioural symptoms of MPA would affect expressivity and emotion perception remain limited. In this section, the literature on possible non-verbal behaviour and modality in relation to perception of expressivity, performance quality and emotions will be reviewed.

2.3.1 Perception of Expressivity

A performance is a two-way communication. In this process, the performer and the audience are constantly exchanging visual and auditory cues, implying affordances. The term “affordance” was first coined by Gibson (1977). It refers to an organism-related object or event that reflects its potential in action. In a musical performance, the body movement of the performer may interact with the instruments or the air columns that may influence the sound production. In term of music affordances, the body movements of the performer create visual and sound patterns in the music which are then picked up by the audiences in their assessment and understanding of a performance. Concurrently, the performer gathers different cues from the audiences (Windsor, 2011).

Expressiveness is often an integral rating item in the assessment of music performance quality (Thompson & Williamon, 2003; Wapnick, Ryan, Lacaille & Darrow, 2004). While some body movements are essential for sound production, some musicians make “ancillary movements” during performances that are not necessary for sound production but rather as deliberate gestures to demonstrate the intended expressivity (Wanderley & Vines, 2006), and such gestures could potentially influence the performance outcome (Huang & Krumhansl, 2011). In Davidson’s (1993) experiment, the same piece of music was presented to participants with three different intended expressions: ‘deadpan’, ‘normal’ and ‘exaggerated’. These expressions can only be distinguished in the audiovisual and video-only conditions, but not in the audio-only condition. Recent studies have also shown that visual and auditory cues alone were capable of transmitting expressive intentions (Vuoskoski, Thompson, Clake & Spence, 2014). Nevertheless, it appeared to be that body movement characteristics and visual cues may provide more information than auditory cues in judgment of a performance,

especially when perceiving expressivity and tension (Davidson, 1993; Juchniewicz, 2008; Vuoskoski et al., 2014), whereas audiovisual stimulus may enhance judgment accuracy (Davidson, 1993; Vines, Krumhansl, Wanderley & Levitin, 2006). This may have indicated that auditory and visual information are transmitted through independent pathways. The combination of auditory and visual stimuli would provide a more comprehensive understanding of a musical performance (Platz & Kopiez, 2012).

An intended expressive performance is often associated with different kinds of body gestures. For example, the audience rated the pianists as expressive when the pianists demonstrated a certain level of swaying and circular movements, with the hip region serving as a pivotal point for the upper body movements (Davidson, 1991). This is confirmed by Davidson & Dawson (as cited in Davidson, 2005) that pianists with constrained body movements could not fully express their intended expression, while increasing amount of body movement enhanced perceived levels of expressivity (Thompson & Luck, 2008; Juchniewicz, 2008; Siddell-Strebel, 2007). Alternatively, if an expression deviates too far from its threshold, it can produce “dull, awkward, inappropriate, or even comical-sounding effects” (Schubert, 2002; as cited in McPherson & Schubert, 2004). For example, Ryan, Wapnick, Lacaille & Darrow (2006) found that professional pianists of a piano competition generally received higher expressivity ratings in the audiovisual condition than that of audio-only condition, but pianists with low stage behaviour scored higher ratings than pianists with high stage behaviour in both conditions. Furthermore, Broughton and Stevens (2009) investigated the effect of performing manners (“deadpan” and “projected”) and modalities (audio-only and audiovisual) on expressivity ratings and the observer’s interest in the marimba performances. A significant difference was found between modality in projected performances but not in deadpan performances. These indicate that expressive movements at the right level will make a performance more engaging.

Since enhanced anxiety can lead to differences in non-verbal behaviours (Craske & Craig, 1984; Broughton, 2015) and postural changes in MPA processors (Endo et al., 2014), one may expect that that highly anxious performers may receive lower expressivity ratings than performers with less anxieties, especially when performing under anxiety-induced conditions, such as audition, competition and public recitals. Music students are well-aware of the negative impacts of MPA on their expressivity (Papageorgi, 2014):

At times I find that anxiety may not only affect my mental state of being, but also may hinder my physical ability to deliver an accurate and sensitive interpretation of the piece. Expression is sometimes lost in this. (p.312).

While most of the previous studies focused on the effect of intended body movements and modality on expressivity ratings, studies that focused on the effect of performing context (e.g. between anxiety-induced condition and relaxed condition) on perceived expressivity remains scarce. To date, none of the studies on MPA have attempted to investigate whether viewing visual components alone would affect perceived expressivity.

2.3.2 Performance Quality

A growing body of literature has demonstrated the dominance of visual components in assessing performance quality, despite the common impression that sound is more important in a musical experience (Tsay, 2013). Additional information provided by visual elements may assist adjudicators in making more conclusive responses when assessing performance quality (Lehmann & Davidson, 2002; Ryan & Costa-Giomi, 2004). In Tsay's (2013) study, it was found that although both novice and professional musicians considered hearing the performer as more important than seeing the performer in assessing the performances, both groups were able to predict the winners of a piano competition based on video-only recordings but not through audiovisual recordings. The same results were reported in identifying winners of group performances (Tsay, 2014).

Ryan et al. (2006) found that attractiveness and modality may influence evaluations, in which the high-level pianists categorized as less attractive received more favorable ratings in the audio-only condition than in the audiovisual condition. In line with Ryan et al.'s (2006) finding, Siddell-Strebel (2007) and Howard (2009, as cited in Pope & Barnes, 2015) have also found that better ratings were assigned to audio-only performances in comparing to audiovisual performances, regardless of audio-quality. However, Benson (1996) and Wapnick, Mazza, and Darrow (2000) did not find such differences across audio-only and audiovisual presentations, and that video-only presentations were not given higher performance quality ratings. Other researchers have found music performances presented in the audiovisual condition received higher ratings than those in the audio-only condition (Wapnick, Mazza, & Darrow, 1998; Ryan & Costa-Giomi, 2004; Pope, 2012). These mixed results implied the need for further investigations.

If perception of performance quality is heavily based on visual components, and if performers with high levels of MPA would illustrate non-verbal behaviours that impairs performance outcome (Craske & Craig, 1984; Fredrikson & Gunnarsson, 1992), one may expect that anxious musicians would receive lower ratings when being viewed in video-only recordings in comparing to audiovisual and audio-only recordings, and that the audiovisual recordings would be used as the “marker of authenticity” (Auslander (2008), as cited in Platz & Kopiez, 2012).

2.3.3 Emotion Perception

In order to execute an effective performance, it is important for musicians to acknowledge that body movements can convey emotions. The neuroscientist Beatrice de Gelder postulated that the brain of the observer may be more reactive to emotions conveyed through body language than facial expression because faces may carry other irrelevant information (O’Neil, 2004).

Individuals are able to communicate basic emotions more effectively than complex emotions (Juslin & Lindström, 2003, as cited in Juslin & Laukka, 2004). Juslin (2000) reported that the expressive intentions communicated by the performer (happy, sad, fear and angry) can be explained by approximately 70% of the variance in listeners’ judgment of the emotional expression regardless of the type of melody performed, and that different emotions are associated with distinctive types of acoustic properties. It was uncovered that fear is associated with slow tempo, very low sound level, staccato articulation and inconsistencies of most articulations, although there were individual differences in their efficiency of conveying specific emotions. In spite of the fact that the study demonstrated that listeners can perceive intended emotions from performers, Juslin (2000) criticized on the artificial nature of the task (i.e. asking the performers to perform the same piece of music with different expressions), which can be improved by studying emotional expression in a more naturalistic context (e.g. a concert) or by analysing existing recordings of performances.

Dahl and Friberg (2007) conducted a study using marimba performances. It was demonstrated that individuals can pick up intended emotions such as happy, sad and angry from the performer by looking at specific regions of the body, but this does not apply to perceiving fear. Van den Stock, Righart and De Gelder (2007) also reported that bodily

expression of fear was the most difficult emotion to be recognized. On the contrary, De Silva and Bianchi-Berthouze (2004) found that over 50% of the observers were able to recognize the affective gestures for the same intended emotions conveyed by the participants, of which the fear condition elicited the most accurate responses. McDonnell, Jörg, McHugh, Newell and O'Sullivan (2009) also reported that individuals were robust in perceiving different emotions (including fear) from body movements, even when facial expressions were hidden. Dahl and Friberg (2007) argued that failure in recognizing fear in musical performance could be the case that the performers misinterpreted fear as anxiety or nervousness, and that there would be limited gestures for audience to analyse if the performers interpreted the fear expression with 'freezing' behaviour.

While a majority of these studies focused on intended emotions or expressivity, studies that focused on the emotion of the performer remain scarce. In some cases, emotion induction could cause changes to the participants' emotional state, which in turn influence how they moved (Van Dyck, Maes, Hargreaves, Leasaffre & Leman, 2012). The differences between expressive performance (i.e. expressing the intended emotion in music) and emotional performance (i.e. expressing the experienced emotions of the performer) in sound, movement behaviour and their perception have been recently demonstrated. Van Zijl and Luck (2012) asked the violinists to play the same piece of music following three different instructions – to play the music technically, to play the music expressively, and to play the music by focusing on their experienced emotions after a sadness-induction task. They found that the violinists stood the straightest in the 'expressive' condition, bent slightly backwards in the 'technical' condition, and further backwards in the 'emotional' condition. In terms of playing, the expressive performances are characterized by more movement, faster tempo and more jerk movement. In contrast, the violinists moved less, slower and more fluidly in expressing sadness, demonstrating that focusing on different aspects of performance intention can lead to differences in movement characteristics. A followed up study by Van Zijl and Luck (2013) reported that while the audience preferred the expressive performance, they perceived sadness the most in the 'emotional' condition, of which the emotion of sadness was more perceivable through auditory cues. However, Glowinsky et al. (2008) failed to find gestural differences related to angry, sad, joyful and peaceful after a mood induction task.

The felt emotion of the observers has also been investigated by means of physiological studies. Vuoskoski, Gatti, Spence and Clarke (2016) also reported a higher emotional arousal response of felt emotions in the audio-only presentations than in the video-only presentations, although Chapados and Levitin (2008) recorded higher physiological responses in the participants who have viewed the performances in audiovisual mode in compare with those who have evaluated the performances in audio-only and video-only mode.

In the context of MPA, anxiety is a genuine emotion experienced by the performer, thus it is possible that the audience is able to perceive the performer's nervousness through the music and body movements. Empirical studies in music have confirmed the effects of performing context on MPA, in which the presence of an audience often triggers physiological responses and increased anxiety in musicians. When the performers feel more exposed, it is more likely that they will feel anxious (Wilson, 1997; Miller & Chesky, 2004). Musicians reported significantly higher performance anxiety in solo performance settings than in a group performance setting (Cox & Kenardy, 1993). Papageorgi, Creech and Welch (2011) reported that high level of trait anxiety impaired the quality of solo performances, but it facilitated performance in ensemble settings. Evaluative performances (e.g. examinations, recitals and auditions) also elicited higher level of self-reported anxiety in performers than other types of performance such as making music during a practice session, or musical performance in front of a tape recorder (LeBlanc et al., 1997, Osborne & Franklin, 2002; Wilson, 1997). As MPA processors often relate the audience with evaluation, anxiety symptoms may be activated in settings that involved judgment of the musical performance (McGrath, 2012).

However, Dahl and Friberg (2007) commented that anxiety and fear may be consciously suppressed by the performers in a musical performance. If this is the case, the audience should not be able to perceive traces of anxiety or fear in a musical performance. Stewart, Taylor and Baker (1997) commented the notion that girls are psychologically more vulnerable than boys may lead to the boys learning to hide their expression of anxiety at their early age. This may also explain why MPA is more prevalent in female than male (LeBlanc et al., 1997; Ryan, 2004). Nevertheless, previous findings have demonstrated that anxiety-related movements are observable (Endo et al., 2004; Gregersen, 2005; Pijpers, Oudejans & Bakker, 2005).

To date, the author only found one study that has explored the association between perception of MPA and performance evaluation in an orchestral audition setting. Kubzansky and Stewart (1999) asked the two male conductors of the orchestra to evaluate on the anxiety, ability and overall performance quality of the students and to indicate orchestral acceptance. Prior to the auditions the students were asked to fill out self-reported questionnaires about state-emotion and trait-anxiety, and to fill out a self-evaluation questionnaire after the audition. It was found that self-reported anxiety was not associated to the conductors' performance evaluation however, and students who were perceived as more anxious received lower ratings in performance quality. Although some association was reported between self-reported state anxiety, trait anxiety and ratings of perceived anxiety, felt anxiety was not the strongest predictor of perceived anxiety in the conductors. The result was in line with Kokotsaki and Davidson (2003)'s findings that felt anxiety did not correlate with judgment of performances. Kubzansky and Stewart (1999) commented that anxiety stereotypes (i.e. anxiety and performance) may have negative effects on performers who are perceived as more anxious during live performances, regardless of their internal state, stressing the importance of visual components on evaluative performances.

To the author's knowledge, no study has examined how different modalities may influence the experienced emotion of the performers (in this case, anxiety), and whether the performers' anxiety are perceivable from the observers. If the severity of felt anxiety is observable in visual components, seeing movements alone would elicit higher perceived anxiety ratings than hearing the music alone, and that high-anxious performers would be perceived as more anxious than mid-anxious and low-anxious performers in visual-alone performances.

2.3.4 Music Expertise on Performance Evaluation

Judgment of musical performances is known to associate with the characteristics of the observers, such as their liking of the piece (Thompson, 2006), perceived attractiveness of the performer (Ryan et al., 2006), familiarity of the musical work (Flôres & Ginsburgh, 1996) and musical training (Broughton & Stevens, 2009; Wapnick et al., 2004; Standley, Brooker & Gilbert, 2002).

It is suggested that expert musicians can make a conclusive assessment very early in the performance (Standley, Brooker & Gilbert, 2002), and that audience with high level of formal

musical training gave lower ratings than audience without such training, although the pattern of ratings was similar (Thompson, 2006). Contrarily, Broughton and Stevens (2009) reported that other researchers have found that musicians generally gave higher ratings than non-musicians. Musicians with formal musical training are also better in assessing performance quality in the way that they were able to discriminate performances by professional and all state orchestra (Pope, 2012), to distinguish the recordings accurately between professional, university, and high school wind ensembles (Geringer & Johnson, 2007; Johnson & Geringer, 2007), and to differentiate between very similar performances (Sundberg, Friberg, & Frydén, 1988). Besides, musicians are more sensitive to timing (Bhatara, Tirovolas, Duan, Levy & Levitin, 2011) and amplitude variation (Sundberg, Friberg, & Frydén, 1991).

In addition, an electroencephalogram (EEG) experiment has demonstrated that musicians and non-musicians process emotional content of music differently (Halpem, Martin & Reed, 2008). Differences in ratings between musicians and non-musicians were also recorded when they viewed the performances in different modalities (Wapnick et al., 2004). Siddell-Strebel (2007) reported that non-musicians rated higher scores in solo cello performances when presented with audio-only excerpts than with audiovisual excerpts. Davidson (2005) revealed that non-musicians seemed to be more affected by visual cues than auditory cues in differentiating expressive intentions. In addition, non-musicians were able to perceive differences across three levels of expressivity only in the audiovisual condition but not in the audio-only condition, while musicians perceived these differences under both audiovisual and audio-only conditions (Huang & Krumhansl, 2011).

However, it is possible that non-musicians acquire knowledge of musical structure through passive exposure, as demonstrated in neuroscience studies (Levitin & Tirovolas, 2009, as cited in Bhatara et al., 2011; Sridharan, Levitin, Chase, Berger, & Menon, 2007, as cited in Bhatara et al., 2011). For example, both novice and professional musicians were able to pick out competition winners above chances when presented with video-only recordings. However, the accuracy of judgment decreased when they saw the audiovisual recordings (Tsay, 2013). Moreover, it appeared that musical training is not the prerequisite for emotion perception in musical performance, in which non-musicians had similar abilities in recognition of performers' intended emotional expressions as musicians (Juslin, 1997; Gabrielsson & Juslin, 2003).

In addition, children were able to recognize emotions of the musical excerpts (happiness, sadness, anger and fear) reliably (Cunningham & Sterling, 1989, as cited in Kopiez, 2002). Such recognition is similar among participants between 6 to 22-year-old (Kratus, 1993, as cited in Kopiez, 2002), suggesting that general mechanisms for emotion perception, rather than specific mechanisms, are involved in recognition of emotion in musical performances (McPherson & Schubert, 2004), although some other literature suggested that the responses may be influenced by age, and social-cultural background (Dolgin & Adelson, 1990, as cited in Kopiez, 2002; Terwogt & Grinsven, 1991, as cited in Kopiez, 2002).

Even musicians showed individual differences in judgment of musical performances. For example, musicians rated performances of their own instruments differently from musicians who are unfamiliar with the instrument (Wapnick et al., 2004; Thompson & Williamson, 2003; Broughton & Davison, 2014). Hunter and Russ (1996) found that students who were untrained in peer-assessments were disinclined to give low marks to peers, and that their marks did not reflect the performance quality but the expectation about the performer's capability; while students with training were more objective and realistic in their assessment. However, higher education level does not necessarily yield differences in performance evaluation (Byo & Brooks, 1994).

Based on the literature mentioned in this section, it is possible to assume that individuals will make similar judgments in perceived anxiety in MPA processors regardless of musical training, whereas musicians may be in advantage of differentiating performances from different performance contexts (i.e. anxiety-induced and relaxed condition), which may result in differences in performance ratings. To date, none of the studies have attempted to investigate whether observers with different levels of musical training will give different judgments on expressivity, overall performance and perceived anxiety in MPA processors under the three different modalities.

3 RESEARCH QUESTIONS

The main objective of this thesis was to study the effect of MPA on observers' responses. That is, whether the observers would be able to perceive MPA and whether the effect of MPA will be manifested through ratings of expressivity and performance quality. This study will also examine the effect of modalities in performance evaluation. Therefore, the research questions for this thesis are:

Does the severity of the performer's MPA affect the observers' expressivity ratings when the concert and rehearsal performances are viewed in different modalities?

Does the severity of the performer's MPA affect the observers' performance quality ratings when the concert and rehearsal performances are viewed in different modalities?

Does the severity of the performer's MPA affect the observers' perceived anxiety ratings when the concert and rehearsal performances are viewed in different modalities?

Are there associations between ratings of expressivity, performance quality and perceived anxiety?

How does the observer's level of musical expertise contribute to the observer's perception of musical performances?

4 EXPERIMENTAL DESIGN

4.1 Variables

A 3 x 2 x 3 x 2 mixed factorial design was employed to investigate the differences in observers' ratings of the three statements (i.e. expressivity of the performers, overall quality of the performances, and perceived internal state of the performers). The within-subjects variables are anxiety level of the performers (three levels: high-anxious, mid-anxious and low-anxious) performance context (two levels: rehearsal and concert), and modality (three levels: audiovisual, audio-only and video-only). The between-subjects variable is the level of musical training of the observers (two levels: less than 5 years, and more than 5 years).

4.2 Participants

Performers

Six pianists and three singers (7 female & 2 male, N = 9) from University of Jyväskylä volunteered to participate in the study. One pianist left during the process because she was unable to perform in the concert. The eight remaining performers were between 20 and 36 years old (M = 25.25, SD = 5.15) with varying amounts of training in the main instrument (M = 9.25, SD = 7.25). All except one pianist were studying for a music-related degree. The pianist who studied a non-music related degree had 12 years of musical training in the instrument. All the performers were known by between 10 to 15 observers in the sample. The performers were given the video and audio clips of their own performances as an incentive for their participation.

Observers

A total of 53 observers (19 male, 34 female), mostly university students, were recruited through the mailing lists of University of Jyväskylä, and the flyers advertising about the perceptual study. The observers were between 19 and 40 years old (M = 25.75, SD = 6.57) with varying amounts of musical training in terms of years. Thirty-four of the participants were studying for a music-related degree. Twenty-four raters reported that they had never

played a musical instrument or had played one or many musical instruments for less than 5 years, and 29 raters had experience of playing one or many musical instruments for more than 5 years. Nine raters have never been to a classical concert before, three raters have been to a classical concert sometime before, 32 raters reported that they go to classical concerts 1 to 2 times a year, and seven raters attend classical concerts more than 3 times per year. The observers each received a lunch coupon for participation.

4.3 Pre-Procedure

The performers were asked to prepare a performance of a musical piece of their own preference (Appendix 1). For logistical reasons, their chosen repertoire had to be less than 6 minutes in total. The music was not standardized across the performers because the researcher aimed to stimulate a genuine concert situation for the anxiety-induced condition, where the performers could play the musical piece they have mastered. In addition, it has been reported that musicians who were allowed to choose their own music were found to perform better than having to play the pre-selected music (LeBlanc et al., 1997). Besides, it would be unattractive for the concert audience to listen to the same piece many times. The performers were informed that they had to play or sing the piece on two occasions: in the presence of the researcher only (rehearsal condition), and in front of the audience in a public concert (concert condition). The performers were well-informed that their performances would be videotaped and audio-recorded.

4.3.1 Apparatus

Piano

A Yamaha C7 (midi) grand piano was used throughout the sessions. The piano lid was kept closed throughout the sessions to avoid unwanted acoustics that could affect the recorded audio quality.

Audio

Two Neumann KM 184 microphones in X-Y configuration were placed 17 inches above the middle of the music rack prop of the grand piano. An AKG microphone C 414B-ULS was used to record the singer's voice. The AKG microphone was placed parallel to the singer's chin to avoid obstructions, so that the camera could obtain a clear view of the singers' facial expressions. A pre-amplifier Millennia HV-3D was applied to increase the gain level of the recorded volume. The audio were recorded with ProTools HDX into .wav format. ProTools were also utilized to create the audio clips used in the perceptual study.

Video Cameras

The pianists were videotaped their upper body from the right side with a Canon Legria HFS20 camera. The singers were videotaped their full body from the front with a Sony NEX-3n camera. The video quality for both cameras was set at a frame rate of 25p 17M FH (1,920 x 1,080) in AVCHD format. Throughout the sessions, the performers were videotaped from the same camera angle and distance.

4.3.2 Self-Reported Measure

The performers filled out three questionnaires: Revised Kenny Music Performance Anxiety Inventory (K-MPAI) (Kenny, 2009); the State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA; Ree, MacLeod, French & Locke, 2000, as cited in Grös, Antony, Simms & McCabe, 2007) and Roseberg Self-esteem Scale (Rosenberg, 1965).

Revised Kenny Music Performance Anxiety Inventory (K-MPAI)

The revised K-MPAI is designed to measure physiological, cognitive and behavioural components of MPA based on the theory of anxiety proposed by Barlow (2000). The inventory has been expanded from 24 to 40 items. The first K-MPAI has a high internal reliability, with a Cronbach's alpha value of 0.94 (Kenny, Davis & Oates, 2004). The Cronbach's alpha of reliability for the revised K-MPAI has not been published yet. The revised version was tested on music students of tertiary level (Kenny, 2009) and professional orchestral musicians (unpublished, as cited in Kenny, 2011). Respondents rate each statement

based on a 7-point Likert scale, ranging from 0 (strongly disagree) to 6 (strongly agree). Higher scores imply greater anxiety and psychological distress.

The State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA)

The STICSA consists of two 21-item self-descriptive statements that measure the state and trait components of anxiety, and it separates anxiety into cognitive and somatic symptoms. The state version of STICSA (STICSA-S) focuses on how the respondents feel "right now, at this very moment", whereas the trait version of STICSA (STICSA-T) assesses how the respondents feel "in general". Respondents rate each statement based on a 4-point Likert scale, ranging from 1 (not at all) to 4 (very much so). Higher scores indicate higher levels of anxiety. The format of STICSA resembles that of the State-Trait Anxiety Inventory (S-TAI; Spielberger et al., 1983). Although the S-TAI has been used extensively in psychological research, including measurement of MPA (Brotons, 1994; Kokostaki & Davidson, 2003; Broughton, 2015), it has been criticised for its inefficiency in distinguishing symptoms between anxiety and depression (Bieling et al., 1998, as cited in Grös et al., 2007; Caci et al., 2003, as cited in Grös et al., 2007). On the contrary, the STICSA was more strongly correlated with anxiety than depression (Grös et al., 2007), hence STICSA would be a more appropriate tool than S-TAI in assessing anxiety specifically (Elwood, Wolitzky-Taylor & Olatunji, 2012).

Roseberg Self-Esteem Scale (RSE)

The Rosenberg Self-esteem Scale (RSE) (Rosenberg, 1965) is a 10-item scale for measuring individual self-esteem. Respondents rate each statement based on a 4-point Likert scale, ranging from 1 (strongly agree) to 4 (strongly disagree). Half of the statements were positively phrased and half are phrased in the reverse. Higher score demonstrates higher self-esteem.

4.3.3 Recording Sessions

The recording took place in the recording studio of University of Jyväskylä, Music department. The floor plans for rehearsal condition and concert condition are depicted in Figures 2 and 3 respectively. To examine the possible effects of performing contexts on

MPA, the performers were asked to perform in both the rehearsal condition and the concert condition.

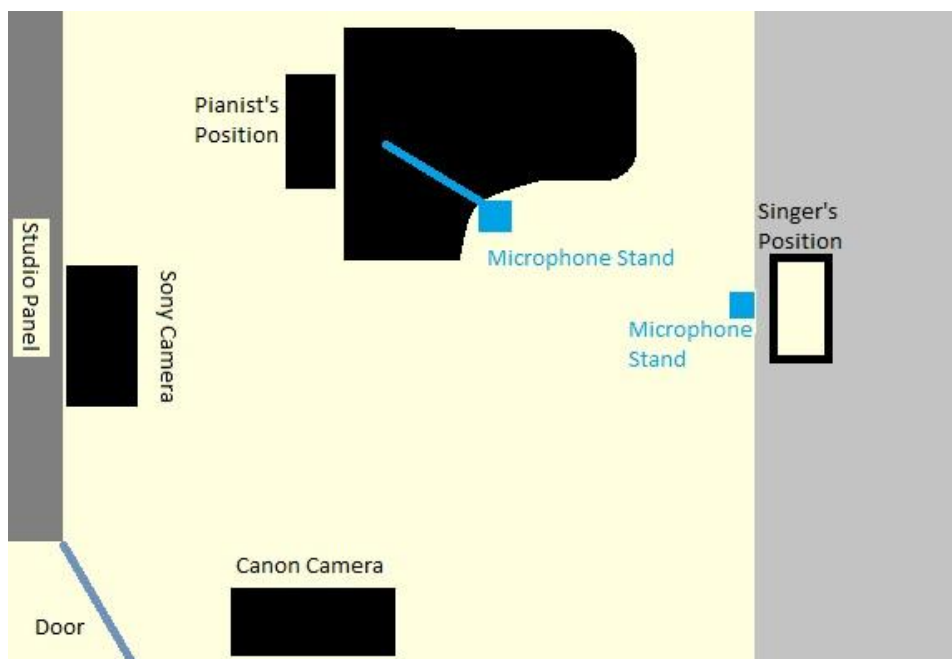


Figure 2. Floor plan for rehearsal condition.

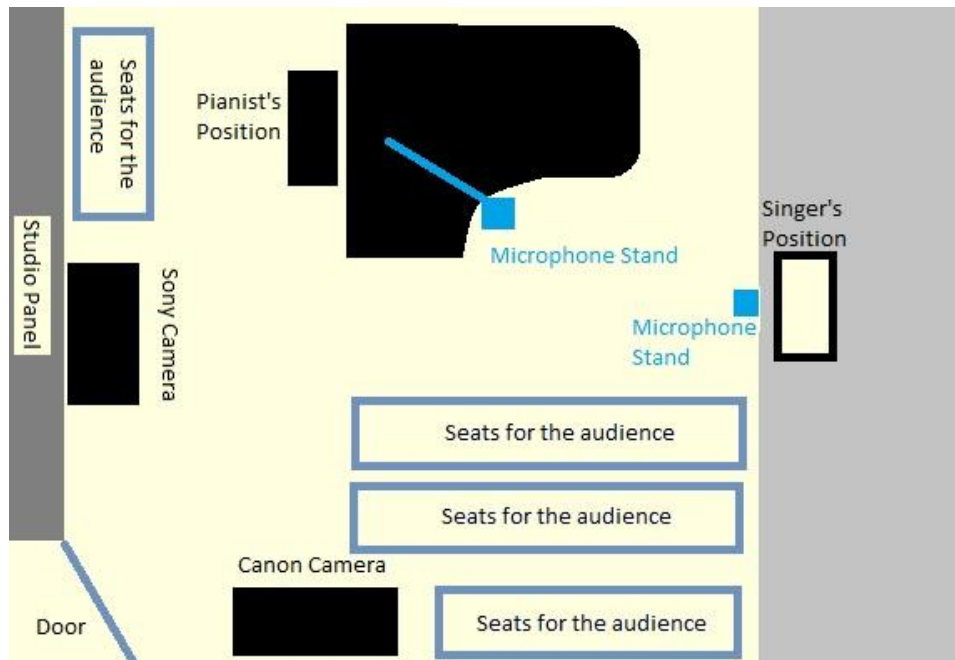


Figure 3. Floor plan for concert condition.

Rehearsal Condition

In the rehearsal condition, performers were invited to the recording session individually, where they would play their chosen piece with the presence of the researcher. Performers were asked to fill out the STICSA-S before the recording session began. Once the performers filled out the questionnaire, a sound check was executed to make sure the audio was recorded at the right volume and frequency. The researcher then switched on the cameras and microphones and began recording the session. Once the sound check was completed, the researcher explained to the performers that they had 60 minutes to play their music as many times as they wanted to until they felt satisfied with the performance, and that they could restart the piece at any moment they wanted, as long as there was a completed performance by the end of the session. The performers were allowed to take breaks and evaluate their own recordings between performances. After the performers felt satisfied with the recordings, they completed the revised K-MPAI; the STICSA-T; the RSE and a questionnaire about their musical background and demographics.

Concert Condition

In the concert condition, the performers participated in the "experimental concert" held during the first semester of 2015-2016, where they performed their chosen piece in public. On the concert day, the performers were asked to arrive at the performing venue 30 minutes in advance to the concert. They were asked to fill out the STICSA-S before the performances. After the audience was seated, the researcher welcomed the audience and switched on the cameras and microphones to record the whole concert. The performers were informed the order of the concert programme a week in advance. The order of the programme was arranged based on the difficulty level of the pieces. The concert was 90 minutes long with a 15-minute intermission.

The concert audience was invited by the researcher and the performers through Facebook event. A total of 22 audiences attended the concert. The audience was not given any special instructions and was not required to provide any rating or feedback, as the role of the concert audience was just to set up a concert atmosphere. The concert audience was excluded from the perceptual study.

To avoid learning effect, half of the performers first performed in the rehearsal condition a week before the concert condition, and the other half in the reversed order. For the purpose of the perceptual experiment, the performers were advised to wear what they would normally wear when performing in a concert, and to dress exactly the same way for all of the recording sessions.

4.4 Procedure

4.4.1 Stimulus Design

Seventeen excerpts (8 performers x 2 performing conditions, plus 1 test video) were made using iMovie software (version 10.1) running on Mac OS X. The audio recorded from the studio was dubbed onto the video to enhance the audio quality of the excerpts. Since the entire piece was considered to be too long for this experiment, only the segment from the beginning of each performance was used to create the experimental stimuli. Theories in cognitive and somatic anxiety have postulated that anxiety peaks immediately prior to a performance, but reduces significantly during the event (Martens, Burton, Vealey, Bump & Smith, 1990), and that raters make similar judgments between hearing the first sections of the performances and hearing the entire performance (Vasil, 1973, as cited in McPherson & Schubert, 2004). The cutting-point for each performance depended on musical phrasing, with a range from 30 to 45 seconds.

An interface for the perceptual experiment was made by a computer in the Max/MSP version 7.0.6 (32-bit) programme (Cycling '72, San Francisco, CA, USA), which controlled the presentation of the stimulus. The excerpts were further customised into three different modalities (audiovisual, audio-only & video-only) using Max/MSP. To create the audio-only excerpts, a black panel object was placed over the video image, while the sound was muted for the video-only excerpts. In this way, the sound and moving images of the audiovisual excerpts were identical to the excerpts of audio-only and video-only conditions. This resulted in having six excerpts for each performer, i.e. a total of 48 excerpts for the whole experiment.

4.4.2 Perceptual Experiment

The perceptual experiment was conducted in a computer lab, with the use of Max/MSP to present the stimuli and to collect the data. The excerpts were presented in .mov format with a resolution of 950x540 pixels and a frame rate of 24fps. The audio of the excerpts were presented through high quality headphones (Audio-Technica ATH-M50x). The raters completed the experiment either individually or collectively (in groups of up to five raters) in the same room depending on the number of raters who signed up at the same timeslot. The raters were asked to read the instructions about the experiment and were given the opportunity to ask questions. After the raters clicked the “Test” button on the instruction page, a test excerpt was presented to the raters for volume adjustment. The test video was followed by 48 excerpts, of which the order of the different modalities was randomized across participants. The excerpts within each modality were also presented in random order across the participants. In this way, the “order effect” on performance rating could be eliminated (Flôres & Ginsburgh, 1996).

For each excerpt, the raters were asked to respond to three statements on a Likert scale of 1-7:

- Expressivity of the performer: (1 = Not at all Expressive; 7 = Very Expressive)
- Overall quality of performance: (1 = Poor; 7 = Excellent)
- Performer’s inner state: (1 = Very Calm; 7 = Very Anxious)

In the excerpts of video-only and audiovisual conditions, the raters were also asked to indicate whether they know the performer by clicking the “Yes” or “No” button. To ensure that the raters were attending to the whole excerpt, they could not proceed to the next excerpt until the current excerpt has entirely been played and evaluated. The interface automatically recorded the order of excerpts played as well as observer’s responses into a text file.

After the raters finished rating the 48 excerpts, they filled out a short questionnaire about their musical background and concert-going habits. The study took approximately 45 minutes to complete.

5 RESULTS

5.1 Self-reported Measure

The total K_MPAI score for the eight performers (P1-P8) and their mean and standard deviation are shown in Table 1.

Table 1. Total Score, mean and standard deviation of K_MPAI

K_MPAI Total Score	
P1	167
P2	97
P3	129
P4	124
P5	100
P6	128
P7	147
P8	174
Mean	133.25
SD	28.13

According to Kenny (2015), the clinical cut-off score for K_MPAI is dependent on the type of clinically established tests that against which they were evaluated, of which the cut-off score ranged from 84.5 to 118.5 points. Since only P2 and P5 scored less than 118.5 and that P1 and P8 scored extremely high in the questionnaire, it seemed worthy to categorize the six performers who scored higher than 118.5 into two groups to determine whether there were any substantial differences in ratings between these six performers. Thus, the 8 performers were divided into 3 groups based on the interquartile range of their K-MPA score: High-anxious (N=2), mid-anxious (N=4) and low-anxious (N=2), where N stands for number of performers.

Although the scores obtained from STICSA and RSE questionnaires were obtained, but the scores were not analysed at this point because it would have added complexity in answering the current research questions.

5.2 Observer Ratings

Using “modality”, “anxiety level” and “performing context” as the within-subjects variables, and “musical training” as the between-subjects variable, three separate four-ways (3 x 2 x 3 x 2) mixed-design analysis of variance (ANOVA) were performed on the measurement of expressivity of the performers, performance quality and perceived anxiety of the performers. The data was imported into SPSS and was screened for outliers. All the outliers were winsorised (i.e. they were replaced by a less extreme value within the interquartile range). After winsorisation, the normality assumption of the data was achieved with kurtosis for all mean ratings falling within the range of +/-1.96. The mean ratings for all the dependent variables were computed and analysed using Statistical Package for the Social Sciences (SPSS) version 22.0. The data from all 53 participants was included in the analysis. Although the assumption of homogeneity of variances was violated in a few dependent variables, as assessed by Levene’s test for equality of variance ($p < .05$), ANOVA is robust to such violations if the sample size is almost equal (Nimon, 2012).

In cases where the assumption of Sphericity is violated ($p < 0.05$), the F -values are reported with Greenhouse-Geisser correction when the estimated epsilon (ϵ) is less than 0.75, whereas Huynh-Feldt correction is applied when (ϵ) is greater than 0.75 (Field, 2013). Post hoc tests with Bonferroni corrections were applied to all pairwise comparisons. An alpha level of .05 was set for all significant tests.

5.2.1 Expressivity Ratings

The mean and the standard deviation of the expressivity ratings given by the two observer groups for each of the modalities (viz. audiovisual, audio-only and video-only) under the concert and the rehearsal performing conditions by the three anxiety groups (viz. high-anxious, mid-anxious and low-anxious) are displayed in Table 2.

Table 2. Mean ratings and standard deviation (SD) of expressivity ratings in association with anxiety levels, performing context, modality and observer's musical training.

	Expressivity Ratings						
	Observers with Musical Training (<5 years) (N=24)		Less	Observers with Musical Training (>5= years) (N= 29)		Overall ratings (N = 53)	
	Mean	SD		Mean	SD	Mean	SD
High-Anxious							
Concert-AV	4,79	1,26		4,41	0,95	4,58	1,10
Concert-Audio	5,35	1,09		4,88	0,88	5,09	1,00
Concert-Video	4,02	1,22		3,43	0,87	3,70	1,08
Rehearsal - AV	4,85	1,18		4,55	0,87	4,69	1,02
Rehearsal - Audio	5,17	1,04		4,57	0,74	4,84	0,93
Rehearsal - Video	4,15	1,07		3,66	0,96	3,88	1,03
Mid-Anxious							
Concert-AV	4,64	1,09		4,56	0,66	4,59	0,88
Concert-Audio	5,29	0,92		4,86	0,88	5,06	0,91
Concert-Video	4,22	1,10		4,08	0,83	4,14	0,95
Rehearsal - AV	4,98	1,10		4,96	0,61	4,97	0,85
Rehearsal - Audio	5,31	0,82		4,95	0,79	5,11	0,81
Rehearsal - Video	4,58	1,03		4,43	0,78	4,50	0,90
Low-Anxious							
Concert-AV	4,98	1,16		4,55	0,87	4,75	1,02
Concert-Audio	5,33	1,10		4,31	0,74	4,77	1,04
Concert-Video	4,54	1,35		4,34	1,09	4,43	1,21
Rehearsal - AV	4,65	1,42		4,07	1,01	4,33	1,23
Rehearsal - Audio	5,31	1,11		4,36	0,96	4,79	1,13
Rehearsal - Video	4,31	0,94		3,93	0,98	4,10	0,97

To investigate whether there were significant differences in the mean expressivity ratings, a four-way mixed ANOVA (anxiety level * performing context * modality * musical training) was conducted.

The ANOVA uncovered a significant main effect of anxiety level, $F(2, 102) = 6.04$, $p = .003$, $\eta_p^2 = .106$. Post hoc pairwise comparisons revealed that the mid-anxious performers were rated as significantly more expressive than the high-anxious performers ($p = .006$), while the mean expressivity ratings for the low-anxious performers did not differ from the ratings of both the mid-anxious and low-anxious performers (both $p > .05$). There was also a significant main effect of modality, $F(2, 102) = 33.52$, $p < .001$, $\eta_p^2 = .40$, with post hoc pairwise comparison indicating significant differences in the mean expressivity ratings between the audio-only and audiovisual conditions, ($p = .004$), between the audiovisual and video-only

conditions ($p < .001$), and between the audio-only and video-only conditions ($p < .001$). The main effect of performing context was non-significant. A significant main effect of musical training was also identified, $F(1, 51) = 4.7$, $p = .035$, $\eta_p^2 = .08$, with post hoc pairwise comparisons indicating that the less musically trained observers, in comparison with the observers with more musical training, considered the performances as more expressive in general than the observers with more musical training.

The ANOVA also revealed two-way interactions between anxiety level and musical training, $F(2, 102) = 3.68$, $p = .29$, $\eta_p^2 = .07$, between anxiety level and performing context, $F(2, 102) = 18.73$, $p < .001$, $\eta_p^2 = .27$, and between anxiety level and modality, $F(4, 204) = 10.54$, $p < .001$, $\eta_p^2 = .17$. Significant three-way interactions between anxiety level, performing context and modality, $F(3.51, 178.77) = 6.06$, $p < .001$, $\eta_p^2 = .11$, and between musical training, anxiety level and modality, $F(4, 204) = 2.74$, $p = .03$, $\eta_p^2 = .05$, were also recorded. The other interactions were non-significant.

This result rendered the other significant main effects and two-way interactions less straightforward, because the lower-order interactions cannot fully explain the phenomenon. For this reason, the three-way interaction between anxiety level, performing context and modality, and the two-way interaction between anxiety level and musical training were further examined by conducting separate ANOVAs. Although a three-way interaction between musical training, anxiety level and modality was identified, due to the complicated nature of the interaction, the present study did not explore the interaction with post hoc analysis.

Interactions between anxiety level, performing contexts and modality

Figure 4 depicts the anxiety level * performing contexts * modality interaction in mean expressivity ratings. To acquire a clearer picture about the nature of the interaction, the three anxiety levels (high, mid and low) were analyzed separately by three-way mixed (performing context * modality * musical training) ANOVAs.

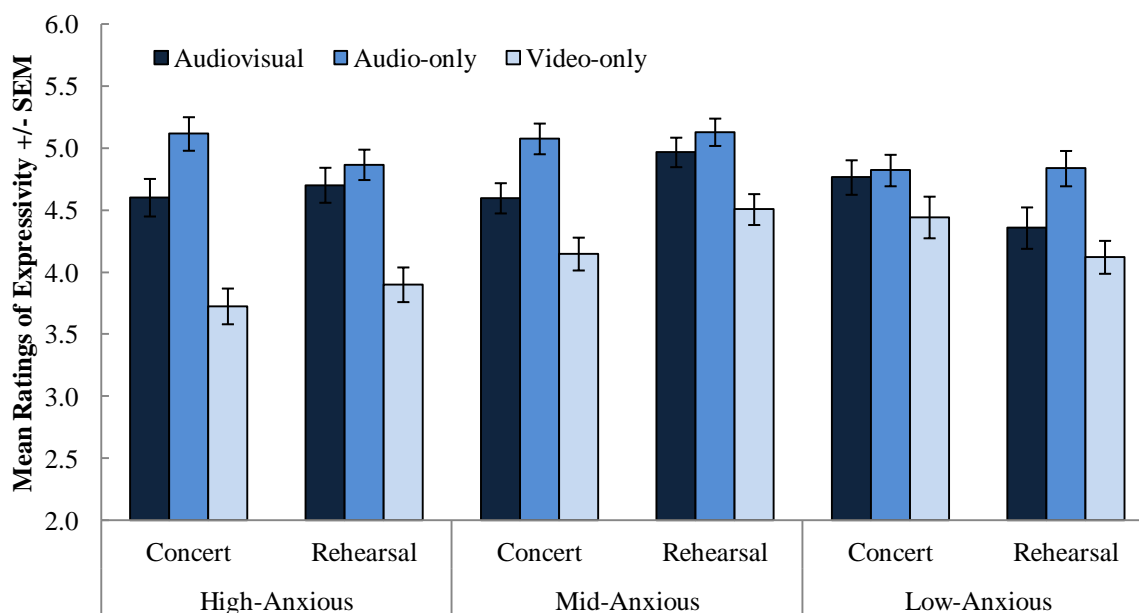


Figure 4. A three-way interaction in mean expressivity ratings, grouped by anxiety level, performing context and modality. Error bars represent stand error mean (SEM).

High-anxious performers

The ANOVA for high-anxious performers revealed a highly significant main effect of modality $F(2, 102) = 44.85, p < .001, \eta_p^2 = .47$, with post hoc pairwise comparisons indicating significant differences in the mean expressivity ratings between audio-only and audiovisual conditions, ($p = .02$), between audiovisual and video-only conditions ($p < .001$), and between audio-only and video-only conditions ($p < .001$). The main effect of performing context was non-significant. There was also a significant two-way interaction between performing context and modality, $F(2, 102) = 6.34, p = .003, \eta_p^2 = .11$ (Figure 4a). Follow-up ANOVAs revealed a significant simple main effect of modality for high-anxious performers in the concert condition, $F(2, 102) = 25.98, p < .001, \eta_p^2 = .50$, with post hoc pairwise comparisons revealing significant differences in the mean ratings between audio-only and audiovisual conditions, ($p < .001$), between audiovisual and video-only conditions ($p < .001$), and between audio-only and video-only conditions ($p < .001$). There was also a significant simple main effect of modality for high-anxious performers in rehearsal condition, $F(2, 102) = 24.59, p < .001, \eta_p^2 = .33$. Post hoc pairwise comparison indicated that expressivity mean ratings in both audiovisual ($p < .001$) and audio-only conditions ($p < .001$) were significantly higher than that in the video-only condition. Follow-up ANOVAs also revealed a significant main effect of performing context for high-anxious performers in the audio-only condition, $F(1, 51) = 12.01,$

$p < .001$, $\eta_p^2 = .02$, in which the high-anxious performers were perceived as being more expressive in concert than in rehearsal performances ($p < .001$). However, no significant differences between performing contexts for high-anxious performers were found in audio-only and video-only conditions.

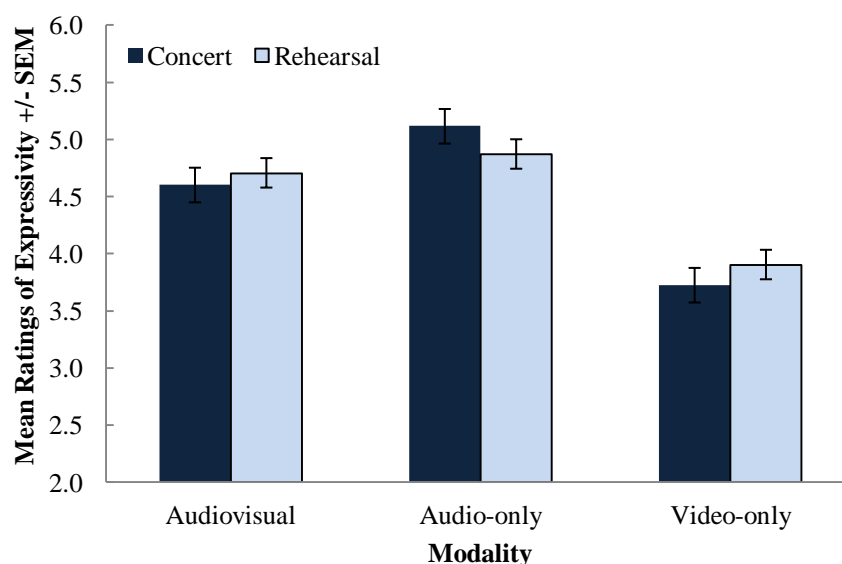


Figure 4a. A two-way interaction in mean expressivity ratings obtained by the high-anxious performers, grouped by performing context and modality. Error bars represent SEM.

Mid-anxious performers

For the mid-anxious performers, significant main effects of performing context, $F(1, 51) = 31.17$, $p < .001$, $\eta_p^2 = .38$, and modality, $F(2, 102) = 15.97$, $p < .001$, $\eta_p^2 = .33$, were observed in the ANOVA. Post hoc pairwise comparisons revealed that the mid-anxious performers were rated significantly more expressive in the rehearsal setting than in the concert setting ($p < .001$). In addition, the mid-anxious performers received significantly higher mean expressivity ratings in the audio-only condition when comparing with the mean ratings of audiovisual ($p = .009$) and video-only conditions ($p < .001$). Also, the mean expressivity ratings obtained from the audiovisual condition were significantly higher than the ones from the video-only condition ($p = .001$).

A significant two-way interaction was also identified between performing context and modality, $F(2, 102) = 5.5$, $p = .005$, $\eta_p^2 = .10$ (Figure. 4b). Follow-up ANOVAs revealed a significant simple main effect of modality for mid-anxious performers in the concert

condition, $F(2, 102) = 27.09$, $p < .001$, $\eta_p^2 = .35$. Post hoc pairwise comparisons indicated significant differences in mean expressivity ratings between audio-only and audiovisual conditions ($p < .001$), between audio-only and video-only conditions ($p < .001$) and between audiovisual and video-only conditions ($p = .003$). A significant main effect of modality for mid-anxious performers in the rehearsal condition was also recorded, $F(2, 102) = 14.8$, $p < .001$, $\eta_p^2 = .23$, with post hoc pairwise comparisons revealing that the mid-anxious performers received significantly lower mean expressivity ratings in the video-only condition than in both audiovisual ($p = .001$) and audio-only conditions ($p < .001$). There were also significant main effects of performing context for mid-anxious performers in the audiovisual, $F(1, 51) = 24.40$, $p < .001$, $\eta_p^2 = .32$, and in the video-only condition, $F(1, 51) = 19.25$, $p < .001$, $\eta_p^2 = .34$. In both cases, mid-anxious performers were rated as being more expressive in the rehearsal condition than in the concert condition ($p < .001$).

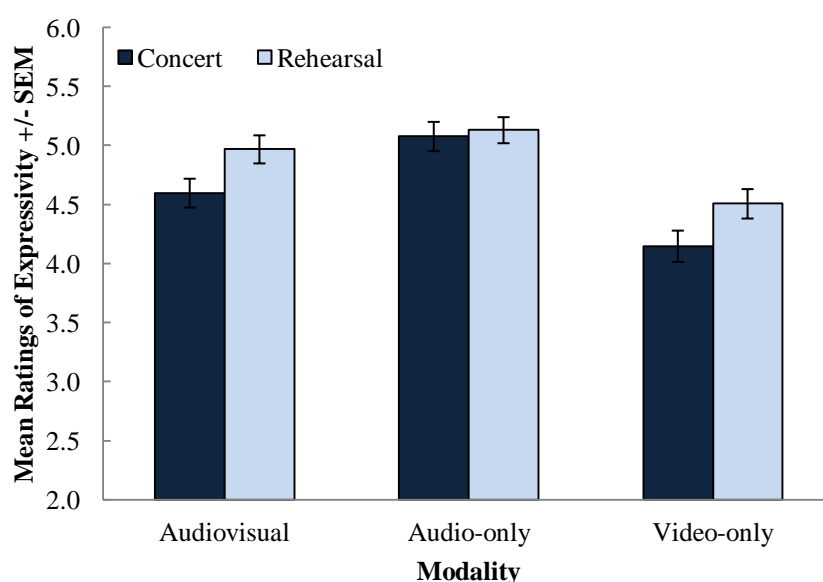


Figure 4b. A two-way interaction in mean expressivity ratings obtained by the mid-anxious performers, grouped by performing context and modality. Error bars represent SEM.

Low-anxious performers

The ANOVA analysis for low-anxious performers also indicated a significant main effect of performing context, $F(1, 51) = 10.44$, $p = .002$, $\eta_p^2 = .17$, and modality, $F(2, 102) = 9.94$, $p < .001$, $\eta_p^2 = .16$. Post hoc pairwise comparisons showed that the observers rated the low-anxious performers as being significantly more expressive in the concert condition than in the rehearsal condition ($p = .002$), and that they were perceived as being more expressive in the

audio-only condition than in the audiovisual ($p = .038$) and video-only ($p < .001$) conditions. There was also a significant two-way interaction between performing context and modality, $F(2, 102) = 3.38$, $p = .038$, $\eta_p^2 = .06$ (Figure 4c). A significant main effect of modality for low-anxious performers in the concert condition, $F(1.74, 88.56) = 3.48$, $p = .041$, $\eta_p^2 = .06$, and in the rehearsal condition, $F(2, 102) = 12.7$, $p < .001$, $\eta_p^2 = .20$, was also reported in the follow-up ANOVAs. While the post hoc pairwise comparisons did not reveal any significant difference of modality in the concert condition, the low-anxious performers were awarded significantly higher mean expressivity ratings when the observers rated the audio-only excerpts than when they rated the audiovisual ($p = .004$) and video-only excerpts ($p < .001$) in the rehearsal condition. The analysis also yielded a significant main effect of performing context for low-anxious performers in the audiovisual condition, $F(1, 51) = 11.87$, $p = .001$, $\eta_p^2 = .19$, and in the video-only condition, $F(1, 51) = 7.58$, $p = .008$, $\eta_p^2 = .13$. Contrary to the mid-anxious performers, the low-anxious performers were perceived as being more expressive in the concert condition than in the rehearsal condition when audiovisual ($p = .001$) and video-only ($p = .008$) excerpts were rated. There was also a significant two-way interaction between modality and musical training, $F(2, 102) = 4.24$, $p = .017$, $\eta_p^2 = .077$, but it was not further analysed with post hoc analysis because it was irrelevant to the results of the four-way mixed ANOVA.

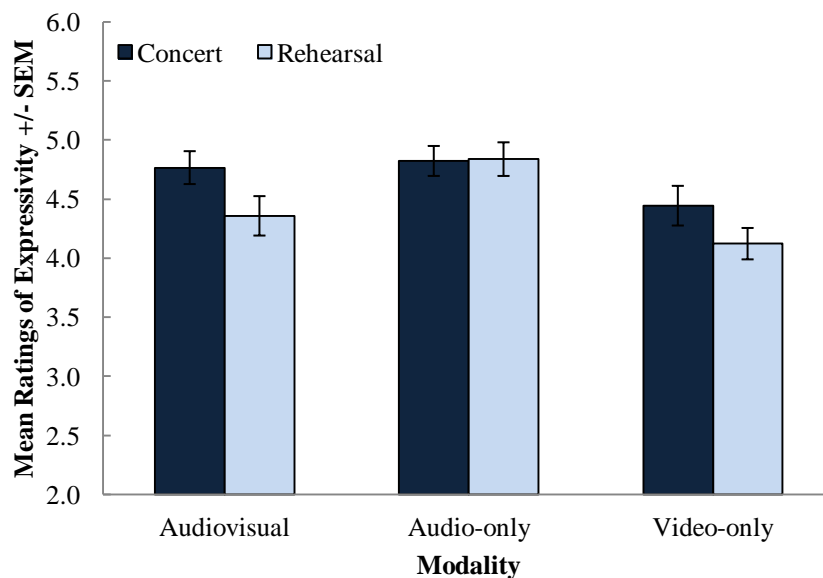


Figure 4c. A two-way interaction in mean expressivity ratings obtained by the low-anxious performers, grouped by performing context and modality. Error bars represent SEM.

Performing context and modality

To further examine the role of performing context and modality within the three-way interaction (Fig.4), two separate mixed ANOVAs on each performance context (modality, anxiety level & musical training), and three separate mixed ANOVAs on each modality (anxiety level, performing context & musical training) were conducted.

Concert Setting

The ANOVA for concert indicated a significant main effect of anxiety level, $F(2, 102) = 3.14$, $p = .047$, $\eta_p^2 = .06$, and modality, $F(1.89, 96.4) = 34.5$, $p < .001$, $\eta_p^2 = .40$. Post hoc pairwise comparisons revealed that the high-anxious performers scored significantly lower in mean expressivity ratings than the low-anxious performers ($p = .032$), and that the mean expressivity ratings between audio-only and audiovisual conditions, ($p = .001$), between audiovisual and video-only conditions ($p < .001$), and between audio-only and video-only conditions ($p < .001$) were significantly different.

There was also a significant two-way interaction between anxiety level and modality, $F(4, 204) = 11.61$, $p < .001$, $\eta_p^2 = .19$ (Figure 4d). The follow-up ANOVAs showed a significant main effect of anxiety level for concert in the video-only condition, $F(2,102) = 19.78$, $p < .001$, $\eta_p^2 = .28$. Post hoc pairwise comparison revealed that the high-anxious performers scored significantly lower mean expressivity ratings on average than the mid-anxious ($p = .001$) and the low-anxious performers ($p < .001$) in the video-only condition. Although a significant main effect was reported for the audio-only condition, $F(2,102) = 3.3$, $p = .041$, $\eta_p^2 = .06$, post hoc pairwise comparison did not reveal any significant differences across the three anxiety level groups. The results did not reveal significant main effect of anxiety level for concert in the audiovisual condition. A marginally significant main effect of musical training was also reported, $F(1, 51) = 4.05$, $p = .049$, $\eta_p^2 = .07$, nevertheless it was unrelated to the results obtained from the four-way mixed ANOVA.

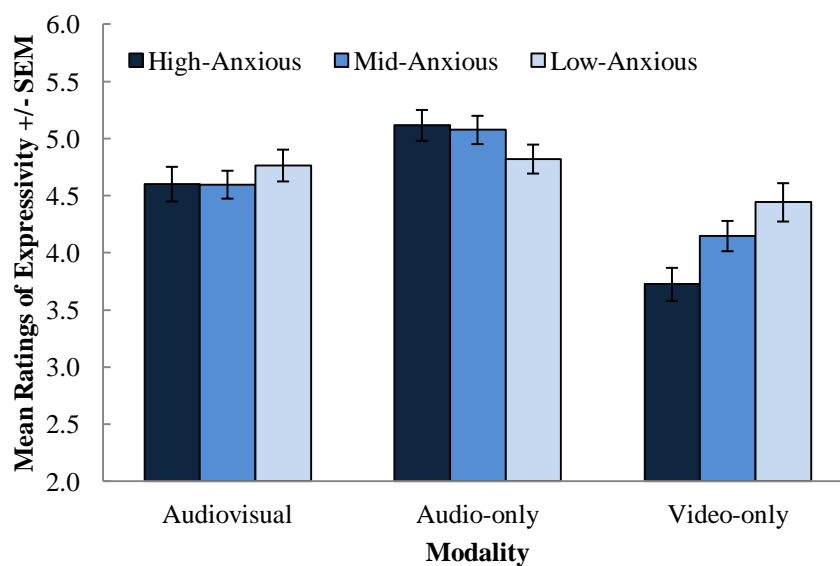


Figure 4d. A two-way interaction in mean expressivity ratings in concert setting, grouped by anxiety level and modality. Error bars represent SEM.

Rehearsal Setting

The ANOVA for rehearsal indicated significant main effects of anxiety level, $F(2, 102) = 13.34$, $p < .001$, $\eta_p^2 = .21$, and modality, $F(2, 102) = 24.83$, $p < .001$, $\eta_p^2 = .33$. Post hoc pairwise comparisons revealed that the mid-anxious performers received significantly higher mean expressivity ratings than the high-anxious ($p < .001$) and the low-anxious ($p < .001$) performers, and that significant differences in mean expressivity ratings were identified between audiovisual and audio-only conditions ($p = .043$), between audiovisual and video-only conditions ($p < .001$) and between audio-only and video-only conditions ($p < .001$). There was also a significant two-way interaction between anxiety level and modality, $F(4, 204) = 4.89$, $p = .001$, $\eta_p^2 = .09$ (Figure 4e). Main effects of anxiety level for rehearsal in the audiovisual, $F(2,102) = 10.55$, $p < .001$, $\eta_p^2 = .17$, audio-only, $F(2,102) = 3.86$, $p = .024$, $\eta_p^2 = .07$, and video-only conditions, $F(2,102) = 13.86$, $p < .001$, $\eta_p^2 = .21$, were found significant in the follow-up ANOVAs. Post hoc pairwise comparisons revealed that in the rehearsal performances, the low-anxious performers received significantly lower mean expressivity ratings than the mid-anxious ($p < .001$) and high-anxious performers ($p = .037$) when the audiovisual excerpts were examined. However, when the audio-only excerpts were assessed, the mid-anxious performers were recognised as significantly more expressive than both the high-anxious ($p = .041$) and the low-anxious performers ($p = .041$). Such mean differences were even greater between the mid-anxious and high-anxious performers ($p < .001$) and

between the mid-anxious and low-anxious performers ($p = .001$) when video-only excerpts were presented. A significant main effect of musical training, $F(1, 51) = 5.09$, $p = .028$, $\eta_p^2 = .09$ was also observed, although it was irrelevant to the current investigation. The other two-way and three-way interactions were non-significant.

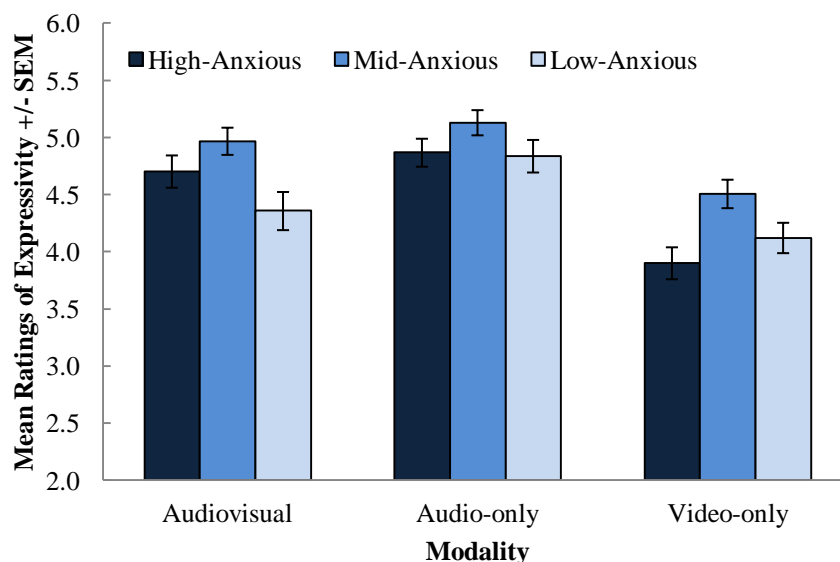


Figure 4e. A two-way interaction in mean expressivity ratings in rehearsal setting, grouped by anxiety level and modality. Error bars represent SEM.

Audiovisual Condition

The ANOVA for audiovisual did not reveal any significant main effects, but there was a significant two-way interaction between performing context and anxiety level, $F(2, 102) = 16.77$, $p < .001$, $\eta_p^2 = .25$. The nature of the underlying main effects has been elucidated in the previous session (see Figures 4d & 4e).

Audio-only Condition

The ANOVA for audio-only revealed a significant main effect of anxiety level, $F(2, 102) = 4.17$, $p = .018$, $\eta_p^2 = .08$, but not for performing context. Post hoc pairwise comparisons indicated the mean expressivity ratings for the mid-anxious performers was significantly higher than that for the low-anxious performers when the observers were presented with audio-only excerpts ($p = .012$). There was also a significant main effect of musical training, $F(1, 51) = 9.82$, $p = .003$, $\eta_p^2 = .16$, and a significant two-way interaction between anxiety

level and musical training, $F(2, 102) = 5.21, p = .007, \eta_p^2 = .09$, although these are unrelated to the present exploration. The other main effects and interactions were non-significant.

Video-only Condition

The ANOVA for video-only showed a significant main effects of anxiety level, $F(2, 102) = 19.14, p < .001, \eta_p^2 = .27$. Post hoc pairwise comparison revealed that the high-anxious performers received significantly lower mean expressivity ratings than the mid-anxious ($p < .001$) and the low-anxious performers ($p < .001$) when only visual cues were available to the observers. There was also a significant two-way interaction between performing context and anxiety level, $F(2, 102) = 12.66, p < .001, \eta_p^2 = .20$. The nature of the underlying main effects has been accounted for in the previous analysis (see Figures 4d & 4e).

Interactions between anxiety level and musical training

To apprehend the anxiety level * musical training interaction occurred within the four-way mixed ANOVA (Figure 5), two separate three-way repeated measures ANOVAs (anxiety level * performing context * modality) were computed on each level of musical training. There was a significant main effect of anxiety level in the observers with more musical training, $F(2, 56) = 9.95, p < .001, \eta_p^2 = .26$, in which the post hoc pairwise comparisons indicated that they considered the mid-anxious performers as being more expressive than the high-anxious ($p = .003$) and the low-anxious ($p = .001$) performers. Follow-up ANOVAs also revealed a significant main effect of musical training in the high-anxious condition, $F(1, 51) = 4.74, p < .034, \eta_p^2 = .09$, and in the low-anxious condition, $F(1, 51) = 6.9, p = .011, \eta_p^2 = .12$. The expressivity mean ratings given to the high-anxious ($p = .034$) and the low-anxious ($p = .011$) performers by the observers with less musical training were significantly higher than that given by the observers with more musical training.

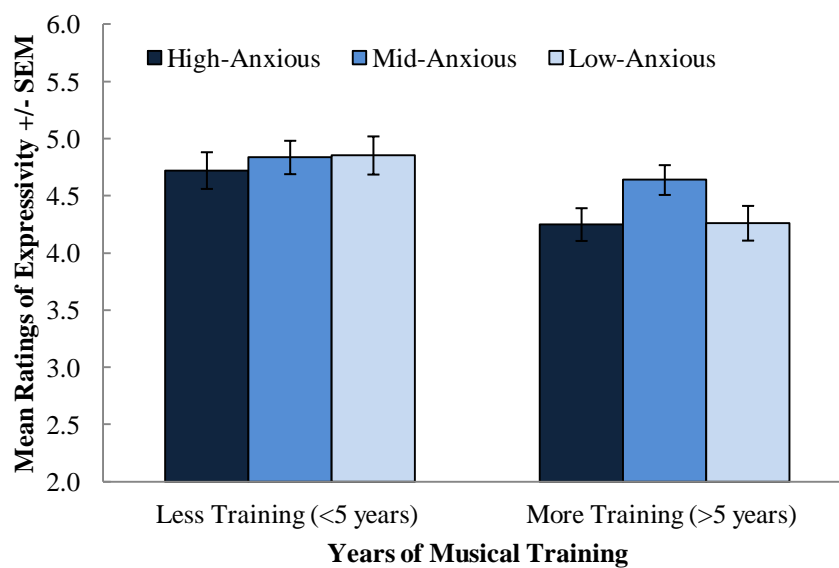


Figure 5. Mean expressivity ratings, grouped by level of anxiety and musical training. Error bars represent SEM.

5.2.2 Performance Quality Ratings

The mean and the standard deviation of the performance quality ratings for each condition given by the two observer groups are displayed in Table 3.

Table 3. Mean ratings (M) and standard deviation (SD) of performance quality ratings in association with anxiety levels, performing context, modality and observer's musical training.

	Performance Quality Ratings					
	Observers with Less Musical Training (<5 years) (N=24)		Observers with Less Musical Training (>5 years) (N= 29)		Overall ratings (N = 53)	
	Mean	SD	Mean	SD	Mean	SD
High-Anxious						
Concert-AV	5,27	0,96	4,72	0,88	4,97	0,95
Concert-Audio	5,35	0,84	4,79	0,96	5,05	0,94
Concert-Video	4,04	0,93	3,97	1,09	4,00	1,01
Rehearsal - AV	5,17	0,86	4,57	0,99	4,84	0,97
Rehearsal - Audio	5,17	1,02	4,57	1,02	4,84	1,05
Rehearsal - Video	4,08	1,28	4,05	1,14	4,07	1,20
Mid-Anxious						
Concert-AV	5,33	0,87	5,00	0,81	5,15	0,85
Concert-Audio	5,33	0,84	4,93	1,01	5,11	0,95
Concert-Video	4,60	1,10	4,58	0,96	4,59	1,02
Rehearsal - AV	5,49	0,76	5,43	0,75	5,46	0,75
Rehearsal - Audio	5,36	1,00	5,15	0,93	5,25	0,96
Rehearsal - Video	4,46	0,86	4,81	0,74	4,65	0,81
Low-Anxious						
Concert-AV	5,27	0,96	4,47	1,09	4,83	1,10
Concert-Audio	5,04	1,09	4,34	0,88	4,66	1,03
Concert-Video	4,88	1,07	4,83	1,12	4,85	1,09
Rehearsal - AV	5,31	1,19	4,50	1,09	4,87	1,19
Rehearsal - Audio	5,23	1,14	4,52	0,96	4,84	1,10
Rehearsal - Video	4,83	0,87	4,64	1,08	4,73	0,99

A mixed four-way ANOVA (anxiety level * performing context * modality * musical training) was calculated to examine the potential differences in mean ratings across all conditions.

The ANOVA revealed a significant main effect of anxiety level, $F(2, 102) = 13.1, p < .001, \eta_p^2 = .20$, and modality, $F(1.21, 61.82) = 19.22, p < .001, \eta_p^2 = .27$. Post hoc pairwise comparisons showed that the mid-anxious performers received significantly higher mean performance quality ratings than the high-anxious ($p < .001$) and low-anxious performers ($p = .01$). Furthermore, the mean performance quality ratings obtained from the video-only condition were significantly lower than those given to the audiovisual ($p < .001$) and audio-only conditions ($p < .001$). The main effect of performing context was non-significant.

The ANOVA also revealed a two-way interaction between musical training and anxiety level, $F(2, 102) = 4.05, p = .02, \eta_p^2 = .07$, between musical training and modality, $F(1.21, 61.82) = 4.6, p = .029, \eta_p^2 = .08$, between anxiety level and performing context, $F(2, 102) = 4.38, p = .015, \eta_p^2 = .08$, and between anxiety level and modality, $F(3.67, 187.05) = 17.46, p < .001, \eta_p^2 = .26$. There was also a significant three-way interaction between anxiety level, performing context and modality, $F(3.68, 187.83) = 2.94, p = .025, \eta_p^2 = .05$. The remaining two-way and three-way interactions were non-significant. Since the lower-order interactions could not fully explain the results, the current investigation will focus on the interactions between anxiety level, performing context and modality, between musical training and anxiety level, and between musical training and modality.

Interactions between anxiety level, performing contexts and modality

The anxiety level * performing contexts * modality interaction in mean performance quality ratings is illustrated graphically in Figure 6. To explore the anxiety level * performing context * modality interaction, three separate ANOVAs on each anxiety level were conducted.

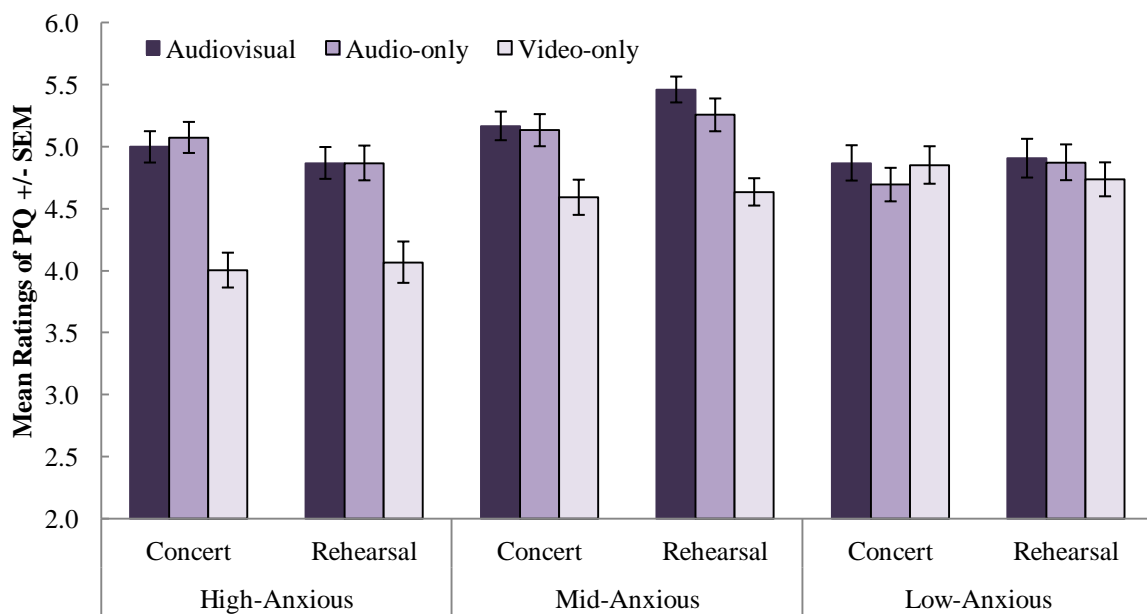


Figure 6. A three-way interaction in mean performance quality (PQ) ratings, grouped by anxiety level, performing context and modality. Error bars represent SEM.

The Performers

The ANOVA for high-anxious performers did not reveal any interaction between performing context and modality. There was a significant simple main effect of modality for the high-anxious performers, $F(1.59, 81.25) = 38.33, p < .001, \eta_p^2 = .43$, but not for performance context. Post hoc pairwise comparisons showed that the high-anxious performers received significantly lower mean performance quality ratings in the video-only condition in comparison with the audio-only ($p < .001$) and audiovisual conditions ($p < .001$).

Regarding mid-anxious performers, the ANOVA revealed a significant main effect of performing context, $F(1, 51) = 31.17, p = .002, \eta_p^2 = .38$, in which post hoc pairwise comparison revealed that mid-anxious performers received significantly higher performance quality mean ratings in the rehearsal condition than in the concert condition in general ($p = .002$). A significant main effect of modality for the mid-anxious performers was also observed, $F(1.6, 81.47) = 23.74, p < .001, \eta_p^2 = .32$, in which the post hoc pairwise comparisons indicated a significantly lower mean performance quality ratings in the video-only condition than in the audiovisual ($p < .001$) and audio-only conditions ($p < .001$). A significant two-way interaction between performing context and musical training was also discovered, $F(1, 51) = 8.97, p = .004, \eta_p^2 = .15$, although it was unrelated to the interactions retrieved from the four-way mixed ANOVA. Other main effects and interactions were non-significant.

As for low-anxious performers, there were no significant main effects or interactions between performing context and modality. However, there was a marginally significant two-way interaction between modality and musical training, $F(1.34, 68.29) = 3.59, p = .05, \eta_p^2 = .07$, which was irrelevant to the results obtained from the four-way mixed ANOVA.

Performing context and modality

Five separate mixed ANOVAs were carried out (two on each performing context, and three on each modality) to gain a better understanding of the three-way interaction (Figure 6).

Concert Setting

The ANOVA for concert showed a significant main effect of anxiety level, $F(2, 102) = 5.51$, $p = .005$, $\eta_p^2 = .10$, and modality, $F(1.89, 72.28) = 34.5$, $p < .001$, $\eta_p^2 = .40$. Pairwise comparisons showed that the high-anxious performers received significantly lower mean performance quality ratings than the mid-anxious performers, and that video-only excerpts were given lower mean performance ratings than both the audiovisual ($p = .001$) and the audio-only conditions ($p = .001$). A significant main effect of musical training was also found in the analysis, $F(1, 51) = 4.06$, $p = .049$, $\eta_p^2 = .07$, although it was unrelated to the results from the four-way mixed ANOVA. There was also a significant interaction between anxiety level and modality, $F(3.41, 173.97) = 20.26$, $p < .001$, $\eta_p^2 = .29$ (Figure 6a). Follow-up ANOVAs indicated a significant main effect of anxiety level for concert in the audiovisual condition, $F(2,102) = 3.43$, $p = .036$, $\eta_p^2 = .06$, although post hoc pairwise comparison did not reveal any significant differences between the anxiety groups. Significant main effects of audio-only condition, $F(2,102) = 7.56$, $p = .001$, $\eta_p^2 = .13$, and video-only condition, $F(2,102) = 29.04$, $p < .001$, $\eta_p^2 = .36$, were also uncovered. Post hoc pairwise comparisons showed that in the audio-only condition, the perceived performance quality ratings for the low-anxious performers was less favourable than that of the high-anxious ($p = .006$) and the mid-anxious performers ($p = .004$). Conversely, in the video-only condition, the high-anxious performers received lower mean performance quality ratings than the mid-anxious ($p = .001$) and the low-anxious performers ($p = .001$).

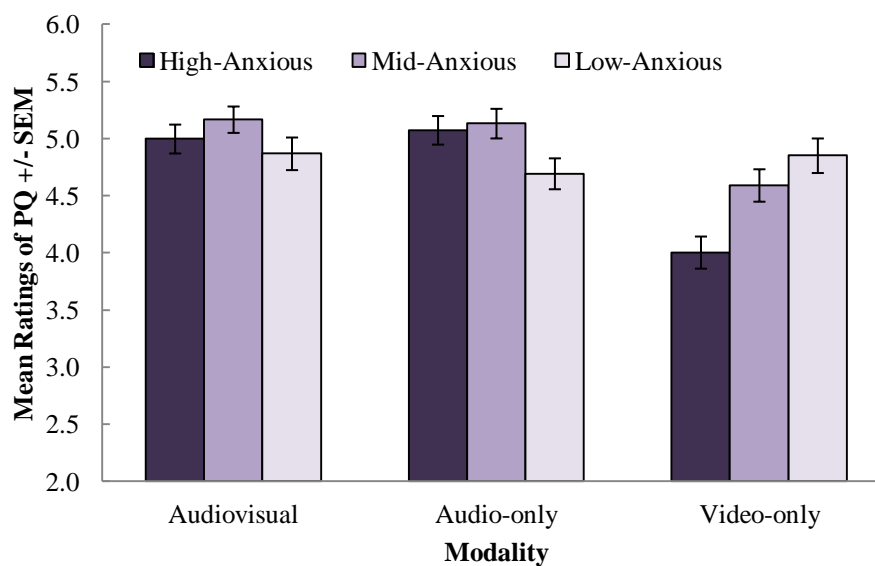


Figure 6a. A two-way interaction in mean performance quality ratings in concert setting, grouped by anxiety level and modality. Error bars represent SEM.

Rehearsal Setting

A significant main effect of anxiety level, $F(1.89, 96.47) = 15.65, p < .001, \eta_p^2 = .24$, and modality, $F(1.62, 82.37) = 4.29, p = .009, \eta_p^2 = .09$, were observed in the ANOVA for rehearsal. Post hoc pairwise comparisons showed significant differences in mean performance quality ratings between the high-anxious and mid-anxious performers ($p < .001$), between the high-anxious and low-anxious performers ($p = .021$) and between the mid-anxious and low-anxious performers ($p = .005$). A two-way interaction between anxiety level and modality was also observed, $F(3.47, 176.93) = 7.65, p < .001, \eta_p^2 = .13$ (Figure 6b). Follow-up ANOVAs indicated a significant main effect of anxiety level for rehearsal in the audiovisual, $F(2,102) = 16.82, p < .001, \eta_p^2 = .25$, audio-only, $F(2,102) = 4.9, p = .009, \eta_p^2 = .09$, and video-only conditions, $F(1.86, 95.09) = 15.24, p < .001, \eta_p^2 = .23$. Post hoc pairwise comparison indicated that in the audiovisual condition, a significantly higher mean performance quality ratings were given to the mid-anxious performers than those given to the high-anxious ($p < .001$) and the low-anxious ($p = .001$) performers. A similar pattern was observed in the audio-only condition, although such differences were slightly smaller when comparing the mean ratings between the mid-anxious and high-anxious performers ($p = .032$) and between the mid-anxious and low-anxious performers ($p = .018$). In the video-only condition, the high-anxious performers received significantly lower mean performance quality ratings than the mid-anxious ($p = .001$) and low-anxious ($p < .001$) performers. There was

also a two-way interaction between modality and musical training, $F(1.62, 82.37) = 4.28$, $p = .024$, $\eta_p^2 = .08$, although it was irrelevant to the investigation here.

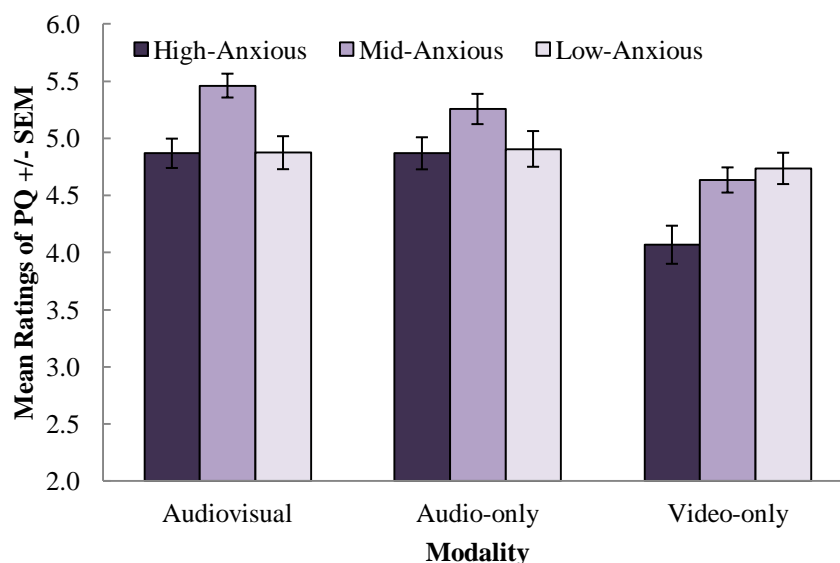


Figure 6b. A two-way interaction in mean performance quality ratings in rehearsal setting, grouped by anxiety level and modality. Error bars represent SEM.

Audiovisual Condition

The ANOVAs for audiovisual showed a significant main effect of anxiety level, $F(2, 102) = 11.6$, $p < .001$, $\eta_p^2 = .19$, with pairwise comparisons revealing that the mid-anxious performers received significantly higher mean performance quality ratings in general when compared with the high-anxious ($p = .002$) and the low-anxious performers ($p < .001$). There was also a significant two-way interaction between performing context and anxiety level for audiovisual, $F(1.87, 95.28) = 6.65$, $p < .005$, $\eta_p^2 = .12$, in which the nature of the interaction has been accounted for in the above analysis (see Figures 6a & 6b). A significant main effect of musical training, $F(1, 51) = 5.72$, $p = .02$, $\eta_p^2 = .10$, and a significant two-way interaction between anxiety level and musical training, $F(2, 102) = 4.14$, $p = .019$, $\eta_p^2 = .08$, were also reported. However, these were not investigated further because it was unrelated the results obtained from the four-way ANOVA.

Audio-only Condition

The ANOVA for audio-only revealed a significant main effect of anxiety level, $F(2, 102) = 6.73, p = .002, \eta_p^2 = .12$, with pairwise comparisons showing that the mid-anxious performers received significantly higher mean performance quality ratings than the low-anxious performers ($p = .001$). A significant two-way interaction between anxiety level and performing context was also discovered, $F(2, 102) = 4.66, p = .012, \eta_p^2 = .08$. The nature of the interaction for these two variables has been accounted for in the previous analysis (see Figures 6a & 6b). There was also a significant simple main effect of musical training, $F(1, 51) = 6.1, p = .017, \eta_p^2 = .11$, although it was unrelated to the investigation here.

Video-only Condition

For video-only, the ANOVA revealed a significant main effect of anxiety level, $F(2, 102) = 19.14, p < .001, \eta_p^2 = .27$ but not for performing context. Post hoc pairwise comparisons showed that in the video-only condition, the high-anxious performers received significantly lower mean performance quality ratings than the mid-anxious ($p < .001$) and low-anxious performers ($p < .001$). Other main effects and two-way interactions were non-significant.

Interaction between anxiety level and musical training

For the anxiety * training interaction (Figure 7), two separate three-way repeated measures (anxiety level * performing context * modality) ANOVAs were computed on each level of musical training. Significant main effects of anxiety level were reported for observers with less musical training, $F(2, 46) = 4.24, p = .02, \eta_p^2 = .16$, and also for observers with more musical training, $F(2, 56) = 12.5, p < .001, \eta_p^2 = .31$. Follow-up post hoc pairwise comparisons did not reveal any significant differences in performance quality ratings between the anxiety groups in the less musically trained observers, but the observers with more musical training gave significantly better mean performance quality ratings to the mid-anxious performers than to the high-anxious ($p = .001$) and the low-anxious ($p = .001$) performers. There was also a significant main effect of musical training, $F(1, 51) = 6.6, p = .013, \eta_p^2 = .12$, in the mean ratings for the low-anxious performers. Post hoc pairwise comparison revealed that observers with less musical training allocated significantly higher mean performance quality ratings to the low-anxious performers than the observers with more

musical training ($p = .011$). There were no significant main effects of musical training in the mid-anxious and high-anxious performers.

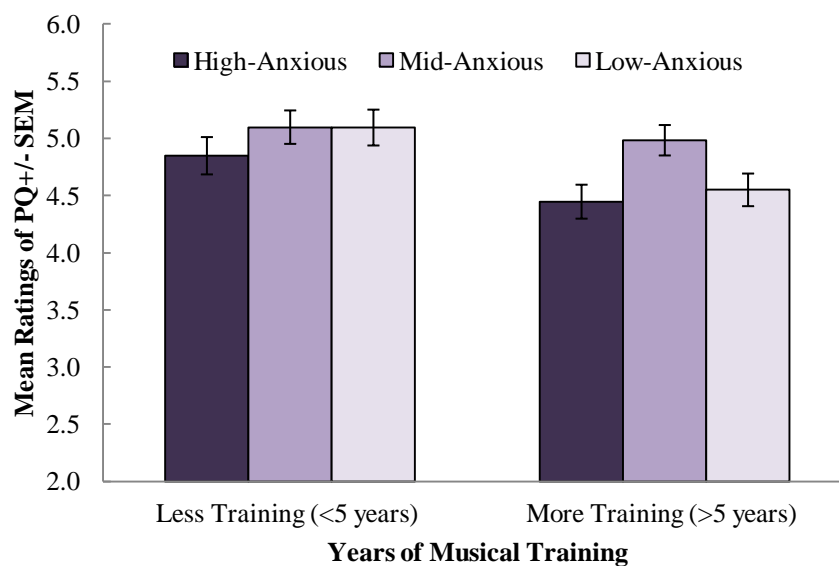


Figure 7. Mean ratings of performance quality, grouped by anxiety level and musical training. Error bars represent SEM.

Interactions between modality and musical training

The modality * training interaction (Figure 8) revealed a significant main effect of modality for the observers with less musical training, $F(2, 46) = 16.9, p < .001, \eta_p^2 = .42$. Post hoc pairwise comparison showed that the observers with less musical training gave significantly lower ratings to the video-only performances than to the audiovisual ($p = .001$) and the audio-only performances ($p = .001$). There were also significant main effects of modality in audiovisual, $F(1, 51) = 5.72, p = .02, \eta_p^2 = .10$, and audio-only conditions, $F(1, 51) = 6.1, p = .017, \eta_p^2 = .11$. In general, observers with less musical training gave significantly better performance quality ratings in audiovisual ($p = .02$) and audio-only ($p = .017$) conditions than observers with more musical training, as indicated by post hoc pairwise comparison. The other main effects and interactions were non-significant.

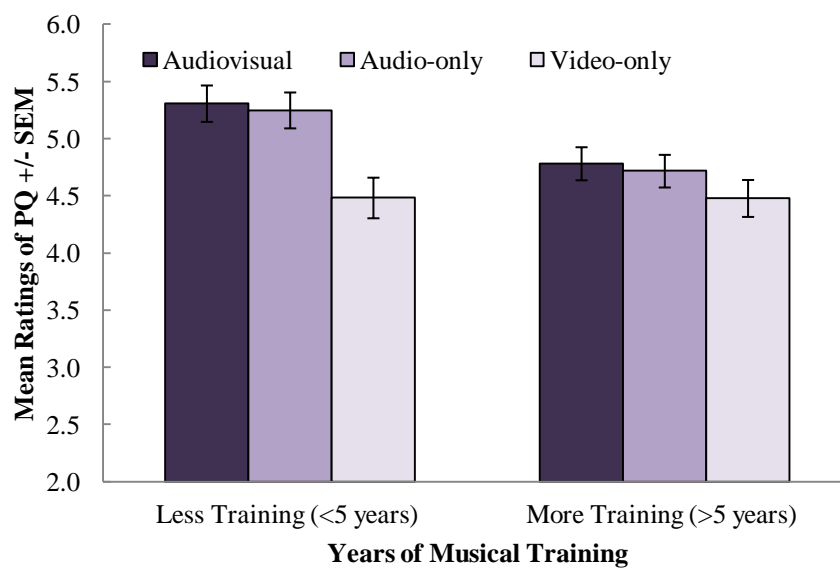


Figure 8. Mean ratings of performance quality, grouped by modality and musical training. Error bars represent SEM.

5.2.3 Inner State Ratings

The mean and the standard deviation of the inner state ratings across all conditions are tabulated in Table 4.

Table 4. Mean ratings (M) and standard deviation (SD) of inner state ratings by anxiety levels, context, modality and observer's training.

	Inner State Ratings					
	Observers with Less Musical Training (<5 years) (N=24)		Observers with More Musical Training (>5 years) (N= 29)		Overall ratings (N = 53)	
	Mean	SD	Mean	SD	Mean	SD
High-Anxious						
Concert-AV	3.32	0.87	3.52	1.09	3.43	0.99
Concert-Audio	2.67	0.90	2.98	0.78	2.84	0.85
Concert-Video	3.56	1.31	3.67	1.22	3.62	1.25
Rehearsal - AV	3.00	0.83	3.66	1.14	3.36	1.06
Rehearsal - Audio	3.08	1.01	3.22	0.53	3.16	0.78
Rehearsal - Video	3.44	1.20	3.59	1.07	3.52	1.12
Mid-Anxious						
Concert-AV	2.78	0.71	2.99	0.89	2.90	0.81
Concert-Audio	2.78	0.72	2.91	0.85	2.85	0.79
Concert-Video	2.88	0.58	2.90	0.83	2.89	0.72
Rehearsal - AV	2.30	0.57	2.69	0.70	2.51	0.67
Rehearsal - Audio	2.66	0.79	2.64	0.92	2.65	0.85
Rehearsal - Video	2.97	0.65	2.64	0.65	2.79	0.66
Low-Anxious						
Concert-AV	2.79	0.95	2.97	0.89	2.89	0.91
Concert-Audio	3.38	1.18	3.59	1.03	3.49	1.09
Concert-Video	2.60	0.77	2.67	0.72	2.64	0.74
Rehearsal - AV	2.38	0.95	2.88	1.00	2.65	1.00
Rehearsal - Audio	3.13	1.18	3.26	0.97	3.20	1.06
Rehearsal - Video	2.79	0.76	2.79	1.14	2.79	0.98

A similar four-way mixed ANOVA was executed to investigate the ratings of inner state. The ANOVA revealed a highly significant main effect of anxiety level, $F(1.7, 86.79) = 21.9, p < .001, \eta_p^2 = .30$, in which the post hoc pairwise comparisons revealed that the high-anxious performers were perceived as being significantly more anxious than the mid-anxious ($p < .001$) and the low-anxious performers ($p < .001$). A significant main effect of performing context was also observed, $F(1, 51) = 6.53, p = .014, \eta_p^2 = .11$. Post hoc pairwise comparison showed that the performers were given higher inner state ratings in the concert setting than in the rehearsal setting ($p = .014$). The main effect for modality was non-significant.

There were also significant two-way interactions between anxiety level and performing context, $F(2, 102) = 3.55, p = .032, \eta_p^2 = .07$, between anxiety and modality, $F(3.58, 182.38)$

= 25.43, $p < .001$, $\eta_p^2 = .33$, and between performing context and modality, $F(2, 102) = 3.66$, $p = .029$, $\eta_p^2 = .07$. A significant three-way interaction between anxiety level, performing context and modality, $F(5.21, 63.39) = 4.19$, $p = .003$, $\eta_p^2 = .08$ (Figure 9), and a three-way interaction between musical training, performing context and modality, $F(2, 102) = 4.06$, $p = .02$, $\eta_p^2 = .07$ was also uncovered. The anxiety level * performing context * modality interaction was proceeded with further analysis.

Interactions between anxiety level, performing contexts and modality

The anxiety level * performing contexts * modality interaction in mean inner state ratings is illustrated in Figure 9. Three separate ANOVAs on each anxiety level were generated to explore the three-way interaction between anxiety level, performing context and modality.

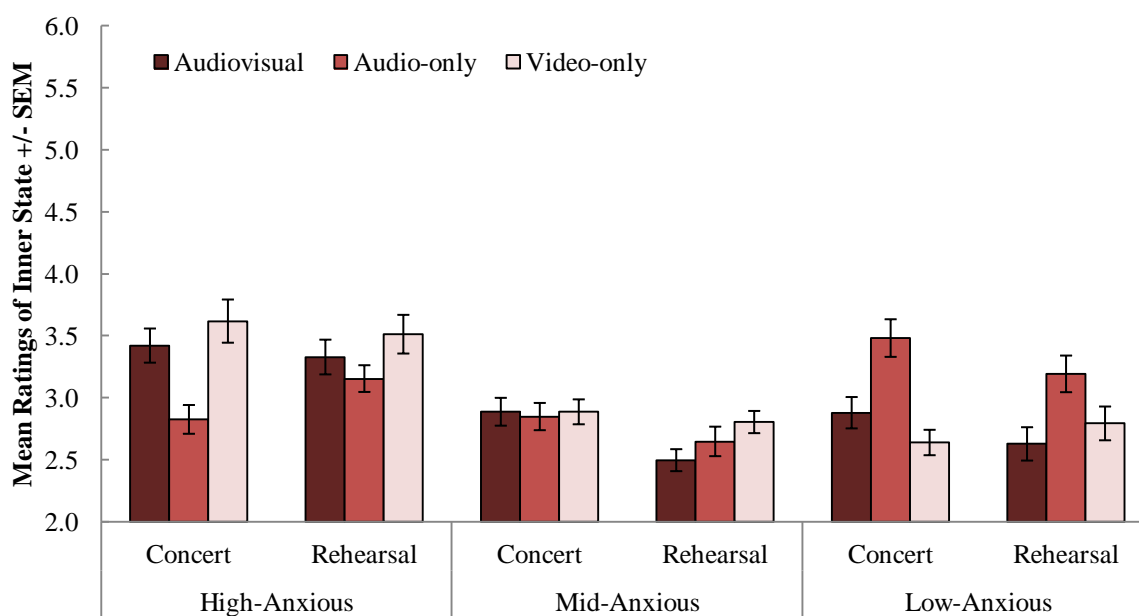


Figure 9. A three-way interaction in mean inner state ratings, grouped by anxiety level, performing context and modality. Error bars represent SEM.

High-anxious Performers

The ANOVA for high-anxious performers showed a significant main effect of modality, $F(1.86, 77.11) = p < .001$, $\eta_p^2 = .19$, with post hoc pairwise comparison revealing that the high-anxious performers received significantly lower mean inner state ratings in the audio-only condition than in the audiovisual ($p = .004$) and the video-only conditions ($p < .001$). A

significant two-way interaction between performing context and modality was also uncovered, $F(2, 102) = 5.16, p = .007, \eta_p^2 = .09$ (Figure 9a). Follow-up ANOVAs showed a highly significant main effect of modality for high-anxious performers in the concert condition, $F(2, 102) = 16.19, p < .001, \eta_p^2 = .24$. Post hoc pairwise comparison revealed that in the concert condition, the high-anxious performers received significantly lower mean inner state ratings in the audio-only condition than in the audiovisual ($p < .001$) and video-only conditions ($p < .001$). A significant main effect of modality was also discovered for high-anxious performers in the rehearsal condition, $F(2, 102) = 3.28, p = .042, \eta_p^2 = .06$. However, post hoc pairwise comparisons did not show any significant differences between the modalities. A significant main effect of performing context for high-anxious performers in the audio-only condition was reported, $F(1, 51) = 12.01, p = .001, \eta_p^2 = .019$, in which the post hoc pairwise comparison showed that the high-anxious performers are perceived as less anxious in the concert condition than in the rehearsal condition when the observers were presented with sound only. There were no significant main effects of performing context for the audiovisual and audio-only conditions.

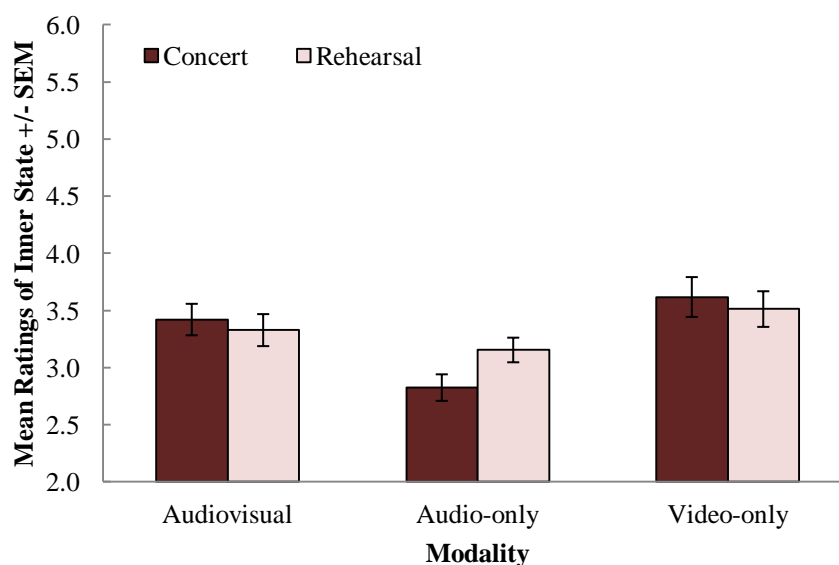


Figure 9a. A two-way interaction in mean inner state ratings in the high-anxious performers, grouped by performing context and modality. Error bars represent SEM.

Mid-anxious Performers

The ANOVA for mid-anxious performers revealed a significant main effect of performing context, $F(1, 51) = 15.02, p < .001, \eta_p^2 = .23$, in which the post hoc pairwise comparison

indicated that the mid-anxious performers received significantly higher inner state ratings when performed in the concert setting than in the rehearsal setting ($p < .001$). A significant interaction between performing context and modality, $F(2, 102) = 3.36$, $p = .039$, $\eta_p^2 = .06$, was also reported (Figure 9b). Follow-up ANOVAs indicated a significant main effect of modality for mid-anxious performers in the rehearsal condition, $F(2, 102) = 4.33$, $p = .016$, $\eta_p^2 = .08$ but not in the concert condition. Post hoc pairwise comparison showed that in the rehearsal condition, the mid-anxious performers received significantly higher mean inner state ratings in the video-only condition than in the audiovisual condition ($p = .005$). A significant main effect of performing context for mid-anxious performers was observed in the audiovisual condition, $F(1, 51) = 23.63$, $p < .001$, $\eta_p^2 = .32$, in which the post hoc pairwise comparison showed that the mid-anxious performers were perceived as being more anxious when performing in the concert than in the rehearsal condition ($p < .001$). No significant main effects of performing context for mid-anxious performers were found in the audio-only and video-only conditions. There was also a significant two-way interactions for modality and musical training, $F(2, 102) = 3.53$, $p = .033$, $\eta_p^2 = .07$, although it was not related to the current investigation. Other main effects and interactions were non-significant.

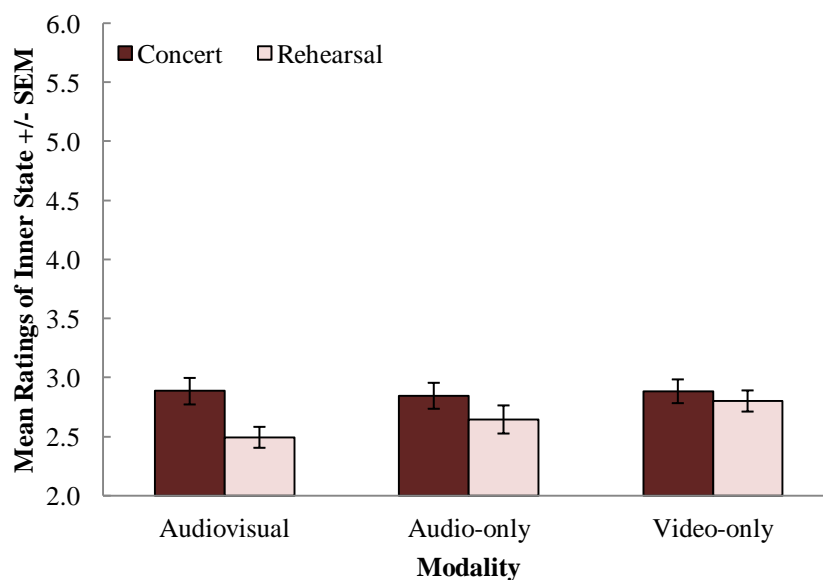


Figure 9b. A two-way interaction in mean inner state ratings in the mid-anxious performers, grouped by performing context and modality. Error bars represent SEM.

Low-anxious Performers

For the low-anxious performers, a significant main effect of modality was revealed, $F(1.89, 96.46) = 18.4, p < .001, \eta_p^2 = .27$, with pairwise comparisons showing that the audio-only condition yielded a significantly higher mean inner state rating when compared with the audiovisual ($p < .001$) and video-only conditions ($p < .001$). A two-way interaction between performing context and modality was revealed, $F(2, 102) = 3.49, p = .034, \eta_p^2 = .06$ (Figure 9c). The follow-up ANOVAs showed a significant main effect of modality for low-anxious performers in the concert condition, $F(1.84, 94.05) = 17.92, p < .001, \eta_p^2 = .03$, and also in the rehearsal condition, $F(2, 102) = 7.44, p < .001, \eta_p^2 = .13$. Post hoc pairwise comparisons revealed that the low-anxious performers appeared to be significantly more anxious in the audio-only condition than in the audiovisual ($p = .001$) and video-only conditions ($p < .001$) when the concert performances were being rated. A similar pattern was found in the rehearsal condition, of which the mean inner state ratings obtained in the audio-only condition were significantly higher than that in the audiovisual ($p = .001$) and audio-only ($p = .043$) conditions. There was also a significant main effect of performing context for the low-anxious performers in the audiovisual condition, $F(1, 51) = 5.32, p = .025, \eta_p^2 = .09$. Post hoc pairwise comparison indicated that the low-anxious performers were perceived as more anxious in concert than in rehearsal performances when audiovisual excerpts were assessed ($p = .025$). The ANOVAs did not reveal any significant main effects of performing context in the audio-only and video-only conditions.

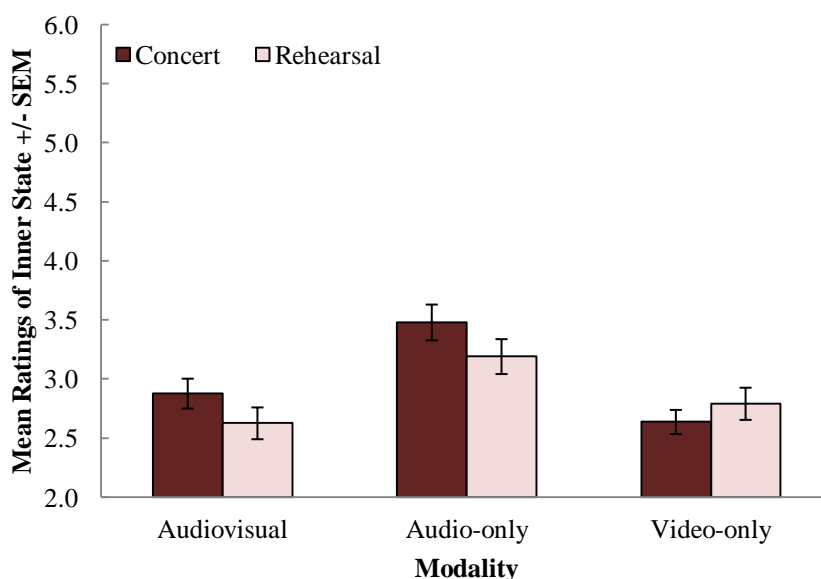


Figure 9c. A two-way interaction in mean inner state ratings in the low-anxious performers, grouped by performing context and modality. Error bars represent SEM.

Performing context and modality

Again, five separate mixed ANOVAs (two on each performance context, and three on each modality) were computed to allow a better understanding of the three-way interaction (Figure 9).

Concert Setting

The ANOVA for concert indicated a significant main effect of anxiety level, $F(1.8, 91.53) = 10.04$, $p < .001$, $\eta_p^2 = .16$, with post hoc pairwise comparisons showing that the high-anxious performers received significantly higher mean inner state ratings than the mid-anxious ($p < .001$) and the low-anxious performers ($p = .032$) in the concert setting. There was also a two-way interaction between anxiety level and modality, $F(3.6, 183.63) = 24.08$, $p < .001$, $\eta_p^2 = .32$ (Figure 9d), in which the follow-up ANOVAs revealed a significant main effect of anxiety level when the concert performances were presented in audiovisual, $F(2,102) = 11.08$, $p < .001$, $\eta_p^2 = .18$, audio-only, $F(2,102) = 15.88$, $p < .001$, $\eta_p^2 = .24$, and video-only manners, $F(2,102) = 23.65$, $p < .001$, $\eta_p^2 = .32$. Post hoc pairwise comparisons revealed that in both the audiovisual and video-only conditions, the high-anxious performers were perceived as significantly more anxious than the mid-anxious ($p < .001$ & $p < .001$ respectively) and the low-anxious performers ($p = .002$ & $p < .001$ respectively). In the audio-only condition, the

low-anxious performers were given significantly higher mean inner state ratings than the high-anxious ($p < .001$) and mid-anxious ($p < .001$) performers. No significant main effect of mid-anxious performers was recorded.

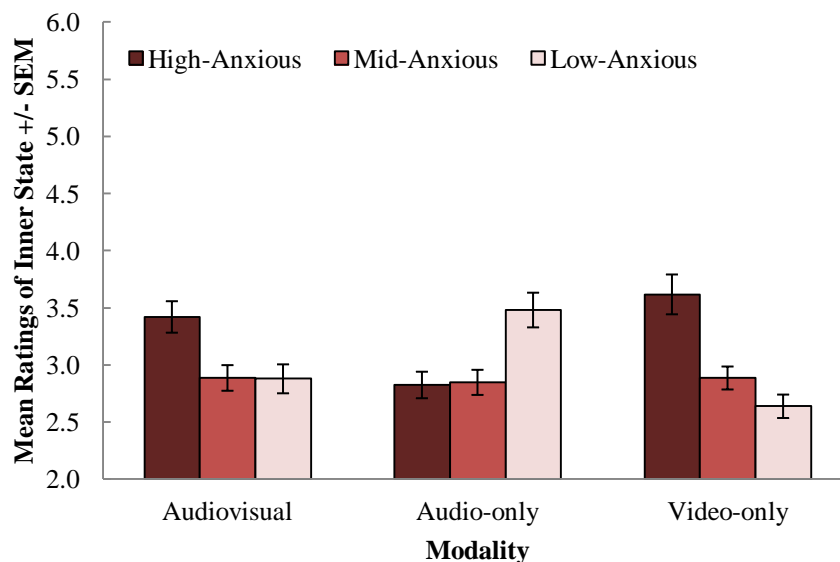


Figure 9d. A two-way interaction in mean inner state ratings in concert setting, grouped by anxiety level and modality. Error bars represent SEM.

Rehearsal Setting

The ANOVA for rehearsal revealed a significant main effect of anxiety level, $F(1.73, 88.2) = 22.97$, $p < .001$, $\eta_p^2 = .31$, in which the post hoc pairwise comparisons indicated that the high-anxious performers were considered as being significantly more anxious in comparison with the mid-anxious ($p < .001$) and the low-anxious performers ($p = .001$), and that the low-anxious performers were rated as significantly more anxious than the mid-anxious performers ($p = .021$). There was also a significant two-way interaction between anxiety level and modality, $F(3.48, 177.61) = 7.62$, $p < .001$, $\eta_p^2 = .29$ (Figure 9e). Significant main effects of anxiety level for rehearsal performances were found in audiovisual, $F(2,102) = 24.65$, $p < .001$, $\eta_p^2 = .33$, audio-only, $F(2,102) = 10.09$, $p < .001$, $\eta_p^2 = .17$, and video-only conditions, $F(2,102) = 14.74$, $p < .001$, $\eta_p^2 = .22$, in the follow-up ANOVAs. Post hoc pairwise comparisons revealed that in the audiovisual condition, a significantly higher mean inner state ratings were given to the high-anxious performers than to the mid-anxious ($p < .001$) and low-anxious ($p < .001$) performers. Similar pattern was found in the video-only condition, although the mean difference between the high-anxious and low-anxious performers was

slightly smaller ($p = .001$). Conversely, the low-anxious performers received significantly higher mean inner state ratings than the mid-anxious ($p < .001$) performers in the audio-only condition. A significant two-way interaction between modality and musical training was also identified, $F(2, 102) = 4.29, p = .009, \eta_p^2 = .09$. The other main effects and interactions were non-significant.

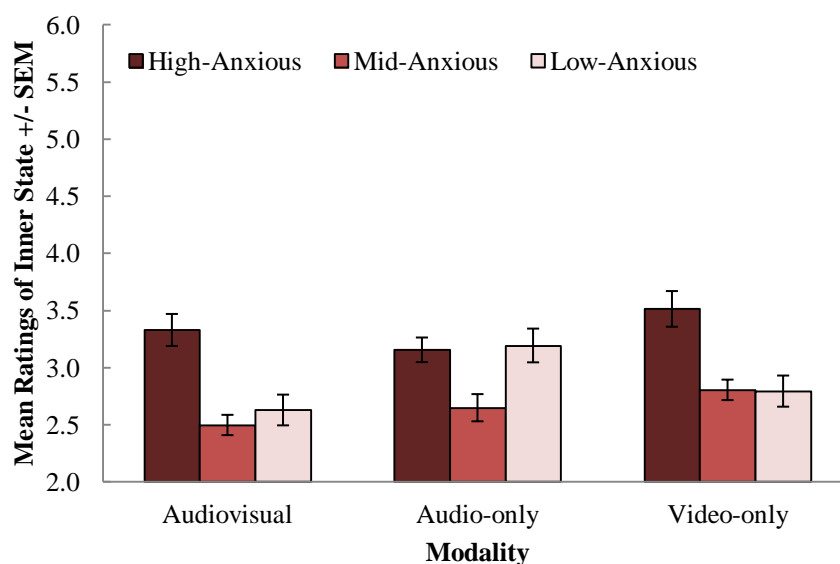


Figure 9e. A two-way interaction in mean inner state ratings in the rehearsal setting, grouped by anxiety level and modality. Error bars represent SEM.

Audiovisual Condition

Again, three separate ANOVAs were carried out on each modality. The ANOVA for audiovisual revealed a significant main effect of anxiety level in the concert condition, $F(2, 102) = 25.85, p < .001, \eta_p^2 = .34$, in which post hoc pairwise comparison indicated a significantly higher mean inner state rating was given to the high-anxious performers than to the mid-anxious ($p < .001$) and low-anxious performers ($p < .001$) when the observers rated the excerpts with the presence of both the auditory and visual cues. A significant main effect of performing context in the audiovisual condition was also recorded, $F(1, 51) = 23.67, p < .001, \eta_p^2 = .32$, in which post hoc pairwise comparison showed that performances in the concert condition were perceived as marginally more anxious than in the rehearsal condition ($p = .05$). There was also a significant two-way interaction between performing context and musical training, $F(1, 51) = 10.3, p = .002, \eta_p^2 = .17$, although it was unrelated to the current analysis. Other main effects and interactions were non-significant.

Audio-only Condition

A significant main effect of anxiety level was reported in the ANOVA for audio-only, $F(2, 102) = 15.57, p < .001, \eta_p^2 = .23$. A significant interaction between anxiety level and performing context was identified in the audio-only condition, $F(1.84, 96.07) = 8.42, p = .001, \eta_p^2 = .14$. Details of the interaction have been accounted for in previous sessions (see Figures 9d & 9e).

Video-only Condition

For video-only, the ANOVA showed a significant simple main effect of anxiety level, $F(1.43, 72.97) = 27.43, p < .001, \eta_p^2 = .35$, but not for performing context. Post-hoc pairwise comparison showed that the high-anxious performers were perceived as significantly more anxious than the mid-anxious ($p < .001$) and low-anxious performers ($p < .001$) when only visual cues were available. Other main effects and interactions were non-significant.

5.2.4 Associations between Expressivity, Performance Quality and Inner State

A Pearson correlation was executed to determine the degree of association between the mean ratings of expressivity, performance quality and inner state. Mean ratings for each performance excerpts were used in the analysis. A significant strong positive correlation was revealed between expressivity mean ratings and performance quality mean ratings, $r(46) = .74, p < .001$, while perceived anxiety was significantly negatively correlated with expressivity, $r(46) = -.48, p < .001$ and performance quality, $r(46) = -.80, p < .001$.

To examine whether the type of presentation manner would affect the associations between the dependent variables, Pearson correlations were computed between the observer's ratings of expressivity, performance quality and inner state under the three modalities across all the performances. Table 5 shows that the correlations are strongly significant between the audiovisual and audio-only conditions across the rating categories, with the correlation between the mean ratings of anxiety-audio and expressivity-audiovisual as an exception. However, the associations between audio-only and video-only conditions are much weaker, especially when the expressive-video condition was compared to the other categories. This may indicate that performers who appear to be expressive do not necessarily sound more

expressive; neither do they perform better in the performances. The observers also did not perceive them as less nervous.

Table 5. Pearson correlations between mean ratings of perceived expressivity, overall and anxiety, under different modalities across performances

	Expressivity			Performance Quality			Perceived Anxiety		
	AV	Audio	Video	AV	Audio	Video	AV	Audio	Video
<i>Expressivity</i>									
AV	-	,63**	,89**	,70**	,50*	,66**	-,57*	-,45	-,52*
Audio		-	,35	,87**	,90**	,51*	-,79**	-,82**	-,73**
Video			-	,43	,19	,70**	-,39	-,09	-,40
<i>Performance Quality</i>									
AV				-	,91**	,58*	-,89**	-,82**	-,78**
Audio					-	,46	-,87**	-,90**	-,78**
Video						-	-,77**	-,31	-,84**
<i>Perceived Anxiety</i>									
AV							-	,72**	,95**
Audio								-	,63**

Note: * $p < .05$ ** $p < .01$.

6 DISCUSSION

The primary goal of this thesis was to investigate the effect of MPA, performing context and modality on ratings of expressivity, performance quality and perceived anxiety, the associations between the dependent variables, and whether observers with different levels of musical training would give ratings differently.

The results revealed some overall patterns. For example, out of the three anxiety groups, the mid-anxious performers were considered as being the most expressive and delivered the performance at highest quality. For the expressivity and performance quality ratings, the observers considered the video-only presentations as less expressive and less favourable than that of the audio-only and audiovisual presentations in general. Regarding ratings of inner state, the high-anxious performers were perceived as more anxious than the mid-anxious and low-anxious performers on the whole. Also, the observers with less musical training rated the performers as more expressive in general than the observers with more musical training. The findings will be discussed in a more specific manner in this chapter.

6.1 Perceived Expressivity

The first objective of the present study was to investigate whether self-reported MPA, performance context and modality would affect ratings on expressivity.

In line with previous findings (Fredrikson & Gunnarsson, 2002; Craske & Craig, 1984, Broughton, 2015), the results illustrated that visual cues could impair perceived expressivity if the performer was anxious. The high-anxious and mid-anxious performers received the lowest mean expressivity ratings in the video-only condition, relative to the audiovisual and video-only conditions, in both concert and rehearsal settings. The similar patterns in expressivity ratings between the high-anxious and the mid-anxious performers could be that according to the preliminary cut-off points proposed by Kenny (2015), the mid-anxious performers were also categorized as anxious musicians, so that they were also vulnerable to the effects of MPA. These findings also support the previous findings that enhanced anxiety can lead to changes in non-verbal behaviours (Endo et al., 2014; Broughton, 2015). From this

perspective, it is possible that anxiety can lead to awkward body movements and rigid posture (Step toe, 2001; Gregersen, 2005), and the constrained movements in the anxious performers affected the performers' ability to express their intended expressivity (Davidson & Dawson, 1995; Thompson & Luck, 2008; Juchniewicz, 2008).

Interestingly, the low-anxious performers were also reported as being significantly more expressive in the audio-only condition than in both the audiovisual and video-only conditions when performed in the rehearsal but not in the concert setting. This is in agreement with the findings by Davidson (2003) that in a normal performance, without manipulating the manner of expression, perceived expressivity was lowered by the presence of visual cues. While the low-anxious performers were supposed to be less prone to the effect of behavioural symptoms of MPA, it is also possible that they were unable to fully express their expressive intention through their body movements when the arousal is low. In fact, the performers across the anxiety groups were recognized as being more expressive in the audio-only condition than the other two conditions in general, when not taking the performing contexts into account. Thus, it is very likely that the absence of visual cues in the audio-only condition forced the observers to focus on the sound quality of the performance (Tsay, 2013), and this may have also explained the findings that the mid-anxious performers were rated as being more expressive than the other two anxiety groups in the audio-only condition in general, but not in the audiovisual and the video-only conditions. Nevertheless, what type of non-verbal behaviour or postures that would have led to the impairment of expressive outcome in these performers remains unknown.

The results have also demonstrated the impact of performance settings and presentation modes on perceived expressivity in the mid-anxious and low-anxious performers. When the observers had access to only either the auditory or the visual cues, the mid-anxious performers were rated as being more expressive in the rehearsal performance than in the concert performance, while the low-anxious performers were rated as being more expressive in the concert performance than in the rehearsal performance. These results are in agreement with the inverted U-shaped theories (Papageorgi et al., 2007; Oxendine, 1980; Wilson, 2002), indicating that extra arousal facilitated performance of non-anxious performers but impaired the performance outcome of the anxious performers.

The differences between expressivity ratings obtained from both the concert and rehearsal settings in the audiovisual and video-only conditions in the mid-performers could be due to the experimental design. In the rehearsal performance, the performers were allowed to re-record their performances within a designated timeframe. This may have facilitated the mid-anxious performers to achieve their optimal arousal as they may have made use of the time to refine their body movements in rehearsal setting, so that the anxiety-related behavioural symptoms were less apparent especially when combined with auditory cues. On the other hand, the performers were only allowed to play the musical work once. The presence of the audience may have also made the mid-anxious performers felt more self-exposed (Miller & Chesky, 2004), hence led to impairment in their expressivity outcome when they performed in the concert setting. Regarding the low-anxious performers, it seemed that they were under-aroused in the rehearsal setting. Nevertheless, the increased arousal induced in the concert setting seemed to be adaptive for them (Wilson, 2002), so that they became more competent in communicating their expressive intentions to the observers. However, what type of non-verbal behaviour or postures that would have led to the differences of perceived expressive outcome in the performers is still in question.

For the high-anxious performers, performance contexts had an effect on the expressivity ratings in the audio-only condition, but not in the conditions where the observers could see the performer's movements. Previous studies have shown that performers can feel anxious even when performing in front of the researcher and a video-recorder (LeBlanc et al., 1997; Osborne & Franklin, 2002). Since the performances in both the concert and rehearsal conditions were recorded with the presence of the researcher, one may postulate that the high-anxious performers felt equally anxious in both the concert and the rehearsal conditions because of trait anxiety, and that the anxiety was manifested through body movements. Thus, it is possible that the anxiety-induced movements produced by the high-anxious performers were apparent in the high-anxious performers across the performance contexts, so that the observers rated them as less expressive when visual cues were present. Trait anxiety had been shown to associate with MPA (Kokostsaki & Davidson, 2003; Osborne & Kenny, 2008). However, the present study did not analyse the scores obtained from the STICSA questionnaires. The next step would be to analyse the data from the questionnaires to further examine the association between state-trait anxiety, K_MPAI scores and expressivity ratings.

6.2 Perceived Performance Quality

The second objective of the present study is to investigate whether self-reported MPA, performance context and modality would affect ratings on performance quality.

The results suggested that performance context did not affect performance quality ratings in the high-anxious and the low-anxious performers. In addition, the performance quality ratings obtained by the low-anxious performers were unaffected by modality, while impaired performance quality was recorded in high-anxious performers in the video-only condition. One of the possible explanations is that the high-anxious performers considered both the concert and the rehearsal setting to be anxiety-inducing, and that the anxiety triggered the behavioural symptoms of MPA. For the low-anxious performers, it is possible that the performance contexts have elicited other MPA symptoms (e.g. physiological & cognitive), but the behavioural symptoms were less perceivable by the observers. In fact, Craske & Craig (1984) and Brotons (1994) have already demonstrated that the different aspects of MPA symptoms could occur separately in non-anxious performers.

The results also revealed that the mid-anxious performers were more vulnerable to the effects of the performing contexts, as they received more favourable ratings in the rehearsal performance than in the concert performance in general. In addition, their rehearsal performances received better performance quality ratings when auditory cues were present. These results confirmed the previous findings that performance context and situational stress can affect performance quality (Craske & Craig, 1984; Miller & Chesky, 2004; LeBlanc et al., 1997; Wilson, 2002), in which excessive arousal can lead to impairment of performance quality (Wilson, 2002). It is also possible that the mid-anxious performers had refined their technique of sound production during the rehearsal performance. However, it is yet to confirm whether the trait and state anxiety scores obtained from the performers can support the current findings.

The results suggested that auditory cues were more important than visual cues in perceiving performance quality in the anxious performers. Both the high-anxious and the mid-anxious performers received lower performance quality ratings in the video-only presentations, while the ratings they obtained from the audiovisual and audio-only conditions were very similar.

This seemed to be consistent with previous findings that ratings for the audiovisual and audio-only presentations were not significantly different from each other (Wapnick et al., 2000; Vuoskoski et al., 2016), and was also partially in line with Tsay's (2013) survey that their participants considered auditory cues as being more important than visual cues in performance assessment. However, it contradicts with other findings that have reported the dominance of visual cues in judgment of performance quality (Tsay, 2013; Lehmann & Davidson, 2002; Ryan & Costa-Giomi, 2004), or findings that have confirmed that audiovisual performances enhance liking of a musical performance (Wapnick et al., 1998; Ryan & Costa-Giomi, 2004; Pope, 2012; Platz & Kopiez, 2012). It could be argued that the visual cues alone did not contain sufficient information about the performance quality when compared with the auditory cues because the present study focused on the effect of anxiety rather than on having the performers intentionally manipulate their level of expressivity on musical performances. When the visual cues were accompanied by the auditory cues, the performance became more interpretable to the observers. Another possible explanation could be that the sound quality of the performances was simply so much more appealing that it led the observers away from focusing solely on the visual cues.

6.3 Perceived Anxiety

The third objective of the present study was to investigate whether self-reported MPA, performance context and modality would affect ratings on perceived anxiety. The results showed that the anxiety of the performers was noticeable in the musical performances. The high-anxious performers were perceived as being more anxious than the mid-anxious and low-anxious performers when visual cues were involved (i.e. in the audiovisual and in the video-only conditions) regardless of performing contexts. This supports the earlier literatures that anxiety could be noticeable through the non-verbal behaviours, (Steptoe, 2001; Valentine, 2002; Williamson, 2004; Pijpers et al., 2004; Broughton, 2015), and that felt emotion could induce changes in the performer's body movement (Van Zijl & Luck, 2012). This result also confirms previous findings that fear can be easily communicated to the observers through visual cues (De Silva & Bianchi-Berthouze, 2004; McDonnell, 2009). Nevertheless, further steps are required to investigate which aspects of non-verbal behaviour contributed to the perception of anxiety, and whether these high-anxious performers displayed limited gestures in comparing with the mid-anxious and low-anxious performers.

The results also revealed that the observers were robust to the effect of performing context when the observers could only see or hear the performance by the mid-anxious performers. However, when the observers could both see and hear the performers, the mid-anxious performers were perceived as more anxious in the concert setting than in the rehearsal setting, suggesting a possible role of auditory cues and reduced arousal in concealing anxiousness from the observers. It is also possible that the mid-anxious performers made use of the time to improve the techniques of sound production in the rehearsal setting, and that the sound quality was enhanced in a way that even the mid-anxious performers were perceived as equally anxious in the video-only condition. Apparently, when the visual cues were combined with auditory cues, the observers were drawn unconsciously to focus exclusively on the auditory cues. However, further research is needed to confirm this finding.

One interesting finding was that the low-anxious performers were perceived as being more anxious than the high-anxious and the mid-anxious performers in the audio-only condition. In contrast to Val Zijl & Luck's (2013) findings, the results of the present study failed to show that experienced emotion of the performer (in this case, anxiety) can be heard from a musical performance. This inconsistency may be due to the acoustic properties of the musical piece chosen by the low-anxious performers, in which the low-anxious performers were so expressive that the emotional characteristics of the music were picked up by the observers in the absence of visual cues. Indeed, the music selected by both the low-anxious pianist and singer were from the classical era, containing acoustic features related to fear, such as staccato articulations & low sound level (Juslin, 2000), which might have conveyed the emotion of fear, more than the music performed by the mid-anxious and high-anxious performers. It could also be argued that the low-anxious performers were visually calm in comparison with the sound they produced. To confirm the current findings, a follow-up study would need to have all the performers playing the same piece of music.

The results also showed that the inner state ratings obtained from the high-anxious and the low-anxious performers in the audiovisual condition were much closer to those obtained in the video-only condition, but not to those obtained in the audio-only condition, implying that visual cues seemed to be more prominent than auditory cues in judging the experienced emotion of the performers. This is consistent with the assumptions that visual cues are important in the emotional perception of musical performances (Chapados & Levitin, 2008),

and the suggestion that audition and vision are transmitted through independent pathways (Vines et al., 2006). However, the inner state ratings for the mid-anxious performers did not reveal this pattern. It may be that the anxiety-related gestures were less apparent in the mid-anxious performers in comparison with the high-anxious performers, and that the musical works chosen by the mid-anxious performers were less expressive of fear. Further investigation is needed to confirm this postulation.

Furthermore, the results revealed that the observers generally rated the performers as being more anxious in the concert setting than in the rehearsal setting, even when the observers have not been told that the excerpts they viewed consisted of performances recorded under two different contexts. This is in line with Broughton's (2015) findings that performing context may manifest the performer's subjective feelings of MPA through their non-verbal behavior. It could also be interpreted by means of musical affordances (Windsor, 2011). In the concert performance, the performers gathered different cues from the audience. This made the performers become more sensitive to situation stress and trait anxiety. It is possible that the anxiety-related musical attributes were exhibited through visual cues and were picked up by the observers in their evaluation of the performer's inner state. To confirm this interpretation, further research would need to investigate which type of cues given by the audience would make the performers feel unease during performance situations.

6.4 Associations between Expressivity, Performance Ratings and Perceived Anxiety

The fourth objective of the current study was to examine whether an association existed between ratings of expressivity, performance quality and perceived anxiety. The results indicated that the more expressive the performer appeared to be, the higher the performance quality ratings the performer would receive. On the other hand, the more anxious the performer appeared to be, the lower the perceived expressivity and the performance quality ratings the performer would get. These results extended the findings of Kubzansky and Stewart (1999), which have shown that performance quality ratings are negatively associated with perceived anxiety. However, the association between felt anxiety and perceived anxiety was not investigated here due to the small sample size of the performers.

Interestingly, the results revealed that looking expressive has no association with sounding expressive in a musical performance, and that vision and sound alone has no association in the assessment of performance quality, thus suggesting that visual cues and auditory cues provided conflicting information to the observers. These findings seemed to be consistent with the earlier studies which suggested that auditory and visual information are transmitted by means of different pathways (Vine et al., 2006). On the other hand, the expressivity ratings and performance quality ratings given by observers in the audiovisual presentations were associated with both the ratings obtained in the audio-only and the video-only presentations. Being consistent with previous findings (Davidson, 1993; Vines et al., 2006; Platz & Kopiez, 2012), the results imply that the combination of visual and auditory cues will facilitate the assessment of musical performances. Furthermore, it seems that both visual and auditory cues are important in perceiving anxiety in the performer, which supports the previous literature that MPA and felt emotions can be communicated to the observers through visual (Williamson, 2004; Craske & Craig, 1984; Broughton, 2015) and auditory channels alone (Van Zijl & Luck, 2013; Vuoskoski et al., 2016).

The results also reflected that visual cues seemed to be more important in recognizing expressivity and anxiety, while auditory cues are more important in assessing performance quality of a musical performance. This confirmed the previous findings that visual cues are dominant in perceiving expressivity (Davidson, 1993, Vuoskoski et al., 2014), and provided new insight on perception of felt emotion in MPA processors, although it did not fully support the previous findings in which visual cues were more important than auditory cues in assessing performance quality (Lehmann & Davidson, 2002; Ryan & Costa-Giomi, 2004; Tsay, 2013). In fact, the current study also demonstrated that visual cues are important in performance quality assessment, but just that the association between audiovisual and auditory cues was found to be somewhat stronger.

The results also suggested that looking anxious would have a negative effect on both expressivity and performance quality ratings regardless of modalities. This supports previous findings that the visual aspects of MPA can potentially impair performance outcome (Craske & Craig, 1984; Williamson, 2004; Fredrikson & Gunnarsson, 1992). Another interesting finding is that looking expressive did not necessarily enhance performance quality ratings, nor would it provide specific information about the inner state of the performer, while the

expressiveness perceived from the auditory cues seemed to be the best indicator of performance quality and perceived anxiety. Further research is needed to confirm these conflicting findings.

6.5 The Effect of Musical Expertise on Judgment of Performances

The fifth objective of the current study is to investigate whether the observer's musical expertise would result in different ratings in expressivity, performance quality and inner state. The results revealed differences between the two observer groups in rating expressivity and performance quality in musical performances.

The observers with more musical training awarded better expressivity ratings to the mid-anxious performers than to the other two anxiety groups. Nevertheless, the observers with less musical training were less judgmental in the way that they rated all the performers as equally expressive. This supported previous literature that musically trained musicians were more critical in assessing performances (Thompson, 2006), and were better at differentiating different levels of expressivity (Bhatara et al., 2011).

In addition, the observers with less musical training were more generous when evaluating the performance quality of the low-anxious performers than the observers with more musical training, while the mid-anxious and the high-anxious performers were assessed in a similar manner in both observer groups. This result tended to support the previous findings that advanced musicians were better at evaluating performance quality (Pope, 2012), had the ability in making conclusive judgments at the early stage of a musical performance (Standley et al., 2002), and were more judgmental in performance evaluation (Thompson, 2006), although this contradicted with Broughton & Steven's (2009) findings. The ratings given by the observers with more training were also in line with the inverted U-shape models that performers with too little or too much arousal could have a detrimental effect in performance outcome (Wilson, 2002). The results also showed that the less musically-trained observers gave higher ratings to the excerpts presented in the audiovisual and audio-only modes than the observers with more musical training. Consistent with Tsay's (2013) argument but inconsistent with Davidson's (2005) findings on expressive intentions, the presence of

auditory cues led the less experienced observers away from the actual performance outcome, while the more musically trained observers were less affected by the auditory cues.

Regarding perceived anxiety, the results did not reveal any significant differences when the performers were observed under different modalities and performance context by the observers with different levels of musical training. This confirmed the assumption by McPherson & Schubert (2004) that general mechanisms were involved in emotion perception in a musical performance.

6.6 Implications

The results presented in this thesis have practical implications for the domains of music performance and music education. The study demonstrated that performers that appear anxious were considered as less favourable in expressivity and performance quality, especially when auditory cues were absent, stressing the importance of vision in performance evaluation. Thus, it is important for the musicians and performers in the performance arts sectors to be aware of the possible impacts of body movement and non-musical attributes, and to manage their anxiety effectively. The findings also implied the anxious musicians may benefit from blind auditions, where the judges will not be able to see the performer, while non-anxious performers may be of advantage in audition settings where the judge can see the performer.

The findings of the current study also implied that performers may respond differently to situational stress. For those musicians who are prone to situational stress, besides seeking treatments for MPA, it may be useful for them to have access to the performing venue and the instrument prior to public performances.

6.7 Limitations and Future Directions

There are a few possible limitations in the present study. For example, previous research has reported that performance evaluations are influenced by the composer's style (Huang & Krumhansl, 2011). Since the excerpts presented consisted of a repertoire of different eras,

one may speculate that the observers may have rated the performances based on their music preferences and their mood. In addition, other factors such as observer's expertise of the instrument (Wapnick et al., 2004; Broughton & Davidson, 2014), the mood of the observer (Västfjäll, 2002), familiarity of the piece (Flôres & Ginsburgh, 1996) and gender (Wapnick et al., 2000) could also affect judgment of performances. The present study did not take into account any of these factors. Future investigations could attempt to recruit participants who play the same instrument as the performer, to limit the selection of repertoire to a certain musical period, and to measure how well the participants know the musical work.

Due to the limited number of performers available in the present study, it is yet to confirm whether all the differences observed between the high-anxious and the mid-anxious performers were due to their performance manner. It is possible that the mid-anxious performers were generally better at communicating expressivity, or they were better technically. To clarify these uncertainties, future studies may try to recruit more performers with similar levels of musical training and to ask the observers to rate the performer's technicality.

Another possible limitation is that some of the observers knew the performers in person. It is possible that the familiarity of the performer could lead to 'in-group' and 'out-group' bias in performance assessment (Manturzewska, 1970, as cited in Davidson & Coimbra, 2001), or it could be that knowing the performer would result in differences in perceived anxiety ratings. Such investigation was not made in the current study due to the small sample size. Since the findings in this area are very limited, further research could examine the effects of familiarity in identifying felt emotions of the performers.

Regarding the experimental design, the observers rated the expressivity, the performance quality and the perceived anxiety concurrently; it is unclear whether the ratings of the expressivity and performance quality had influenced the ratings of perceived anxiety or vice versa in an unconscious manner (Kubzansky & Stewart, 1999). Further research is needed to identify the causation of these dependent variables.

It is also noteworthy that the scores from the STICSA questionnaires and the Rosenberg self-esteem questionnaire were collected but were not analysed at this point. The next step would

be to examine whether there are differences in the state-anxiety, trait-anxiety and self-esteem scores between the three anxiety groups, and whether these dependent variables would affect perception of a musical performance.

Lastly, while the present study confirmed that visual aspects of performance can impair perceived expressivity ratings and the degree of anxiety in high-anxious performers, it is unknown whether and what kind of non-verbal behaviour may have contributed to the perceived anxiety. Future research using advanced technology, such as motion capture or ELAN, to analyse the movement differences across the performers is therefore recommended.

6.8 Conclusion

To conclude, the present thesis has given new insights into the relationship between MPA, performance context, modality and the observers' musical expertise, and the way these factors have influenced performance evaluation in the terms of expressivity, performance quality and anxiety in the performer. This thesis demonstrated that an optimal level of arousal can enhance performance outcome. If the performer is too anxious, it may have detrimental effects on expressivity and performance quality when the observers cannot hear the performers, while non-anxious performers may benefit from extra arousal. The results also provide evidence that visual cues are more dominant in perceiving expressivity and anxiety in the performer, while auditory cues seem to be more important than visual cues in assessing performance quality. Ratings of expressivity, performance quality and perceived anxiety are interrelated with each other. The more anxious the performer is perceived to be visually, the lower the expressivity and performance quality ratings the performer is given, regardless of the mode of presentation. Lastly, it seems that observers with more musical training are better at identifying qualities that contribute to a better performance than the observers with less musical training. These results confirm and extend previous findings in this area, and further highlight the prominent role of both visual and auditory cues in performance evaluation. Follow-up studies are recommended to confirm and extend the current findings.

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APPENDIX 1: Musical Works Selected by the Performers

Performer	Instrument	Composer	Work Title
P1	Voice	Vincenzo Bellini (1801-1835)	Vaga luna che inargenti
P2	Piano	Daniel Steibelt (1765-1823)	Sonatina in B-flat Major, Op.49, No.2 (excerpt) I: Allegro risoluto
P3	Voice	Franz Lehár (1870-1948)	Die lustige Witwe: Vilja-Lied
P4	Piano	Franz Liszt (1811-1886)	Hungarian Rhapsody No.2 in C-sharp Minor, S.244/2 (excerpt) Lento a capriccio - Lasso: andante mesto
P5	Voice	Christoph Willibald Gluck (1714-1787)	Orfeo ed Euridice: Che faro senza Euridice
P6	Piano	Johannes Brahms (1833-1897)	Intermezzo in A Major, Op.118, No.2
P7	Piano	Frédéric Chopin (1810-1849)	Norturne in E-flat Major, Op.9 No.2
P8	Piano	Ludovico Einaudi (1955-)	Monday