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**The relationship between music performance anxiety, subjective performance quality and
post-event rumination among music students**

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Abstract revised

According to cognitive models, negative perception of one's performance and post-event rumination (PER) after stressful social events maintain social anxiety. These aspects have hardly been studied in music performance anxiety (MPA), a specific form of social anxiety.

The first aim of this study was to analyze the development of negative and positive PER over two days following a soloist concert, depending on the usual MPA level. The second aim was to investigate if subjective performance quality serves as mediator between MPA and PER.

Negative and positive PER were assessed ten minutes, one day and two days after a concert in 72 music students with different levels of usual MPA. Subjective performance quality was measured ten minutes after the study concert.

Higher usual MPA level was associated with more negative and less positive PER. Both decreased over time. Negative PER decreased less rapidly in high-anxious than in low-anxious musicians and positive PER decreased more rapidly in low-anxious than in high-anxious musicians. Subjective performance quality mediated the relationship between MPA and PER. These findings extend previous knowledge in social anxiety to the field of MPA and have implications for interventions aiming at reducing MPA.

Social anxiety is described in the DSM-5 (American Psychiatric Association, 2013a, p. 202) as “marked fear or anxiety about one or more social situations in which the individual is exposed to possible scrutiny by others. Examples include social interactions (e.g. having a conversation), being observed (e.g. eating or drinking), and performing in front of others (e.g. giving a speech)”. A significant change in the DSM-5, compared to previous versions of the manual, is that “performance only” has been included as a specifier. The reason for this change is that persons feeling anxious only when performing in front of an audience “appear to represent a distinct subset of social anxiety disorder in terms of etiology, age at onset, physiological response, and treatment response” (American Psychiatric Association, 2013b, p. 6). Performance anxiety can impair the professional life of musicians, dancers, athletes, or people who often have to speak in public (van Kemenade, van Son, & van Heesch, 1995; Studer, Gomez, Hildebrandt, Arial, & Danuser, 2011). When anxiety appears in the context of music performance, the phenomenon is usually called music performance anxiety (MPA) (Kenny, 2010; Kenny & Osborne, 2006).

Kenny (2010, p. 433) describes MPA as “the experience of marked and persistent anxious apprehension related to musical performance [...] which is manifested through combinations of affective, cognitive, somatic and behavioral symptoms”. Research on MPA has increased during the last decades (e.g. Kenny & Osborne, 2006; Osborne & Kenny, 2008; Studer et al., 2011). Lehrer, Goldman and Strommen (1990) found that worry was associated with debilitating stage fright and Kenny (2008) described rumination as being an element of the vicious cycle from the cognitive part of anxiety. However, rumination has not yet been well studied in the field of MPA. Rumination was described by Martin and Tesser (1996) as thinking repeatedly about a theme, even without immediate

environmental demands making the thoughts necessary. In the present paper, we specifically consider post-event rumination (PER) in the context of MPA among music students. PER has been defined as a process of thinking and rethinking about a recent social interaction, including self-appraisal and other elements linked to the event (Kashdan & Roberts, 2007). Post-event rumination has been identified as a core feature of social anxiety disorder (Abbott & Rapee, 2004; Kocovski, Endler, Rector, & Flett, 2005; Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008), and Fehm, Schneider and Hoyer (2007) found that social situations were more likely to be followed by negative rumination than other phobic situations. In light of this evidence, PER might be an important dimension in MPA as well and deserves further attention.

Following the cognitive models of social anxiety from Rapee and Heimberg (1997) and Clark and Wells (1995), the negative perception of one's performance and the tendency to ruminate after a stressful social event maintain the social anxiety and the negative image about oneself and about social interactions. Clark and Wells (1995, p.74) specify that "the patient's anxious feelings and negative self-perception are likely to figure particularly prominently because they were processed in detail while the patient was in the situation and hence strongly encoded in the memory". Lundh and Sperling (2002) followed college students by using a diary method after a negative social event. They found that the most socially anxious participants showed more negative PER during two days following a negative social event. This tendency was stable over two consecutive days. Furthermore, the link between social anxiety and negative PER has been shown to be mediated by the subjective performance quality in the context of a speech task (Perini, Abbott and Rapee, 2006).

To our knowledge, few studies have investigated positive PER after a social event (Abbott & Rapee, 2004; Kocovski, MacKenzie, & Rector, 2011). Abbott and Rapee (2004) analyzed both negative and positive PER in a group of people suffering from social phobia and healthy participants one week after a speech task. They found a significant difference between the two groups for negative PER but no difference for positive PER. Contrary to Abbott and Rapee (2004), Kocovski et al. (2011) found that low socially anxious participants showed more positive thoughts than high socially anxious ones with respect to a speech task that took place one week earlier. Furthermore, the most anxious participants had more positive PER when they were exposed to distraction after the stressful event than when they were not. As negative and positive PER might coexist, both forms of PER should be addressed when studying the link between PER and MPA.

Therefore, this study focuses on negative and positive PER in the context of MPA and on subjective performance quality as potential mediator between MPA and negative and positive PER. The first aim was to analyze the development of negative and positive rumination in performing musicians over two days following a soloist concert, according to the usual MPA level. Firstly, we hypothesized that increasing levels of MPA would be associated with more negative and less positive PER. Secondly, we expected that negative PER decreases less rapidly and positive PER more rapidly when the level of MPA increases. As the temporal course of PER has not been assessed yet, we treated the question of whether PER change over time differently depending on usual MPA level as an exploratory issue. The second aim was to investigate the role of subjective performance quality in MPA and PER. We hypothesized that the subjective performance quality serves as mediator between MPA and negative and positive PER.

Methods

Data presented here were collected as part of a larger field study on MPA investigating both psychological and physiological variables (e.g. cortisol and alpha-amylase levels during the day, actigraphy and ECG during the night).

Participants

The initial sample consisted of 90 performing musicians, of which 18 had to be excluded because they did not meet the inclusion criteria (see below). The final sample consisted of 72 musicians from the Swiss Music Universities of Lausanne, Genève, Lausanne, Geneva, Sion, Zurich and Basel. Participants' age ranged from 18 to 30 years, with a mean of 22.7 years ($SD = 3.0$) and 67 % were women. Furthermore, 31.9 % of the students were studying in the first academic year, 20.8 % in the second, 16.7 % in the third, 12.5 % in the fourth, 4.2 % in the fifth and 13.9 % in the sixth or seventh year. The Swiss Music Universities follow the Bologna Process, which includes three cycles: the Bachelor studies (generally three years), the Master studies (generally two years) and the doctoral studies (minimum of three years). The instrument types were strings (31.9 %), woodwind (27.8 %), singing (16.7 %), piano (11.1 %), brass (9.7 %) and miscellaneous (2.8 %).

The study was approved by the local ethics committee, and all students gave their informed consent to participate. To thank the participants, we remunerated them with 500 Swiss Francs at the end of the study.

Procedure

Recruitment

As a first step, musicians were recruited through flyers and word of mouth by professors and students at different Swiss Music Universities. Interested musicians contacted the first author. They were sent an electronic link containing recruitment questionnaires, demographic and academic data (see below for description). Interested musicians were asked to report any endocrinologic or cardiovascular diseases. Furthermore, we assessed depression, panic disorder, generalized anxiety disorder, bulimia, binge eating disorder and alcohol abuse with the Patient Health Questionnaire (PHQ; Spitzer, Williams, Kroenke, Hornyak, & McMurray, 2000). Given that we were interested in psychological and physiological manifestations of MPA, which might be affected by endocrinologic, cardiovascular or severe psychiatric disorders, students who indicated suffering from one of these conditions were excluded (except for panic or generalized anxiety disorder, which can be related to MPA). Also students who indicated using psychoactive drugs or other medication with effects on the central and autonomic nervous systems, the cardiovascular system or the endocrine system were excluded for the same reason. Also wearing a pacemaker, participating in night shift work, being pregnant or lactating were considered as exclusion criteria due to their potential influence on physiological variables.

Pre-experimental phase

Students that met inclusion criteria were sent a new electronic link one week before the beginning of the experimental phase, containing trait questionnaires on rumination and worry habits, perfectionism and depression.

Experimental phase

The experimental phase consisted of a concert day and the two days following the concert (called thereafter “study concert”). The participants had no other solo performances four

days before and two days after the study concert, in order to avoid biases in the results due to other stressful music events not linked to the study.

A total of 13 study concerts were organized between 3 p.m. and 7 p.m. with four to six students per concert. The audience was composed of 10 to 15 persons ($M = 12.6$, $SD = 1.4$)¹, not known by the musicians. Participants were told that these people were music connoisseurs. All musicians were asked to choose one or several musical pieces (5-10 minutes in total) that they had not yet fully mastered and that they were practicing during the given time period with their teacher. Participants were allowed to be accompanied by a pianist when the musical pieces required it. Each student performed once.

All participants followed the same procedure: they entered the concert room, performed during 5-10 minutes, left the room, waited for 10 minutes outside of the room and filled in the post-performance questionnaires. These assessed their subjective performance quality, the similarity between the study concert and their usual performances as soloist, their commitment to their performance and their negative and positive PER related to the study concert (with the reference period “since the end of the concert”). The performances were video recorded. The audience was instructed not to interact with the musicians before and after the study concert. The musicians were not allowed to speak to each other before finishing the questionnaires. In the evening (at 9 p.m.) of each of the two days immediately following the study concert, participants reported again their PER (with the reference period “during the last 24 hours”).

Measures

¹ The time of concert and the audience size did not differ as a function of usual MPA level and did not influence our main outcome variables.

The recruitment and inclusion questionnaires were administered via an online questionnaire using the software EFS Survey (©UNIPARK & QuestBack, Germany). During the experimental phase, the students filled in questionnaires with an iPod touch 5 (© Apple) using iDialogPad developed by Gerhard Mutz at Cologne University, Germany.

MPA

We measured usual MPA level during the recruitment phase with the State-Trait Anxiety Inventory (state form, STAI-S; Spielberger, 1983) and adapted the instructions to a soloist music performance as done previously (e.g. Studer et al., 2011). This questionnaire contains 20 items assessing apprehensive feelings of anxiety, each scored from 1 “not at all” to 4 “very much” (e.g. I am worried). The total score can vary between 20 (no anxiety) and 80 (extreme anxiety). We used the French version (Spielberger, Bruchon-Schweitzer, & Paulhan, 1993) and the German version (Laux, Glanzmann, Schaffner, & Spielberger, 1981) of the STAI-S. The internal consistency (Cronbach’s alpha) for this questionnaire was very good (.93)² and similar to Spielberger’s validation study (1983; alphas higher than .90).

Post-event rumination

Post-event rumination was assessed with an adapted version of the Thoughts Questionnaire (TQ) from Abbott and Rapee (2004). The TQ assesses the rumination frequency following a social speech task and contains 24 items rated on a five-point rating scale ranging from 0 “never” to 4 “very often”. We replaced the word “speech” in the instructions and items with “concert”. Furthermore, as the questionnaire was originally used for a one-week period, we changed the instructions from “during the past week” into “since the end of the

² As the number of German speaking participants was very low (10), we only calculated the Cronbach’s alphas for the 62 French speaking participants.

concert” (first assessment) and “during the last 24 hours” (second and third assessments). We adapted the original answer options (“never” to “very often”) to “not at all” to “extremely”. The questionnaire is divided in 9 positive items (e.g. My concert was good) and 14 negative items (e.g. I made a lot of mistakes). The last item (“I wonder what the raters thought of my concert”) was neither negative nor positive and was, thus, eliminated. The positive items score varies from 0 (no positive PER) to 36 (a lot of positive PER) and the negative items score varies from 0 (no negative PER) to 56 (a lot of negative PER). The French and the German versions were translated from the English version and back translated by the authors. The internal consistencies were excellent for both negative (.93) and positive scales (.93) and very similar to Abbott and Rapee (2004)’s alphas (negative: .94, positive: .95).

Subjective performance quality

Musicians judged their performance on eight dimensions ranging from 0 (very bad) to 30 (excellent). Inspired by Ryan’s scale (1998), we assessed the following dimensions: technique, rhythm, musicality, interpretation, tempo, ability to sing/play on pitch (does not apply for pianists and accordionists), tone quality and a global mark. For the analyses, we computed the average of these 8 items. We obtained a Cronbach’s alpha of .88.

Social anxiety

Social anxiety was assessed with the Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987). The LSAS is a 24-item scale, assessing the anxiety induced by a social interaction situation (12 items, e.g. Calling someone you don’t know very well) and by a performance situation (12 items, e.g. Acting, performing or giving a talk in front of an audience) during the last week. Furthermore, the avoidance of the situation experienced during the last week is assessed for the 24 items. The anxiety scale answers are 0 “none” 1 “mild” 2 “moderate”

or 3 “severe” and the avoidance scale answers are 0 “never” 1 “occasionally” 2 “often” or 3 “usually”. The final score used for the analyses results from adding up the scores of both anxiety and avoidance scales and varies between 0 (no social anxiety) and 144 (extreme social anxiety). The French version was validated by Yao et al. (1999), and the German version was translated by Stangier and Heidenreich (2003). The internal consistency was very good (.94). In their validation study, Heimberg et al. (1999) found a similar alpha (.96).

Rumination habits

To assess the perseverative thinking habit of the participants, we used the Perseverative Thinking Questionnaire (PTQ; Ehring et al., 2011), containing 15 items related to the thinking habit about negative experiences or problems (e.g. The same thoughts keep going through my mind again and again). The scale is a 5-point scale ranging from 0 “never” to 4 “almost always”. The total score results from adding up the 15 responses and varies between 0 (no perseverative thinking) and 60 (a lot of perseverative thinking). The French version was translated from German and back translated by the authors. We obtained a very good internal consistency (.92), which was similar to what Ehring et al. (2011) obtained in their validation study (.94 for a non-clinical sample; .95 for a clinical sample).

Worry habits

We assessed the tendency to worry with the Penn State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990), containing 16 items, each scoring from 1 “not at all typical of me” to 5 “very typical of me” (e.g. Many situations make me worry). The total score, which is the sum of the 16 items, varies between 16 (low worry) and 80 (high worry). We used the French version from Gosselin, Dugas, Ladouceur and Freeston (2001)

and the German version from Stöber (1995). The Cronbach's alpha was very good (.91) and similar to what Meyer et al. (1990) obtained (.93).

Perfectionism

The Frost Multidimensional Perfectionism Scale (FMPS; Frost, Marten, Lahart, & Rosenblate, 1990) contains 35 items (e.g. It is important to me that I am thoroughly competent in everything I do) and measures six perfectionism dimensions: Concern over Mistakes, Personal Standards, Parental Expectations, Parental Criticism, Doubts about actions and Organization. The items are coded from 1 "strongly disagree" to 5 "strongly agree". The total score can be calculated by adding up the dimensions (excluding the organization dimension) and varies between 29 (low perfectionism level) and 145 (high perfectionism level). The French version was validated by Rhéaume et al. (1994) and the German version by Stöber (1998). The Cronbach's alpha for this scale was good (.87). In their validation study, Frost et al. (1990) reported a very good internal consistency (.90).

Depression

We assessed the current depression state with the Beck Depression Inventory (BDI; Beck, Steer, Ball, & Ranieri, 1996). The BDI is a unipolar questionnaire assessing depression with 21 items, each containing four sentences, coded from 0 (less close to depression, e.g. I do not feel sad) to 3 (closest to depression, e.g. I am so sad or unhappy that I can't stand it). The total score can be calculated by adding up the score for each item (0 to 63). The French version was from Bourque and Beaudette (1982) and the German version from Hautzinger, Keller and Kühner (2006). The internal consistency for the BDI was satisfactory (.78). Beck et al. (1996) obtained a Cronbach's alpha of .91.

Similarity of study concert to usual performances

Participants rated the similarity of the study concert to usual performances as soloists on a scale ranging from 1 “not at all similar” to 11 “very similar”.

Commitment during study concert

Participants judged their commitment during the study concert on a scale ranging from 1 “not at all committed” to 11 “extremely committed”.

Statistical analyses

All statistical analyses were performed with STATA 14 (©1996–2015 StataCorp LP). We set the significance level at .05 for all statistical tests.

First, we carried out descriptive analyses with demographic and academic data (see the Methods/Participants part), similarity of study concert to usual performances and commitment during study concert. Then, we carried out correlation between the academic year, age, gender, similarity between the study concert and usual performances, commitment in the study concert, negative and positive PER, subjective performance quality, usual MPA level, LSAS, PSWQ, PTQ, FMPS and BDI. For the correlation and regression analyses, we used the usual MPA level as continuous variable. In order to obtain a better visual comprehension of the results, we split the participants in three anxiety groups for the tables and figures shown below. They were obtained by dividing the 72 participants in tertiles on the basis of their usual MPA level: the low-anxious (20-43, n=24), moderate-anxious (44-55, n=26) and high-anxious (56-80, n=22) musicians. As four musicians obtained the score of 55, the moderate- and high-anxious musicians could not be split in two equal groups.

For the first aim, i.e. to analyze the development of negative and positive rumination over two days following the study concert, according to the usual MPA level, we carried out linear mixed regression analyses fitted using restricted maximum-likelihood acknowledging between-day heteroskedasticity. The predicted variables were negative and positive PER. We tested the model including a random intercept for each participant and two fixed effects for the factors of main interest usual MPA level and measurement time (i.e. 10 minutes, one day and two days after the study concert). The interaction between measurement time and usual MPA level was also tested.

For the second aim, i.e. to determine if subjective performance quality serves as mediator between MPA and negative and positive PER, we followed the model suggested by Baron and Kenny (1986). The measurement time variable was always included in the mediation analyses. The first step consists in investigating the overall link between the predictor (i.e. MPA) and the outcome (i.e. negative and positive PER, respectively), tested with a linear mixed model. The second step of the mediation analysis is to analyze the relation between the predictor and the mediator (i.e. subjective performance quality), tested with a simple linear regression. The third step is to assess the joint effect of the mediator and the predictor on the outcome, tested with a linear mixed model. The investigated link between predictor and outcome and the link between predictor and mediator should be significant. Mediation is complete if the link between the predictor and the outcome variable is not anymore significant when controlling for the mediator, whereas the link between the mediator and the outcome remains significant when controlling for the predictor. In a sensitivity analysis, we also controlled for age, gender and academic year in the mediation analyses, as well as LSAS, PSWQ, PTQ, BDI and FMPS scores. From these analyses, we

obtained the estimated mediation proportion of the subjective performance quality on the link between MPA and negative and positive PER. In order to obtain the confidence intervals of these mediated proportions, we used the bootstrap method as suggested by Preacher and Hayes (2004).

Results

The means and standard deviations of negative and positive PER for each measurement time and anxiety group can be found in Table 1.

[Insert Table 1 about here]

The means and standard deviations of all other assessed main variables are given in Table 2.

[Insert Table 2 about here]

The correlation matrix of all assessed variables is shown in Table 3.

[Insert Table 3 about here]

Development of negative and positive PER over two days

The graphic representations of the development of negative and positive PER by anxiety group are given in Figures 1(a) and 1(b), respectively.

As hypothesized, the main effects of the usual MPA level and measurement time on negative PER were both significant³. Negative PER increased with increasing usual MPA level ($\beta = .44$, $SE = .09$, $p < .001$). Furthermore, compared to the situation ten minutes after the study concert, negative PER decreased significantly after one day ($\Delta = -3.92$, $SE = .77$, $p < .001$) and also from one day to two days after the concert ($\Delta = -1.87$, $SE = .79$, $p < .05$).

The interaction effect between assessment time and usual MPA level was significant ($p < .05$) when taking into account heteroskedasticity, which was significant at $p < .001$ (10 minutes after the study concert, $var = 43.53$; one day after the study concert, $var = 3.76$; two days after the study concert, $var = 12.13$). This means that the development of

³ When controlling for academic year, gender, LSAS, PSWQ, PTQ, FMPS and BDI, the results did not change.

negative PER varied in relation to the usual MPA level, as expected. To interpret this significant interaction, we carried out pairwise comparisons of the estimated marginal means between the assessment times across each anxiety group and between the three anxiety groups across each measurement day. To counteract the problem of multiple comparisons, we used Holm's multistage procedure (Holm, 1979). Negative PER did not significantly decrease between 10 minutes and one day after the study concert for the high-anxious musicians ($\Delta = -1.39$, $SE = 1.50$, $p = .36$), contrary to the moderate-anxious ($\Delta = -5.41$, $SE = 1.36$, $p < .001$) and the low-anxious musicians ($\Delta = -4.43$, $SE = 1.41$, $p < .05$). The decrease in negative PER between one day and two days after the study concert was significant for the high-anxious ($\Delta = -3.34$, $SE = .97$, $p < .05$), but not for the moderate-anxious ($\Delta = -1.91$, $SE = .85$, $p = .17$) nor for the low-anxious musicians ($\Delta = -1.07$, $SE = .86$, $p = .43$). The high-anxious group reported significantly more negative PER when compared to the low-anxious group at each measurement time ($ps < .01$), and significantly more negative PER when compared to the moderate-anxious group at one and two days after the study concert ($ps < .05$).

[Insert Figures 1(a) and 1(b) about here]

As hypothesized, the main effects of the usual MPA level and measurement time on positive PER were both significant. Positive PER decreased with increasing usual MPA level ($\beta = -.27$, $SE = .06$, $p < .001$). Furthermore, compared to the situation ten minutes after the study concert, positive PER decreased significantly after one day ($\Delta = -4.06$, $SE = .64$, $p < .001$) and also from one day to after the concert two days ($\Delta = -2.17$, $SE = .66$, $p < .01$). We found a significant interaction effect for positive PER between the measurement time and the usual MPA level ($p < .05$). To interpret this interaction, we performed the

same follow-up pairwise comparisons, as we did for negative PER. The difference between the high-anxious and the low-anxious musicians became smaller over time (Figure 1(b)). The low-anxious musicians reported more positive PER than the high-anxious musicians ten minutes and one day after the study concert ($ps < .05$), but not two days after the study concert ($p = .30$). The differences between the high-anxious and the moderate-anxious musicians, as well as the differences between the low-anxious and the moderate-anxious musicians were not significant ($ps > .11$) at any measurement time.

Concerning the comparisons across measurement times, the decrease of positive PER from ten minutes to one day after the study concert was significant for the low-anxious musicians ($\Delta = -5.24, SE = 1.04, p < .001$) and the moderate-anxious ($\Delta = -3.82, SE = 1.00, p < .001$), but not for the high-anxious ones ($\Delta = -2.94, SE = 1.14, p = .10$). Finally, the decrease from one day to two days after the study concert was significant for the low-anxious musicians ($\Delta = -4.24, SE = 1.06, p < .001$), but not for the moderate-anxious ($\Delta = -.74, SE = 1.04, p = .95$) and the high-anxious musicians ($\Delta = -1.43, SE = 1.18, p = .68$).

Mediation analyses

Negative Post-Event Rumination

To verify our second hypothesis, we analyzed the potential role of subjective performance quality as a mediator between MPA and negative PER. Given that negative PER decreased over time (see above), assessment time was controlled for in all analyses concerning mediation. We analyzed the three paths needed to do a mediation analysis. Firstly, the usual MPA level was positively and significantly linked to negative PER ($p < .001$).

Secondly, the usual MPA level and the subjective performance quality showed a negative and significant link ($p < .001$). Thirdly, the link between the subjective performance quality and negative PER was negative and significant ($p < .001$) when controlling for MPA. Therefore, all the prerequisites for the mediation analysis are met. Figure 2 shows the regression coefficients.

[Insert Figure 2 about here]

Finally, when controlling for the mediator variable, i.e. subjective performance quality, the relationship between usual MPA level and negative PER became smaller and less significant ($p < .05$), showing that subjective performance quality served as mediator between usual MPA level and negative PER. Furthermore, the estimated mediated part was 59% with a bootstrap 95% confidence interval of [27%; 91%].

Sensitivity analysis showed that perfectionism played a role in the mediation, that is, there was a significant positive link between perfectionism and negative PER when controlling for MPA and subjective performance quality. Importantly, this effect of perfectionism did not significantly change the associations between our main variables. The other covariables had no significant link with negative PER when controlling for MPA and subjective performance quality. When including all the covariables (gender, age, academic year, rumination and worry habits, social anxiety, perfectionism and depression), the coefficients in the three paths and hence the percent mediated were not changed. This suggests that these covariables did not confound the shown relationships. However, due to the reduced numbers of degrees of freedom induced by these multiple covariables, the bootstrap-based

confidence interval of the estimated mediated part is consistent with an absence of mediation when considering simultaneously all the covariables.

Positive Post-Event Rumination

As for negative PER, the usual MPA level, the subjective performance quality and the measurement time were included in the basic mediation analysis for positive PER. The negative association between MPA and positive PER was significant ($p < .001$). The relation between MPA and the subjective performance quality remained the same as reported for negative PER. Also the positive association between the subjective performance quality and positive PER was significant ($p < .001$) when controlling for usual MPA level. All the prerequisites for the mediation analysis are also met for positive PER. Figure 3 shows the regression coefficients.

[Insert Figure 3 about here]

Finally, when controlling for the mediator variable, i.e. subjective performance quality, the negative link between MPA and positive PER became smaller but the significance level remained unchanged ($p < .001$) showing that subjective performance quality partially served as mediator between the usual MPA level and positive PER. The estimated mediated part was 38% with a bootstrap 95% confidence interval of [20%; 55%]. The inclusion of the covariables (gender, age, academic year, rumination and worry habits, social anxiety, perfectionism and depression) did not qualitatively alter the three paths and did, thus, not change the basic model. The estimated mediation was still significant.

Discussion

The first aim of this study was to test the development of post-event rumination in musicians over two days following a soloist concert, in relation to the usual MPA level. As hypothesized, the high-anxious music students showed more negative and less positive rumination than the low-anxious music students after a 10-minute solo performance. This finding supports Clark's and Wells' (1995) and Rapee's and Heimberg's (1997) models of social anxiety, according to which socially anxious people tend to ruminate more negatively after a stressful social event than non-anxious people. In our study, usual MPA level and social anxiety assessed with the LSAS were only weakly related to each other, and both negative and positive PER were related to MPA but not to LSAS scores (see Table 2). This supports the idea that MPA is a very specific form of social anxiety confined to performance situations without affecting other social situations. This result also extends previous findings focusing mainly on negative PER (Lundh & Sperling, 2002; Perini et al., 2006) to positive PER and their link with MPA. In line with Clark's and Wells' model (1995), the high-anxious musicians probably focus in detail on the negative aspects of their performance, which are more likely to be remembered than the good aspects.

As hypothesized, the development pattern for negative PER was dependent on the usual MPA level. Negative PER significantly decreased between ten minutes and two days after the study concert for each anxiety group to a similar degree. Yet, the high-anxious musicians showed a less rapid decrease of negative PER than the low- and moderate-anxious ones. Specifically, among the low- and moderate-anxious musicians, the already smaller negative PER compared to the high-anxious musicians just after the study concert

decreased to a large proportion within the first day. On the contrary, among the high-anxious musicians the higher negative PER compared to the low- and moderate-anxious musicians just after the study concert persisted at a similarly high level during the first day and only significantly decreased during the second day after the study concert. Similar to the results for negative PER, positive PER also significantly decreased between ten minutes and two days after the study concert, and the temporal development was different depending on the usual MPA level. The low-anxious musicians had more positive PER immediately after the study concert as compared to the high-anxious musicians, decreased more strongly over time and the difference between the low-anxious and the high-anxious became smaller and non-significant two days after the study concert. Both negative and positive PER significantly decreased two days after the concert for each anxiety group. Given that the low- and high-anxious musicians still differed with respect to negative PER after two days, it would be interesting to analyze their development over a longer time period to determine how many days are necessary for the musicians to stop ruminating after the concert. With respect to positive PER, we found that the difference between the low- and high-anxious musicians was not significant anymore two days after the concert. This means that the low-anxious musicians do not ruminate positively more than the high-anxious ones after a longer time period and reduce positive PER rapidly.

The study concert was not part of the students' curriculum and its outcome did not directly impact their studies or career. Still, the similarity rating between the study concert and usual soloist performances was relatively high, and the concert was the same for each participant, which is an advantage and allowed us to standardize the procedure. Future studies might want to analyze negative and positive PER in different performance situations.

The second aim was to investigate if the subjective performance quality mediated the link between MPA and negative and positive PER. Our results show that the subjective performance quality was indeed a partial mediator in these relationships. A higher subjective performance quality was associated with lower negative PER and higher positive PER. As the subjective performance quality seems to play an important role in the negative and positive PER mechanism, reducing MPA could be possible by working on the perception of one's performance, e.g. by combining a realistic judgment of video recording with a professional music coach.

As described in the cognitive models of social anxiety by Clark and Wells (1995) and Rapee and Heimberg (1997), PER, subjective performance quality and social anxiety strongly influence each other, like a vicious cycle. This model can be extended to MPA. In order to help musicians reduce their MPA, it would be wise to break this vicious cycle. Working on PER (e.g. cognitive behavioral treatment) could help reducing MPA before future concerts. Blackie and Kocovski (2016) assessed participants' PER after a speech task and divided them randomly into three groups: rumination, distraction and control group. They found that a distraction task right after the speech task helped reducing anticipatory anxiety, via PER, before a second speech task. Future research might want to measure PER between two concerts and to investigate whether PER following the first concert predicts MPA before the second concert. Another way of reducing negative PER could be to use constructive self-instruction techniques, as did Hildebrandt and Nübling (2004) and Hildebrandt (2009). They offered courses to the musicians and their teachers with specific techniques focusing on practical aspects, e.g. focusing on clear initiation points in kinetic chains and directly tangible solution strategies instead of analyzing problems when playing/singing. These techniques seem to help reducing the anxiety level

(Hildebrandt & Nübling, 2006) and might help reducing rumination as well, although this remains to be tested in future research. Performers' own judgment of performance quality and PER could also be influenced by the way of hearing and remembering the own sound while playing (Brodsky, Sloboda, & Waterman, 1994, Hildebrandt 2010, 2015).

Interestingly, Studer, Danuser, Wild, Hildebrandt and Gomez (2014) reported similar correlations between usual MPA level and self-perceived performance quality as in the present study not only during a public performance but also during a private performance (i.e., without an audience) suggesting that the link between usual MPA level and self-perceived performance quality may only weakly depend on situational factors such as the presence of an audience. Thus, the observed relationships between MPA, self-perceived performance quality and negative and positive PER may be pervasive across performance situations and in particular may be present during practicing and rehearsing. If this is confirmed in future research, practice and rehearsal situations might be critical in creating and maintaining a vicious cycle between MPA, subjective performance quality and negative and positive PER among the most anxious music students.

According to Brosschot, Pieper and Thayer (2005), perseverative cognition (e.g. worry, rumination) might prolong the physiological response to a stressor and might lead to psychosomatic disorders (e.g. somatic complaints, cardiovascular diseases, poor sleep quality). High-anxious musicians who show relatively high and prolonged levels of negative PER might be at higher risk for developing such disorders as compared to low-anxious musicians. This remains to be investigated.

In conclusion, our results extend previous research on the link between social anxiety and post-event rumination and the role of the subjective performance quality as mediator to the

field of music performance anxiety. These results have implications for the comprehension of MPA and for interventions aiming at reducing it.

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Table 1. Means (standard deviations) of negative and positive PER for each assessment time, by anxiety group and overall

	Negative PER			Positive PER		
	+ 10 min.	+ one day	+ two days	+ 10 min.	+ one day	+ two days
Low-anxious (N = 24)	8.3 (8.6)	3.8 (3.7)	2.6 (4.2)	18.5 (7.3)	13.0 (8.8)	9.5 (9.6)
Moderate-anxious (N = 26)	14.7 (9.4)	9.4 (6.8)	7.4 (7.7)	13.6 (6.8)	9.5 (6.3)	8.3 (7.5)
High-anxious (N = 22)	21.4 (11.8)	20.5 (13.8)	16.4 (14.5)	9.2 (5.0)	6.2 (4.5)	4.5 (4.0)
Overall (N = 72)	14.6 (11.1)	10.6 (10.9)	8.3 (10.8)	13.9 (7.4)	9.7 (7.3)	7.6 (7.7)

Note: PER = post-event rumination

Table 2. Means (standard deviations) of the main variables for each anxiety group and overall

	Low-anxious (N = 24)	Moderate-anxious (N = 26)	High-anxious (N = 22)	Overall (N = 72)
Similarity	7.1 (2.6)	8.2 (2.8)	7.6 (2.4)	7.6 (2.7)
Commitment	8.9 (1.3)	8.4 (2.2)	8.0 (2.3)	8.4 (2.0)
STAI-S	36.5 (4.2)	49.4 (4.0)	64.0 (4.1)	49.6 (11.7)
LSAS	26.5 (17.7)	34.6 (15.8)	42.2 (26.7)	34.3 (21.2)
PSWQ	40.5 (8.3)	48.8 (8.7)	60.9 (9.5)	49.7 (12.0)
PTQ	21.0 (9.8)	28.9 (7.9)	32.9 (11.2)	27.5 (10.8)
FMPS	72.7 (18.2)	80.9 (14.7)	87.1 (11.2)	80.0 (16.1)
BDI	3.8 (4.6)	7.0 (5.0)	7.8 (4.5)	6.2 (5.0)
SPQ	22.0 (3.1)	20.5 (2.7)	17.9 (5.0)	20.2 (4.0)

Note: Similarity = similarity between the study concert and usual performances; Commitment = commitment in study concert; STAI-S = State-Trait Anxiety Inventory-State; LSAS = Liebowitz Social Anxiety Scale; PSWQ = Penn State Worry Questionnaire; PTQ = Perseverative Thinking Questionnaire; FMPS = Frost Multidimensional Perfectionism Scale; BDI = Beck Depression Inventory; SPQ. = subjective performance quality

Table 3. Pearson correlation matrix between academic year, gender, similarity, commitment, negative and positive PER, subjective performance quality, MPA, social anxiety, worry habits, rumination habits, perfectionism and depression

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1. Academic year	-																
2. Gender	-.08	-															
3. Similarity	.06	-.18**	-														
4. Commitment	.06	-.00	.01	-													
5. Neg PER 0	-.32**	.08	.15*	-.33***	-												
6. Neg PER 1 day	-.24	.09	.10	-.25***	.80***	-											
7. Neg PER 2 days	-.20	.23**	.12	-.23**	.80***	.93***	-										
8. Pos PER 0	-.00	-.01	-.08	.32***	-.49***	-.42***	-.33**	-									
9. Pos PER 1 day	.02	.12	.09	.30***	-.52***	-.35**	-.27*	.78***	-								
10. Pos PER 2 days	.03	.15*	.11	.24***	-.32**	-.22	-.10	.67***	.81***	-							
11. SPQ	.14	-.02	-.01	.40***	-.72***	-.67***	-.66***	.63***	.63***	.43***	-						
12. STAI-S	-.10	.16*	.03	-.19**	.42***	.57***	.48***	-.55***	-.43***	-.34**	-.44***	-					
13. LSAS	-.05	.27***	-.02	.02	.15	.16	.11	-.04	-.04	.05	-.11	.30*	-				
14. PSWQ	-.06	.36***	.16*	-.26***	.42***	.45***	.42***	-.39***	-.27*	-.21	-.37**	.67***	.39***	-			
15. PTQ	-.11	.23***	.01	-.08	.20	.25*	.27*	-.22	-.13	-.05	-.14	.45***	.40***	.55***	-		
16. FMPS	-.19	.24***	.12	-.15*	.40***	.34**	.33**	-.30*	-.11	-.15	-.25*	.36**	.27*	.50***	.45***	-	
17. BDI	-.14	.22***	.09	-.17*	.39***	.35**	.32*	-.29*	-.27*	-.21	-.23*	.39***	.43***	.44***	.62***	.57***	-

Note: *** $p < .001$ ** $p < .01$, * $p < .05$; gender: 1 = male, 2 = female, PER 0 = post-event rumination ten minutes after the study concert, PER 1day = PER one day after the study concert, PER 2 days = PER two days after the study concert; Similarity = similarity between study concert and usual performances; Commitment = commitment in study concert; SPQ = subjective performance quality; STAI-S = State-Trait Anxiety Inventory-State; LSAS = Liebowitz Social Anxiety Scale; PSWQ = Penn State Worry Questionnaire; PTQ = Perseverative Thinking Questionnaire; FMPS = Frost Multidimensional Perfectionism Scale; BDI = Beck Depression Inventory

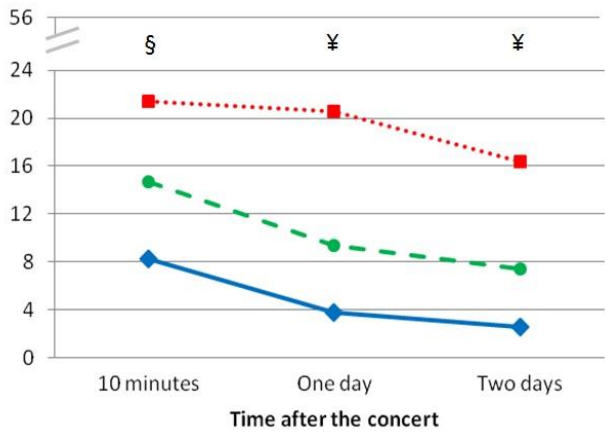


Figure 1(a). Negative PER, 10 minutes, one day and two days after the study concert by anxiety group: low-anxious (solid line), moderate-anxious (dashed line) and high-anxious (dotted line); § comparison between low- and high-anxious was significant ($p < .01$); ¥ comparisons between low- and high-anxious and between moderate- and high-anxious were significant ($p < .05$)

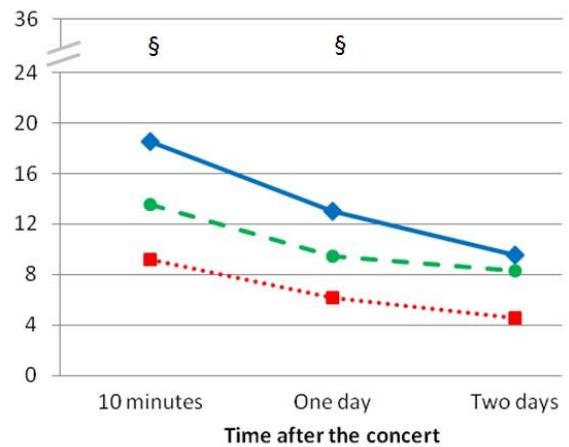


Figure 1(b). Positive PER, 10 minutes, one day and two days after the study concert by anxiety group: low-anxious (solid line), moderate-anxious (dashed line) and high-anxious (dotted line); § comparisons between low- and high-anxious were significant ($p < .05$)

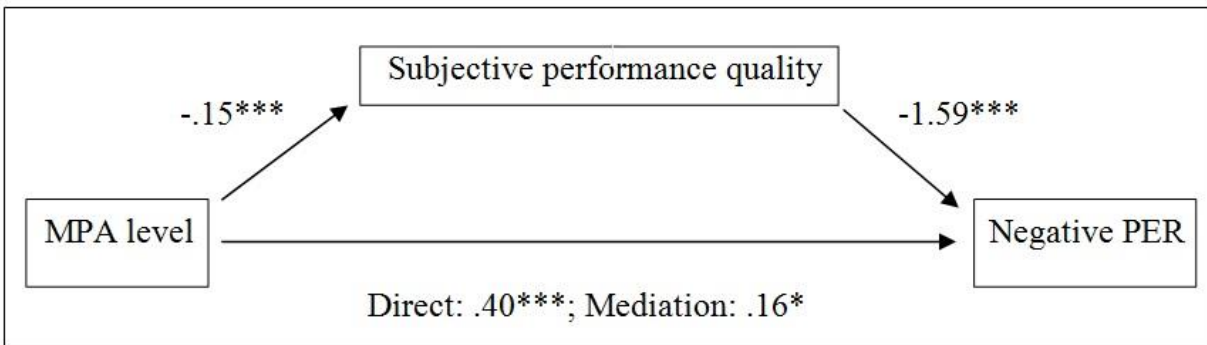


Figure 2. Mediation model for negative PER with regression coefficients; *** $p < .001$, * $p < .05$

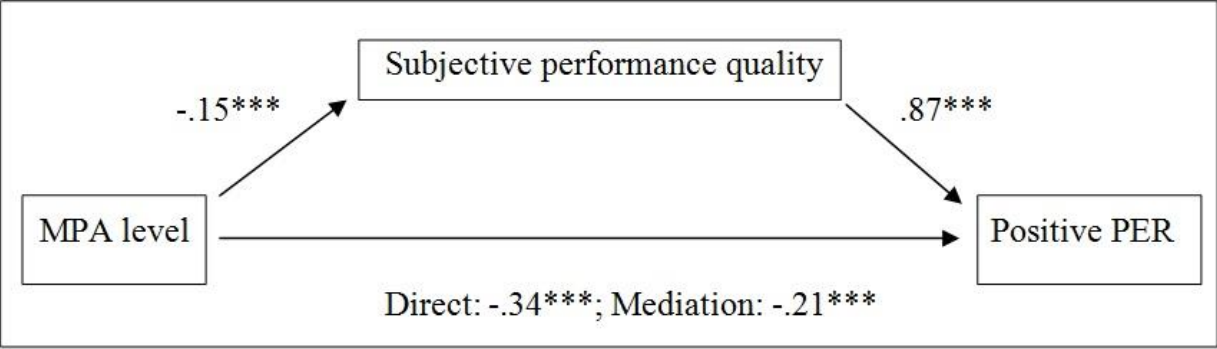


Figure 3. Mediation model for positive PER with regression coefficients; $*** p < .001$