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Electrophysiological markers and pianists' anxiety: A preliminary study

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Subjective measures of music performance anxiety have been commonly applied to assess the impact of relaxation techniques and cognitive behavioural therapy as coping strategies. This pilot study attempts to assess the impact of a stress-management programme (SMP) in the management of performance anxiety levels of piano students playing at public concerts. A descriptive longitudinal controlled study was carried out comparing two groups of music students: pianists who undertook 10 sessions of SMP (the experimental group); music students who did not undergo these sessions (the control group, with 1 guitarist and 1 singer). For both groups, subjective and objective measures of assessment were carried out. A self-report questionnaire and measures of brain activity and physiological arousal—electroencephalogram (EEG) and electrodermal activity (EDA), respectively—were undertaken 30 minutes before public performance. This was done twice for both groups: before the SMP (baseline) and 12 weeks after. Results suggest mild effects of SMP on objective measures. Inconclusive results regarding subjective measures suggest the necessity for developing future protocols applying both subjective and objective measures of music performance anxiety on larger-sized sample groups.

Keywords: cognitive behavioural training; EEG; performance anxiety; coping strategies; performance optimization strategies

Maladaptive music performance anxiety (M-MPA)—i.e. elevated stage-related arousal that impairs music performance (Lehmann *et al.* 2007)—has been reported as one of the most debilitating problems for musicians. Previous studies suggest that half of all instrumentalists may be negatively affected to some extent (Lehmann *et al.* 2007). Several coping strategies have been ad-

vised to musicians: (1) behavioral therapy, (2) hypnotherapy, (3) Alexander technique, (4) behavioral strategies, and (5) cognitive behavioral therapy. Biofeedback using self-regulation of brain activity through electroencephalogram (EEG), also called neurofeedback, has been found to be another efficient strategy. Decreased anxiety levels were observed for anxiety-prone students using alpha neurofeedback training (Hardt and Kamiya 1978) and significant enhancement of performance skills were found associated with alpha/theta neurofeedback (Egner and Gruzelier 2004). However, the precise nature of the alpha/theta neurofeedback has not been completely understood, and effects have not yet been related to relaxation techniques nor to monitoring of pre-performance anxiety (Gruzelier and Egner 2004). This pilot study attempts to assess the impact of a stress-management program (SMP) on piano students, combining both subjective and objective measures of M-MPA.

METHOD

Participants

Portuguese university students were involved in this longitudinal descriptive study: second year piano students that undertook 10 consecutive sessions of SMP (the experimental group, n=4), and a matched group of students who did not participate in SMP (the control group, n=2 pianists: 1 guitarist and 1 singer). All were healthy volunteers, with age ranges between 18 and 26 years. A consent form was previously signed after participants have been informed about the experimental procedures.

Materials

Portuguese validated version of the Spielberger State-Trait Anxiety Inventory (Silva and Campos 1999) was applied to assess both state (STAI Y1) and trait (STAI Y2) anxiety. Both scales include 20 items, each using a 4-point Likert-type scale, running from 20 (low anxiety) to 80 points (high anxiety).

EEG and tonic electrodermal activity (EDA) were selected as psychophysiological measures. Anxiety levels and music performance quality have been successfully monitored through brain activity (Egner and Gruzelier 2004), and individual arousal levels through EDA (Dawson *et al.* 2000). Both EEG and tonic EDA were acquired through a computerized data-acquisition system (MP100, Biopac Systems Inc.) connected to a laptop computer. All recorded data were shown online on the monitor and simultaneously stored in the hard disk using the software AcqKnowledge 3.9 (Biopac Systems).

Procedure

STAI Y1 and Y2 were filled in by each participant prior to psychophysiological data collection. EEG was recorded from 4 electrodes positioned according to the 10-20 international system and sampled at 250 Hz. The tip of the nose was used as reference. EEG signals were digitally filtered with FIR Blackman-61-dB bandpass filters for the following frequency bands: 4-7 Hz (Theta), 8-12 Hz (Alpha), and 13-30 Hz (Beta). As previous studies suggested that "optimal arousal" (moderate levels) may facilitate performance quality (Lehmann *et al.* 2007), brain activity was expressed in terms of beta-theta ratio. Increased amplitude of beta waves has been related to enhanced attention (Egner and Gruzelier 2001) and semantic working memory (Vernon *et al.* 2003), important features for optimal performance. It seems reasonable to assess beta/theta ratio while imagining the performance scenario to understand whether adaptive anxiety was promoted with the SMP. EDA was recorded from the middle and ring fingers of the non-dominant hand with a TSD203 skin resistance transducer (Biopac Systems). Mean amplitudes were calculated for periods of 60 s in each of the three instructions conditions for both EDA and the various EEG band signals. EEG and EDA signals were amplified with EEG100C and GSR100C amplifiers, respectively (Biopac Systems). Participants were seated in a comfortable chair while EEG and EDA recordings were performed simultaneously under three different states: relaxed with the eyes closed, with the eyes open, and imagining a performance-related scenario (i.e. imagining stage performing). Each state lasted approximately 90 s.

All data collection lasted around 25 minutes so that participants could be on stage around 30 minutes after. This choice of situation and timing was based on results of previous research on anxiety levels across musical genres and under different situations (Welch *et al.* 2008). Subjective and objective datasets were collected twice for each participant: the first assessment constituted the baseline measurement; the second assessment was carried out 12 weeks later after 10 sessions (once a week) of SMP, carried out with the experimental group only. During the SMP, participants met weekly for 2 to 2.5 hour sessions to receive instructions and practicing skills which included discussion of stress, coping, and relaxation techniques. Homework was also assigned at the end of the sessions, to promote consolidation of learned practices. At the end, the SMP was assessed by a self-report questionnaire.

RESULTS

Two of the participants included in the control group failed to complete the whole study and did not participate in the second assessment. Thus, the re-

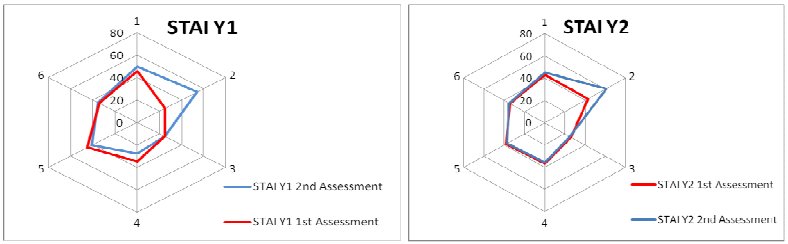

Figure 1. Scores for STAI Y1 (left panel) and STAI Y2 (right panel) for each participant for first (red) and second assessments (blue). Participants 1 to 4 belong to the experimental group, whereas participants 5 and 6 constitute the controls. (See full color version at www.performancescience.org.)

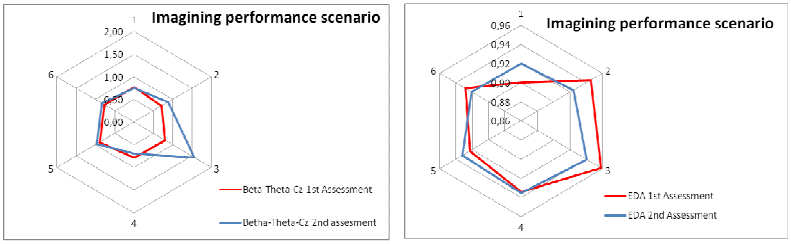

Figure 2. Scores for Beta-Theta ratio (left panel) and EDA (right panel) for each participant for first (red) and second assessments (blue). Participants 1 to 4 belong to the experimental group, whereas participants 5 and 6 constitute the controls. (See full color version at www.performancescience.org.)

sults here presented concern only 4 pianists in the experimental group and 2 controls (rather than the initial 4), allowing for descriptive analysis only.

Figure 1 shows state and trait anxiety levels (STAI Y1 and STAI Y2, respectively) for all participants. For the baseline measurement (i.e. first assessment), participants 1 and 5 present the highest anxiety levels, followed by participants 4, 6, and 2. The lowest values were presented by participant 3. As expected, STAI Y2 scores did not differ between the first and second assessments; however, this was not verified for participant 2. Also, STAI Y1 results were rather unexpected: although state anxiety seemed to decrease after the SMP for participant 4, participants 1 and 2 seemed to be more anxious before the performance after the SMP intervention. Controls 5 and 6 showed mild differences between baseline and after SMP assessments.

Figure 2 shows the variation of beta-theta ratio and EDA for both baseline and after the SMP. For the second assessment, participants 2 and 3 present an increase in beta-theta ratio, whereas EDA decreased. Participant 1 almost does not show changes between first and second assessments for beta-theta ratio; however, EDA are higher for the second assessment as compared with the first. The same can be observed for participant 5 (control). Participant 4 almost does not show changes in EDA and only small differences between beta-ratio, showing higher values for the first than the second assessments. Participant 6 shows an opposite behavior compared with participant 5 as regard to EDA, which was higher for the first assessment. Participants 2 and 3 show increased beta-theta ratio and decrease EDA after the SMP.

DISCUSSION

The results, although of an exploratory nature, may provide interesting insights for future assessments of SMP impact on M-MPA. For example, differences between baseline and after-SMP conditions for STAI Y2 for participant 2 highlight the importance of combining subjective and objective measures. It is possible that perceived levels of M-MPA might not correspond to the underlying psychophysiological processes related to the performance itself. Thus, both measures should complement each other to allow more robust results. The increased beta-theta ratio and decreased EDA observed for participants 2 and 3 after SMP suggest that this type of program may assist students to enhance adaptive performance anxiety, thus being beneficial for the improvement of overall performance quality. This was further supported by the participants' comments on overall quality and efficacy of the SMP. Research to date has been mainly focused on how maladaptive anxiety affects performance quality and how it can be reduced. Thus, it would be interesting to promote strategies of increasing adaptive anxiety, expressed as means of moderate arousal, controlled sympathetic autonomic activation and working memory activation. It would be interesting to assess the effects of beta-theta training and its relation to perceived peak experiences and enhanced performance quality, as a complement to the demonstrated positive effect of alpha-theta training through neurofeedback. The higher values of EDA for participants 1 for the second assessment may indicate the necessity of including personality tests, as personality may influence anxiety levels, and affect the moderated levels needed for an optimal performance.

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