Psychophysiological study: Ambulatory measures of the ANS in performing artists

Paula Thomson¹,² and S. Victoria Jaque¹

¹ Department of Kinesiology, California State University, Northridge, USA
² Faculty of Fine Arts, York University, Canada

Professional performing artists routinely manage stressful demands encountered during public performances. Fourteen professional performing artists (6 dancers, 6 opera singers, and 2 conductors) rehearsed and performed in a concert hall setting while wearing the Vivometric LifeShirt, an ambulatory instrument that measures autonomic regulation. Contrary to our hypothesis, that greater parasympathetic changes from baseline to performance would be related to higher perceived states of subjective flow during performance, we found decreased cardiac autonomic balance (CAB) and regulatory capacity (CAR) was related to dispositional and state flow in performing artists. As a group, they endorsed moderate to high dispositional and state flow as measured by two self-report instruments. This case study is the first study to investigate psychophysiological flow states during public performances. A larger sample size is needed to understand the role autonomic regulation plays in subjective flow experiences; however, the findings in this study suggest that decreased autonomic regulatory capacity is not necessarily deleterious to performance flow experiences.

Keywords: ANS; flow; performing artists; anxiety

The aim of this case study was to examine psychophysiological flow states as measured by self-report and ambulatory measurements of the autonomic nervous system in professional performing artists during rehearsal and performance events. We hypothesized that greater parasympathetic (vagal) changes from baseline to performance would be related to higher perceived states of subjective flow during performance. According to Csikszentmihalyi (1990), flow is considered an optimal experience, one that incorporates a convergence of inter-related elements. Flow
includes: (1) balance between an individual’s perception of challenge and his or her skill-level, (2) action-awareness which is the ability to become absorbed while maintaining awareness of skill execution, (3) appropriate goal setting, especially when the individual is able to define a goal and adequately prepare to achieve that goal, (4) unambiguous feedback that helps clarify goal achievement, through an ability to receive internal and/or external feedback necessary to modify performance, (5) total concentration on the task at hand through blocking extraneous thoughts and distractions, while maintaining awareness of the present moment, (6) sense of control accompanied by challenge-skill balance, (7) loss of self-consciousness, or the quieting of internal doubts and criticism, (8) time is transformed, especially when the self is no longer subjected to ongoing self-evaluation, (9) autotelic experience, or an intrinsically rewarding experience related to an autotelic personality, and (10) total flow which is the sum of all nine flow scales.

Since flow states are considered to be integrating positive experiences in performing artists (Kirchner et al. 2008), we hypothesized that these states would be marked by physiological autonomic regulatory capacity (CAR) and cardiac autonomic balance (CAB) (Berntson et al. 2008). The autonomic nervous system (ANS) controls visceral organs and the cardiovascular system. It is regarded primarily as an involuntary regulating process that synergistically interacts with the endocrine and central nervous systems (Furness 2006). Further, the parasympathetic branch of the ANS, and in particular vagal control, is considered essential for psychological and physiological well-being, since it serves to buffer stress and threat responses (Kok and Fredrickson 2010) and increases the capacity for attentional and emotional regulation (Miskovic and Schmidt 2010).

Based on this psychophysiological response, we hypothesized that performing artists who endorsed higher flow states would also experience greater CAR and CAB during performance.

METHOD

Participants

The 14 professional performing artists included two conductors, six opera singers, and six dancers. All participants had a minimum of five years of training and one year of professional performance experience. There were five males (35.7%) and nine females (64.3%) in the sample, with a mean age of 28.86 years (range=20-61 years).
Materials

Physiological measurements

During all testing, a Vivometrics LifeShirt monitoring device was worn to determine cardiac output (TCG method) and heart rate variability. Embedded in the LifeShirt are two inductive plethysmography bands or sensors. Also incorporated into the shirt is a triaxial accelerometer that detects and records movement and body posture. Three disposable self-adhesive electrodes, one above each breast and the third placed on the lower right abdomen, are inserted through the slots in the shirt. The electrodes, strain gauges, and mercury switches are plugged into a central data cable that is attached to a palm pilot computer, which participants wear around their belts. The LifeShirt requires calibration of the respiration cycle to enhance respiratory sinus arrhythmia measures (Wilhelm et al. 2003). Vivo Logic is a statistical software package that analyzes autonomic physiological variables.

Dispositional Flow Scale-2 (DFS-2) and Flow State Scale (FSS-2)

The DFS-2 and FSS-2 (Jackson and Eklund 2004) are self-report, 36-item instruments that assess the construct of dispositional and state flow. A five point Likert-type scale (1=never to 5=always) is used, with nine subscale scores measuring mean dimensional concepts of flow and a total mean scale score assessing a global flow construct. The flow scale scores can be divided in low agreement (1-2) which suggests that the person’s experience was not substantially “flow-like” in nature, moderate level (3) indicating some endorsement of flow experiences, and high level (4-5) indicating the respondent endorsed frequent flow or always experienced flow in their selected activity. The scales have been used on individuals ranging from 16-82 years. The DFS-2 can be administered at any time to gather dispositional flow experiences regarding a specific activity; whereas state flow experiences are gathered within one hour following the performance of a given activity. There is adequate reliability, construct validity, and internal consistency in the DFS-2 and FSS-2. They are considered to be an excellent measure of the dispositional and state tendencies in flow experiences.

Procedure

In this case study design, the subjects were all professional performing artists who participated in a larger study conducted at California State University, Northridge’s Exercise and Psychophysiology Laboratory in the Department of Kinesiology. After completing an informed consent, they were fitted into the
Vivometrics LifeShirt. After calibration, the artists first rested in a supine position for seven minutes, participated in a rehearsal for an upcoming public performance, and then ended the session with a post baseline rest period. Within a week, the same procedure was followed; however, they were studied during a public performance (costumes or tuxedo were worn over the LifeShirt). Each performing artist completed self-report tests to measure dispositional-state flow. The participant’s ANS responses, collected in the portable computer attached to the LifeShirt, were processed through the Vivologic software system. Variables included the pre-ejection period (PEP), which is the time between depolarization of the ventricles and the actual contraction of the left ventricle. It is a method of measuring SNS activity; PEP decreases when there is increased activity from the SNS, which is associated with an increase in heart rate (Berntson et al. 2008). The respiratory sinus arrhythmia (RSA) is the peak-valley difference in R-R intervals and is a naturally occurring variation in heart rate (HR) that occurs during a breathing cycle, mediated by vagal nerve activity, and thus considered a PNS activity at rest (Berntson et al. 1997). Using spectral frequency analysis, the R-R interval data was converted into normalized high frequency (HFn) (0.15-0.40 Hz) domain in order to assess vagal HF-HRV. Stroke Volume (SV), breaths per minute (Br/min) and a measure for apneas/anxiety (PERCS) were also calculated. All autonomic variables were normalized to their square root values and then converted to z-scores for further analysis. The cardiac autonomic balance (CAB) and the cardiac regulatory capacity (CAR) were derived: $CAB=HF_z-(-PEP_z)$ and $CAR=HF_z+(-PEP_z)$ (Berntson et al. 2008). These derived autonomic response scores were determined for the baseline, dress, performance, and post-base rest periods. The data were entered into SPSS 18. Correlational and independent sample t-test analyses were conducted.

RESULTS

The 14 performing artists endorsed moderate to high subjective dispositional flow, ranging from frequent to always on the total flow and nine flow subscales. During the performance, their state flow responses ranged from agree to strongly agree on all flow scales. The correlation analysis indicated significant relations between CAB performance and PEP ($r=0.71$, $p=0.004$), HFn ($r=0.71$, $p=0.004$), SV ($r=0.65$, $p=0.013$), HR ($r=-0.68$, $p=0.007$), state flow scale for clear goals ($r=0.62$, $p=0.019$), and at post-base rest, state flow scale for challenge at the task at hand ($r=-0.92$, $p=0.008$). Significant relations were found between CAR performance and PEP ($r=0.71$, $p=0.004$), HFn ($r=0.71$, $p=0.004$), SV ($r=0.66$, $p=0.013$), HR ($r=-0.68$, $p=0.007$). At post-
base rest, CAR was related to dispositional flow scale for transformation of time (r=-0.99, p<0.001), and dispositional autotelic flow (r=-0.82, p=0.047).

In the independent sample t-test, when the sample was split by the mean score (mean=4.0) into high and low dispositional total flow, only SV was significantly greater in individuals with high dispositional flow than in those with lower levels of dispositional flow during performance (p=0.030). Whereas, when the group was split based on mean total state flow, a decreased performance baseline CAB score was present in those who had high state flow (p=0.032). Also, an increased post-baseline rest breaths-per-minute was significantly different in those with higher levels of state flow (p=0.004).

The autonomic indicator for anxiety (PERCS) was evident in four of the performing artists at baseline, six individuals during dress rehearsal, six during performance, and four during post-base rest. One of these performers had a panic attack just prior to entering the stage.

**DISCUSSION**

Like the findings of de Manzano *et al.* (2010), our study demonstrated that the high flow group had decreased autonomic balance (CAB). Wellbeing may be experienced by increased cardiac contractility as evidenced by increased SV in the high flow state group. The self-report flow measures demonstrated that performing artists found the experience to contain moderate to high flow. Perhaps the negative correlations between both CAR and CAB and the flow elements (clear goals, transformation of time, challenges at the task at hand, and autotelic personality) amplify the subjective perception of greater flow states, especially when decreased autonomic regulation occurs in the familiar environment of a concert hall. Like the military sample studied by Morgan *et al.* (2007), the performing artists may be able to tolerate greater sympathetic activation with less autonomic balance and regulation because they are buffered from the negative effects of anxiety due to a different neurochemistry that operates effectively under conditions of high stress. Limitations of this case study include small sample size. Future studies should explore other neurochemical variables that may be related to optimal performance especially since they may mediate the decreased CAR and CAB responses found in this study.

**Acknowledgments**

We wish to acknowledge OperaWorks and the California State University, Northridge, Music and Kinesiology Departments.
Address for correspondence
Paula Thomson, Department of Kinesiology, California State University, Northridge, 18111 Nordhoff Street, Northridge, California 91330, USA; Email: paula.thomson@csun.edu

References


