IMPEDANCE AND INDUCTANCE CARDIOGRAPHY: COMPARING CARDIOVASCULAR FUNCTION WITH AMBULATORY ESTIMATES

A thesis submitted in partial fulfillment of the requirements

For the degree of Master of Science in Kinesiology

By

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December 2012
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Abstract

Impedance and Inductance Cardiography: Comparing Cardiovascular Function with Ambulatory Estimates

By:

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Master of Science in Kinesiology

Objective:

An accurate ambulatory monitoring device which detects hemodynamic values outside of the laboratory setting could help researchers and practitioners alike. The ability to monitor changes occurring in a subject during activities of daily living (ADL), could lead to the detection and treatment of many undiagnosed patients. Non-invasive monitoring of hemodynamic variables have gone through many changes since its inception in 1966, when Kubicek et al developed the first impedance cardiograph for NASA. Since then changes have been made to the formula which detects hemodynamic changes, however, the impedance cardiograph is still considered the gold standard for non-invasive monitoring. The current study assessed the accuracy of an ambulatory monitoring device, the Vivometric LifeShirt, compared to the current gold standard impedance cardiograph (Cardiodynamics, Bio-Z), during pre and post rest conditions.

Methods:

The volunteer subjects included 14 healthy males recruited from California State University, Northridge. The male participants were between the ages of 19-33 and all provided written informed consent. Pre and post test values were obtained while the Cardiodynamics Bio-
Z and Vivometric LifeShirt simultaneously recorded hemodynamic values. Heart rate, stroke volume and cardiac output were then analyzed and recorded.

**Results**

There was a very strong correlation to heart rate when comparing pre (Pearson correlation = .988, Sig. 2 tailed = .000) and post rest (Pearson correlation = .990, Sig. 2 tailed = .000) data between the LifeShirt and Bio-Z. Although stroke volume and cardiac output did not show strong correlations, a regression equation was determined for the individual variables when using age and body surface area.

**Conclusions**

The LifeShirt had a very strong correlation to the Bio-Z in detecting heart rate and has the potential to be used outside of a laboratory setting. However, due to stroke volume and cardiac output being recorded on different scales no correlation was found between the two devices. Future research should examine how a higher subject number may influence the results and potentially produce an individual regression equation in order to predict actual values from the LifeShirt values.
Introduction

For years, subjects have been tethered to large cumbersome machines in laboratories in order to obtain cardiovascular data. These complex machines require subjects to be placed in positions that are not often experienced in every-day life. In contrast, ambulatory devices, such as the Holter monitor, were developed to provide 24 hour cardiovascular data outside of the laboratory setting. However, the Holter monitor also has its disadvantages, since data collection is limited to ECG rhythms. A non-invasive ambulatory monitoring device that has been validated to confirm cardiac output, stroke volume and blood pressure would dramatically improve scientists’ ability to examine interactions between systems during rest, exercise and in recovery. The ability to observe a dancer during a performance, an elite runner during a marathon or even a cardiac patient post surgery would yield the most realistic and accurate data.

The purpose of this study was to examine the utility of an ambulatory device used to determine cardiac function. One such device is called the impedance cardiograph. The impedance cardiograph used in this study was a Cardiodynamics Bio-Z (San Diego, California), although the impedance cardiograph can monitor many different hemodynamic variables, this study focused on heart rate, stroke volume and cardiac output. Newer technology, such as the Vivometric LifeShirt system may provide the additional benefit of analyzing subjects in their active settings to provide real time analysis of cardiovascular data. The purpose of the current investigation was to determine convergent validity of an ambulatory monitoring system (Vivometrics LifeShirt), to address the question of whether cardiac data collected on a traditional impedance cardiograph instrument (such as the BioZ) would be comparable.
Review of Literature

Cardiovascular System

Control of the respiratory system and blood flow is essential both at rest and while exercising. The central nervous system is responsible for heart rate control, arterial blood pressure, and left ventricular contractility by varying the amount of impulses sent to the sympathetic and parasympathetic nerves\textsuperscript{3}.

The autonomic nervous system (ANS) is known for controlling particular instinctive functions critical for maintaining homeostasis. The system is responsible for the regulation of cardiac muscle, smooth muscle as well as all glandular secretions. Also, the ANS affects other metabolic pathways due to its control over the release of hormones\textsuperscript{4}. The ANS has two divisions that vary in function. The first division is the parasympathetic nervous system, which is commonly known as the “rest and digest” branch of the ANS. It is responsible for normal maintenance of the body and promotes secretions within the digestive tract. Conversely, the sympathetic nervous system is known as the “fight or flight” branch. The sympathetic nervous system is responsible for increases in cardiac output, and pulmonary ventilation. The sympathetic nervous system also redirects blood away from the stomach and organs and into the muscles. The central nervous system is responsible for controlling these systems. The central nervous system is regulated by a series of neural controls which depending on the situation will react accordingly.

Neural control originates in the central portion of the brain, specifically the subthalamiclocomotor region, which is also associated with motor unit recruitment and
ventilatory control\textsuperscript{5}. The rate in which blood will flow is determined by blood pressure. The pressure at which blood flows is determined by cardiac output (Q, the amount of blood pumped from the heart each minute) and total peripheral resistance (TPR, the resistance of blood flow provided by the vasculature). Changes in cardiac output are often apparent in diseases of the cardiovascular system, such as hypertension\textsuperscript{6}.

Different diagnostic tools have been used to detect these changes; however, the efficacy of these tools during exercise may leave some individuals with undiagnosed abnormalities. For example, exercise has been found to elicit abnormalities within the cardiovascular system that are not present at rest\textsuperscript{7}. Therefore, the ability to monitor subjects over a longer period of time may increase the chance of a proper diagnosis.

In 1966 Kubicek\textsuperscript{8} et al. developed the Minnesota Impedance Cardiograph. Funded through the National Aeronautics and Space Administration (NASA), the group of researchers set out to develop a non-invasive technique in order to assess cardiac output. The researchers empirically validated and developed a computer-based system that calculates stroke volume (SV), where \( p \) equals resistivity of blood and \( L \) equals length of the chest. The calculation also utilized the maximum value of the first derivative of the impedance waveform (\( \frac{dZ}{dt} \)) and the left ventricular ejection time (LVET).

The formula used by Kubicek is:

\[
SV = \rho \frac{L^2}{Z_{io}} \left( \frac{dZ}{dt} \right)_{\text{max}} \cdot LVET
\]
In 1983 Sramek\textsuperscript{9} et al. challenged the formula used by Kubicek. Sramek developed a formula using a truncated cone rather than a cylindrical model of the thorax. Also, Sramek believed the length (L) should be calculated as 17\% of the patient’s height(H).

The formula used by Sramek is:

\[
SV = \left(\frac{(0.17 \ H)^3}{4.2}\right) \left(\frac{dZ}{dt}\right)_{\text{max}} \frac{1}{Z_0} \text{LVET}
\]

Three years later, in 1986, Bernstein\textsuperscript{10} added the patient’s weight into the equation. Based upon the ideal body weight set by the Metropolitan Life insurance tables, he divided the actual weight by the ideal weight (\(\hat{\delta}\)). Bernstein believed this would allow for a more accurate assessment of the thorax volume. The formula used by Bernstein is:

\[
SV = \hat{\delta} \times \left(\frac{(0.17 \ H)^3}{4.2}\right) \left(\frac{dZ}{dt}\right)_{\text{max}} \frac{1}{Z_0} \text{LVET}
\]

Later the Sramek-Bernstein formula was introduced. The Sramek-Bernstein formula has been used in different studies, varying from monitoring patients during surgery\textsuperscript{11} to identifying the effects of exercise on patients with coronary heart disease\textsuperscript{12}. However, due to unsatisfying results in stroke volume and cardiac output\textsuperscript{13, 14, 15, 16}, some physicians recommended that the impedance cardiograph should not be used\textsuperscript{21}. Jensen et al.\textsuperscript{17} proposed that the poor results could be caused by the positioning of subjects during testing, the technique used in the administration of thermodilution and the anthropometric
differences between subjects. To exemplify how subject positioning could impact test results, Easterling et al.\textsuperscript{21} performed a study where the cardiac output measured in pregnant women were performed in a left lateral position. The subjects examined in left lateral position has been found to show an increase in left arterial diameter and a decrease in mean arterial pressure, changing their hemodynamic values as compared to the subjects who were tested in the supine position. Therefore, further examination to validate the use of the impedance cardiograph proves to be worthwhile.

\textit{Validation of the Impedance Cardiography}

More invasive techniques are available to monitor the hemodynamic profile of a patient. The techniques utilize a pulmonary artery catheter (PAC)\textsuperscript{18}. In the PAC Swan-Ganz procedure, a catheter is inserted into a large vein, for example, the subclavian, where it is guided through the right atrium, and right ventricle of the heart, and ultimately into the pulmonary artery. A balloon at the tip of the catheter is inflated, where it becomes “wedged” into a small pulmonary blood vessel. This wedged catheter, along with a catheter which has been lodged into the left atrium, allows for a simultaneous observation of the patients’ hemodynamic levels. The procedure measures certain hemodynamic variables such as pulmonary artery wedge pressure (PAWP), mixed venous oxygen saturation and cardiac output.

Many studies have used these types of invasive techniques, most of which were in a hospital setting. However, the impedance cardiograph has been found to be a valid alternative to invasive techniques, thereby reducing complications such as infection, rupture of the pulmonary artery, and irregular heartbeats.\textsuperscript{19} Other non-invasive
techniques do exist, such as the Doppler-echo-cardiograph and the CO₂ rebreathing technique for cardiac output; however, they require an experienced operator to insure accuracy²⁰. For a device to become reliable and valid, it must be able to be used on multiple populations in different settings. In a review article by Parry and McFetridge-Durdle ²¹, the authors discuss how the impedance cardiograph has been shown to be reliable when compared to invasive techniques such as thermodilution and PAC techniques, in both critical care and laboratory environments within different populations²²,²³. Test–retest reliability of measures derived while using the impedance cardiograph have been performed as well. One such study used 15 healthy subjects to measure stoke volume. Using 15-20 resting measurements on three different days, the researchers derived a coefficient of reliability of .96 by using the Spearman-Brown prophecy formula²⁴ ²⁵.

Considering the validity and ease of use of the impedance cardiograph in assessing cardiovascular function, its choice for convergent validation of new ambulatory devices is intuitive. While the results of the impedance cardiograph are reliable, this type of computer-based analysis still has its limitations, predominately the requirement to examine all subjects within the laboratory setting. The VivometricsLifeShirt, however, has the advantage of examining subjects’ in their natural environments. Therefore, determining convergent validity of the Vivometric LifeShirt as compared to the impedance cardiograph as a reference instrument would provide useful information regarding the potential for ambulatory cardiovascular monitoring, and may provide insight to allow a calibration equation to be developed.
The thoracocardiograph (TCG) is one vital component used in the LifeShirt system, which creates a raw signal that is processed and filtered in order to extrapolate a volume curve similar to that of an echocardiograph\textsuperscript{25}. Although the signal is mainly modulated by respiration, approximately five percent of the total amplitude is from cardiac activity\textsuperscript{26}. Sophisticated programming uses filtering and smoothing techniques to capture the pumping activity of the heart. Once computed, the data obtained can be extremely reliable and have been validated against both invasive and non-invasive techniques such as thermodilution and carbon dioxide rebreathing amongst different populations. One example is Bloch et al. in 1997\textsuperscript{27} performed the first validation study of the inductance cardiograph against simultaneous thermodilution measurement in patients who were critically ill. The study reported a strong correlation between the inductance cardiograph and the more invasive technique of thermodilution. However, there is a large gap in cardiovascular ability between critically ill patients and healthy subjects. In order to see if the same strong correlation holds true for healthy individuals during exercise, Kaplan et al. in 2003\textsuperscript{28} used inductance cardiography for noninvasive monitoring of cardiac output. In eleven subjects, comparisons between cardiac output by impedance cardiography agreed with the values measured by carbon dioxide rebreathing during a progressive ramp exercise protocol until exhaustion. The authors concluded that in healthy subjects, the estimation of cardiac output with inductance cardiography during exercise provided values similar to those determined by gas exchange methods. However, this study did not describe the changes in stroke volume and cardiac output occurring with either steady state or maximal exercise. While the TCG is an incredible
tool, similar to the impedance cardiograph, it lacks the strength to be used on its own, which has led to the development of the Vivometric LifeShirt.

**Vivometric LifeShirt**

The LifeShirt has been used to show validation and reliability of cardiorespiratory measurements during exercise\textsuperscript{25}. Kent et al. (2009) explored the relationships between ventilation, respiratory rate, expiratory time, heart rate, activity, ventilation, respiratory time and expiratory time\textsuperscript{25}. The results showed agreement between the Vivometric LifeShirt versus a standard laboratory system (COSMED) over multiple time points, whereas Clarenbach et al. \textsuperscript{29} only compared the LifeShirt to laboratory equipment at a single time point. Although Clarenback et al. did not analyze the LifeShirt over multiple time points, cardiovascular tests were performed with multiple populations further validating the study performed by Kent et al.

The LifeShirt is an exceptional tool for a variety of reasons. One reason is because of the light-weight material and unobtrusive form. Many subjects will not feel uncomfortable while performing tasks. Additionally, while controlled laboratory experiments are a necessity at times, the ability to record data in a variety of settings will unchain scientist from their laboratories.
Methods

Subjects and Protocol

Fourteen healthy male subjects between 19-33 years of age (Mean=23.79) were recruited from California State University, Northridge. The participants were competent to provide informed consent to participate in the study which was approved by the human subjects committee. The participants also understood that no form of compensation would be given. Inclusion criteria for the study included 1) college-aged males between the ages of 18-35 years of age, 2) able to provide written informed consent. Exclusion criteria from the study included 1) cardiovascular disease, 2) orthopedic injuries which would limit participation in the testing protocol. Study participants who passed the initial screening questionnaire were brought into the laboratory in order to go over the study. Each subject was given verbal as well as written information pertaining to the purpose, procedures, potential risks and benefits of participating in the study. The participant was then given the informed consent and was encouraged to go home and talk to family and friends about the study. Once subjects provided written informed consent, they were enrolled into the study.

The potential risks involved in the study included slight discomfort from wearing the Vivometric LifeShirt. Also, in order to decrease the chance of “noise”, electrode sites were shaved if hair was impeding proper skin contact for electrode adherence. Furthermore, the electrode sites were cleared of dead skin with sand paper as well as cleaned with alcohol, possibly causing slight discomfort to the subject.
Impedance Cardiography (ICG)

All ICG monitoring was conducted with the same machine (Bio-Z ICG Monitor; CardioDynamics; San Diego, CA). All subjects were prepared in the same order each time. Electrodes for the Bio-Z were placed bilaterally to the base of the neck, starting just below the earlobe. The last two electrodes were placed on the thorax. Each electrode was placed at the mid-axially line at the level of the xiphoid process. The impedance cardiograph was used since it is considered the current gold standard for non-invasive hemodynamic measurements during rest in a research setting\(^\text{19}\). The impedance cardiography was used in order to capture blood pressure, stroke volume and cardiac output in order to compare findings gathered from the Vivometric LifeShirt.

Inductance Cardiography

The subjects were fitted into the Vivometric LifeShirt. The Vivometric LifeShirt is an 8 oz washable sleeveless shirt embedded with sensors. Along with the TCG, the LifeShirt also utilizes a three lead ECG. Two electrodes were placed onto the upper chest and one is placed onto the lateral surface of the subject’s abdomen. The single lead set-up allows for heart rate to be calculated and ECG waveforms to be recorded. Also, a tri-axial accelerometer recorded posture and activity level. Respiration was recorded using inductive plethysmography (IP). IP is considered the gold standard for unobtrusive respiratory monitoring in both clinical and research settings\(^\text{30}\). Sensors record data from the ribcage and abdominal level. Movement from the ribcage shows activity mostly from the intercostals and some activity from the accessory muscles of breathing, whereas,
movement from the abdominal level shows activity from the diaphragm. The IP sensors coupled with the programmed algorithms record respiratory rate and tidal volume. Also, in research models such as ours, an IP sensor is set transversely to the xiphoid process. The physiological data is continuously processed through a small portable computer that was worn at the hip. All data was saved onto a compact flash memory card.

The LifeShirt was calibrated using an 800 cc fixed volume calibration bag (Vivometric) for respiratory data. After calibration, the subjects rested five-to-seven minutes pre- and post-test. After base rest values were obtained, the subjects would complete a step test. Once the step test was complete, subjects were brought back into the lab in order to obtain post test cardiovascular measurements. All data was collected in a research laboratory within the Kinesiology Department at California State University, Northridge. Once the LifeShirt and BioZ were connected and calibration was completed, the participants rested on a padded trainer’s table in the supine position for seven minutes. Following the post-rest period the devices were removed and the participants were thanked for their participation.

Data analysis

Analysis of the Vivometric LifeShirt data was performed in Vivologic Version 3.1. Heart rate, cardiac output and stroke volume were calculated for both the Vivometric and the BioZ systems. The LifeShirt data were matched to the same five-minute intervals as the BioZ impedance cardiograph. After all data points were recorded, data was entered into SPSS version 20. Calculations were conducted to determine
correlational statistics between the cardiovascular data collected from the two systems. Moderate to high correlational significance would suggest convergent validity. Repeated measures MANOVA were used to determine differences in the minute-to-minute changes produced by the systems. Any non-normally distributed data were normalized to their square root prior to analysis. Also, a calibration (regression) equation was developed for cardiac output and stroke volume in an attempt to convert estimated values to actual values. Once a calibration equation was developed, values were calculated and correlated to further validate the equation.
**Results**

Fourteen male subjects with a mean age of $23.8 \pm 3.6$ years, and an age range of 19-33 years participated in the study. Subject characteristics are presented in Table 1.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Mean±SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>23.8±3.6</td>
</tr>
<tr>
<td>BSA</td>
<td>1.99±.19</td>
</tr>
<tr>
<td>BioZ Pre HR</td>
<td>67.77±9.8</td>
</tr>
<tr>
<td>LS Pre HR</td>
<td>68.77±9.6</td>
</tr>
<tr>
<td>BioZ Post HR</td>
<td>75.03±12.4</td>
</tr>
<tr>
<td>LS Post HR</td>
<td>76.28±12.8</td>
</tr>
<tr>
<td>BioZ Pre SV</td>
<td>91.73±17.0</td>
</tr>
<tr>
<td>LS Pre SV</td>
<td>128.0±63.6</td>
</tr>
<tr>
<td>BioZ Post SV</td>
<td>92.11±16.4</td>
</tr>
<tr>
<td>LS Post SV</td>
<td>139.07±70.6</td>
</tr>
<tr>
<td>BioZ Pre CO</td>
<td>6.23±1.1</td>
</tr>
<tr>
<td>LS Pre CO</td>
<td>9007.03±5293.8</td>
</tr>
<tr>
<td>BioZ Post CO</td>
<td>6.8±1.2</td>
</tr>
<tr>
<td>LS Post CO</td>
<td>10987.6±6659.2</td>
</tr>
</tbody>
</table>

*BSA (Body Surface Area) , LS (LifeShirt)*

Data captured from the LifeShirt against the BioZ showed a strong correlation between pre- and post-rest heart rate (Table 2). However, due to the LifeShirt reporting estimated values, in units such as Aml, these variables were not absolute units. Comparisons were made with the Bio-Z, and failed to demonstrate significant
correlations between cardiac output and stroke volume determined on the two devices (Table 3 and 4).

Table 2

*Pre and Post Heart Rate (HR) Correlations between LifeShirt (LS) and Bio-Z*

<table>
<thead>
<tr>
<th></th>
<th>Pre HR (LS)</th>
<th>Post HR (LS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre HR (Bio-Z)</td>
<td>.988</td>
<td>.990</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000**</td>
<td>.000**</td>
</tr>
</tbody>
</table>

**Correlation is significant at < .01 level (2-tailed)**

Table 3

*Pre- and Post-Cardiac Output (CO) Correlations between LifeShirt (LS) and Bio-Z*

<table>
<thead>
<tr>
<th></th>
<th>Pre CO (LS)</th>
<th>Post CO (LS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre CO (Bio-Z)</td>
<td>.309</td>
<td>.049</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.283</td>
<td>.868</td>
</tr>
</tbody>
</table>
Further analysis was then performed in order to see if correlations would be present for the relative changes in the variables as measured by the LifeShirt versus the BioZ (table 5). No significant correlations were present; yet, the small sample size again may have been the limiting factor.

Table 4

*Pre- and Post- Stroke Volume (SV) Correlations between LifeShirt (LS) and Bio-Z*

<table>
<thead>
<tr>
<th></th>
<th>N=14</th>
<th>N=14</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre SV (LS)</td>
<td>Post CO (LS)</td>
</tr>
<tr>
<td>Pre SV (Bio-Z)</td>
<td>.076</td>
<td>-.369</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.797</td>
<td>.194</td>
</tr>
</tbody>
</table>

Table 5

*Pearson Correlation between Percent Change in SV between LifeShirt (LS) and Bio-Z*

<table>
<thead>
<tr>
<th></th>
<th>N=14</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% change SV (LS)</td>
</tr>
<tr>
<td>% change SV (Bio-Z)</td>
<td>-.433</td>
</tr>
<tr>
<td>Sig. (2 tailed)</td>
<td>.122</td>
</tr>
</tbody>
</table>

*Pearson Correlation between Percent Change in CO between LifeShirt (LS) and Bio-Z*

<table>
<thead>
<tr>
<th></th>
<th>N=14</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% change CO (LS)</td>
</tr>
<tr>
<td>% change CO (Bio-Z)</td>
<td>.142</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.629</td>
</tr>
</tbody>
</table>
The LifeShirt performed well in detecting heart rate in pre- and post-rest conditions; however, in regards to stroke volume and cardiac output, the LifeShirt reports values at Aml, meaning they are not absolute units. The LifeShirt utilizes the inductive plethmography (IP) sensors at the level of the ribcage and abdomen in order to measure respiration. Also, the thoracocardiograph (TCG) detects changes from occurring at the level of the left ventricle. Together, the IP sensors take out movement from respiration, thereby leaving the volumetric contractions of the heart detected from the TCG. The TCG then derives stroke volume and cardiac output as Aml, meaning they are not absolute values. Therefore, a direct correlation between the LifeShirt variables and the BioZ variables was not able to provide evidence of validity. A regression equation was derived to help predict the absolute values in SV and CO on the Bio-Z. Once a calibration equation was developed, values were calculated and correlated to further validate the LifeShirt’s stroke volume and cardiac output variables. Unfortunately due to a small sample size (n=14), a single regression equation using age, body surface (BSA), and the appropriate LifeShirt variable could not be derived. Future research should incorporate our findings in order to provide further insight into the Life Shirt’s validity.
**Discussion**

The purpose of this research study was to compare the values derived from the Vivometric LifeShirt to the values derived from the Cardiodynamics Bio-Z. In particular, the study assessed the accuracy of the Vivometric LifeShirt in detecting hemodynamic values and changes in such variables as heart rate, cardiac output and stroke volume as compared to the current gold standard measurement system (Cardiodynamics Bio-Z). The findings in this study demonstrated a very strong correlation between the two systems in detecting heart rate. Our findings are similar to those of Kent et al.\(^\text{30}\) which showed the LifeShirt had a strong reliability compared to the COSMED system during exercise with no significant bias (LifeShirt \(p=0.553\); COSMED \(p=0.731\)).

Unfortunately, due to a small sample size \((n=14)\), individual regression equations to predict actual values (Bio-Z) from estimated values (LifeShirt) for cardiac output and stroke volume were unsuccessful. As a result, the derived values obtained during ambulatory monitoring could not be utilized to predict actual values for cardiac output and stroke volume. While this study provided important information, future research with a larger sample should be conducted to determine whether a single regression equation could be derived to analyze the values derived between the two measurement instruments.

**Limitations**

One limitation of this study was the small sample size. Also, future research should incorporate female subjects. The inclusion of females could help in deriving a regression equation to help predict actual values for SV and CO from the LifeShirt data.
Conclusions

The LifeShirt’s ability to monitor subjects outside of a laboratory setting provides a unique ability to evaluate subjects (i.e., athletes, patients) in a naturalistic environment. Also, the LifeShirt’s unique ability to monitor multiple variables by one measurement system can provide a complex portrayal of physiological variables in ambulatory settings. For example, the Lifeshirt is currently being used by psychophysicologists to help show the interactions between the sympathetic and parasympathetic nervous system during exercise, providing a new insight into individual responses to strength and aerobic training\textsuperscript{34}. In conclusion, the findings in this study support a previous study\textsuperscript{32} that demonstrated that the LifeShirt system is extremely reliable in recording heart rate when compared to the current gold standard (Cardiodynamics Bio-Z). The Vivometric LifeShirt is an incredible teaching tool and an extremely valuable tool for researchers, medical doctors and exercise physiologists, allowing for physiological data to be captured outside of the laboratory and in a naturalistic environment.
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Apendix A

Psychophysiological Study of Performing Artists and Athletes

1. Research Description:

The goal of the research project, Psychophysiological Study of Performing Artists and Athletes, is to compare physiological ambulatory assessments to traditional self-report instruments and interviews. Fundamentally, we plan on investigating heart rate variability and self-report responses in subjects engaged in heightened performance settings. Our working hypothesis is that performers (artists or athletes) may endorse perceptual experiences that are contrary to their physiological responses during the same event that was evaluated by self-report measures. Second, we hope to determine some of the psychophysiological variables associated with autonomic nervous system regulation, in particular, the measurement of parasympathetic-sympathetic interactions. The research design will be a quais-experimental, longitudinal, repeated measures, mixed design (between-subject/group and within-subject/group) study. The measuring instruments will include the Vivometric LifeShirt, an ambulatory assessment of psychophysiological behavior during daily life settings, rehearsal / practice sessions and performances. The Vivometric LifeShirt includes a small portable computer monitor, thus it can be used in settings that have previously not been included for research study, settings that may include concert halls, studios, and athletic events. A series of self-report psychometric instruments will be included to gather data on variables such as creativity, state-trait flow/anxiety/anger, emotional regulation, personality and lifestyle. These self-report measures will be administered each time a participant's physiological measures are being gathered by the Vivometric LifeShirt, with at least three sessions conducted during the course of the semester. A similar process will be applied when conducting semi-structured interviews. All sessions will be video-recorded and interviews will be audio-taped and transcribed.

Specific physiological, kinesiological and psychological tests will be incorporated depending on the question(s) the research team and graduate students explore during any given semester. The research data collection will come directly from students enrolled in a new Experimental Topics course, KIN 695 Directed Research - Dance Psychophysiology (this experimental topics course is currently in curriculum approval procedures at CSUN). Although research will be directed primarily within the smaller population of dancers, other performing arts domains will be included to give a broader perspective on psychophysiological regulatory functions within performing artists. Further, the inclusion of athletes (with a potential control group included) will provide a balanced means of measuring and evaluating results.

HYPOTHESIS AND SPECIFIC AIMS

The central hypothesis of this proposal is that performers (artists or athletes) may endorse perceptual experiences that are contrary to their physiological responses during the same event that was evaluated by self-report measures. Unlike the self-report instruments, the
semi-structured interviews should be congruent with the physiological responses since both assess temporal dynamics of behavior. By incorporating an ambulatory assessment of psychophysiological behavior (heart rate, respiratory rate, heart rate variability), measured by Vivometric’s LifeShirt, a clearer understanding of autonomic nervous system capacities in these two populations can be compared to their subjective responses in traditional self-report and interview psychometric instruments.

**HYPOTHESES TO BE TESTED:**

1) The psychophysiological self-regulatory capacity of the autonomic nervous system will be assessed in different populations; performing artists, athletes (and controls). Both performing artists and athletes will demonstrate greater autonomic regulation under baseline and stress conditions.

2) Alterations in autonomic nervous system function (dysautonomia) will be associated with poorer performance and decreased self-regulation.

3) Psychological markers such as depression, anxiety, shame, perfectionism and dissociation will be elevated in individuals with poor autonomic regulation.

4) Functional conditions such as chronic fatigue, chronic pain and recurrent injuries will be associated with poor autonomic regulation.

5) Perceptual responses to subjective self-report psychometric instruments will frequently contradict, or poorly reflect, real-time physiological behaviors in both artists and athletes.

6) Self-report measures will correlate poorly with interview assessments; whereas, interview assessments will correlate significantly with autonomic measures.

**SPECIFIC AIMS:**

In professional / elite performing artists and athletes, we propose to:

1) Determine the resting pulmonary function and both resting and exercise cardiac output, stroke volume, (a-v)O₂ difference, minute ventilation, blood pressure, oxygen consumption, ventilatory threshold and work capacity across multiple settings in performing artists and athletes.

2) Determine the importance of heart rate variability and its relationship to accuracy of self-report and interview assessment protocols.

3) Determine heart rate variability and other dysautonomic responses to exercise across settings, including rehearsal / practice sessions and performances with an audience in attendance.
4) Determine the importance of heart rate variability as a measure of the autonomic nervous system and self-regulation when in the presence of depression, anxiety, and dissociative disorders.

5) Determine the importance of measuring autonomic nervous system variables in the presence of functional conditions such as chronic fatigue, chronic pain and recurrent injuries.

6) Determine the relationship of self-report psychometric instruments to Vivometric LifeShirt ambulatory assessment and the relationship of semi-structured interviews to Vivometric LifeShirt ambulatory assessment.

This project represents collaboration between researchers in the CSUN Department of Kinesiology (Dr. Victoria Jaque and Dr. Paula Thomson). This project will be performed under the direction of Dr. Thomson, with Dr. Jaque overseeing the exercise physiology testing. All of the subject testing will occur at CSUN, with CSUN students and outside performing artists and athletes as the subjects. For many of the individual graduate student studies conducted within this larger project, a control group may be included to provide a balanced research design.

CHARACTERISTICS OF THE STUDY SUBJECT POPULATION:

Target Accrual: Approximately 150 subjects will be screened at California State University, Northridge (CSUN).

Age Range of Subjects: We will study subjects aged 18-65 years, so as to decrease the potential for adverse events during exercise testing.

Gender of the Subjects: This study is open to all participants who meet the criteria for professional / elite performing artists (trained for at least five years and received financial renumeration for services in at least one production; or trained as an athlete for at least 5 years and competed at varsity, national or international events). The control group (when needed) will be matched in gender and age to the professional / elite performing artists and athletes.

Racial And Ethnic Origin: No restrictions for race and ethnicity. In general, non-English speaking participants are eligible for participation; however, some of the limiting factors for inclusion of non-English speaking participants include lack of funds for interpreters/translators, and purchasing of self-report instruments in multiple languages. Certainly, this will be a limitation within the study if the sample is drawn from an only English speaking sample. When research assistants or graduate students are able to include non-English speaking participants, every effort to support this inclusion will be made by the Principal Investigators.
Inclusion Criteria:
   a. Women and men aged 18-65 years
   b. Able to provide informed consent

Exclusion Criteria:
   a. Orthopedic injuries limiting exercise physiology testing
   b. Cardiovascular disease
   c. Untreated psychotic disorders

METHODS AND PROCEDURES:
Research Design and Methods Applied to Human Subjects: Evaluations to be made during the conduct of the study: Main Study: After furnishing written, informed consent, subjects will complete a questionnaire regarding health history and performance experiences. They will perform at least 3 sessions wearing the Vivometric Lifeshirt. The first session will provide baseline data about autonomic regulation and a series of self-report psychometric instruments and the Adult Attachment Interview will be administered. The second session will be conducted during a normal rehearsal or training session and several physiological tests will be given to determine strength, endurance and cardio-pulmonary functioning during exercise. A repeat-measures protocol will be conducted with the self-report psychometric instruments. The third session will be conducted during a performance or competition with a repeated-measures protocol of self-report measures administered post-performance. This research design is a quasi-experimental, longitudinal, repeated measures, mixed design (between and within-subject/group) study.

Evaluations prior to entry: All subjects responding to our recruitment efforts will complete a screening questionnaire prior to study enrollment (See appendix 1). Those who successfully pass the screening process will be enrolled in the study. Visit 1 (preliminary visit). After furnishing written, informed consent subjects will complete a questionnaire regarding health history. On this first visit they will also be fitted in a Vivometric LifeShirt, a simple jacket equipped with a portable computer and electrodes, which measures heart rate during daily life settings. By wearing this LifeShirt, baseline physiological status will be gathered in preparation for future measurements during performance or athletic activities. If subjects are asked to return to the laboratory for more visits, the visits will take place as follows:

Visit 2. Visit two will take place approximately two weeks after the first. During this visit, subjects will be placed in the Vivometric LifeShirt to record a second set of baseline physiological measures. Second, while wearing the LifeShirt, they will complete a series of self-report psychometric instruments and participate in a semi-structured interview that will be audio-taped and transcribed. Third, they will be asked to perform a series of strength tests using free weights and weight machines. They will be given adequate warm-up and familiarization time for each test and will repeat these tests again during their third visit. Additionally, their next appointment will be made. This visit to the laboratory will take approximately 2 hours. Exercise physiology testing will be
conducted during this second session to evaluate strength, endurance, cardio-pulmonary functioning and recovery rate.

**Visit 3.** First, they will be placed in the Vivometric LifeShirt and then will participate in a normal rehearsal or training practice (these rehearsal or training practices will be videotaped to provide further information about the nature of the activities experienced while wearing the LifeShirt). In place of participating in rehearsal or training practices subjects may be asked to walk or conduct normal daily activities for the same period of time. Second, they will be asked to complete the same series of self-report psychological tests from visit 2 following the completion of the activity session. Third, they will be asked to perform a series of strength tests using weight machines for the second time. Fourth, they will return to the Exercise Physiology Laboratory to participate in tests to determine lung function as determined by a graded exercise test on a cycle ergometer. The lung function graded exercise tests will take 30 minutes, and will require that subjects breathe through a mouthpiece. The work levels will begin at an easy walking pace and will be advanced in stages, depending on fitness level. Subjects will be informed to exercise at a level that is not abnormally uncomfortable. They may stop the test at any time because of personal feelings of fatigue or discomfort. This test will give important information about the participant’s fitness. An EKG (electrocardiogram) will monitor the heart during exercise for safety reasons. Additionally, the next appointment will be made. This visit to the laboratory will take approximately 3 hours (including rehearsal or training session).

**Visit 4.** Subjects will once again wear the LifeShirt and participate in a performance event (videotape recording of the performance event will be included). If they are not in a performance or athletic competition they will be asked to wear the Lifeshirt during an event that is considered stressful (such as an examination). Following the performance, self-report measures will be given again, including a test to determine degree of stress, performance anxiety, and flow (in the zone) during the event. This visit will take approximately 3 hours.

**Methods of Procedure**

**Questionnaires.** A screening questionnaire will be administered to assess whether volunteers meet inclusion and exclusion criteria prior to enrollment in the study (Appendix 1). After study entry, a questionnaire assessing health history (including injury history and “functional conditions”, such as chronic pain and chronic fatigue symptoms) will be administered. Unless specified, the questionnaires will be reviewed in the Department of Kinesiology Laboratory by a single researcher. All questionnaires are included in Appendix 1.

**Physiological Measurements.** During all testing, a Vivometrics LifeShirt monitoring device will be worn, to determine cardiac output (TCG method) and heart rate variability. Embedded in the LifeShirt are two inductive plethysmography bands or sensors. These sensors consist of arrays of sinusoidally arranged plethysmography bands surrounding the midthorax and midabdomen. The wires are excited through an extremely low current,
electrical oscillator circuit (no electricity passes through the monitored individual). Movements of the body sections covered by the LifeShirt sensors generate magnetic fields that are converted into voltage changes over time, that is, waveforms. 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 plugged into a palm pilot computer, which participants wear around their belts. The LifeShirt requires calibration of the respiration cycle by having participants inhale and exhale into a fixed volume bag seven times at a relaxed rate. This is done twice, both standing and sitting, so as to better calibrate respiratory sinus arrhythmia. Located in the palm pilot computer is a diary where the participant can record activity level, emotional states, and physical symptoms throughout the recording period (Heilman & Porges, 2007; Wilhelm, Roth & Sackner, 2003). The Vivometric LifeShirt also includes Vivo Logic – a statistical software package that analyzes over 100 physiological variables, including heart rate variability (Ebner-Priemer & Kubiak, 2007).

Exercise Physiology Measures.

Strength testing. Muscular strength will be measured to determine the relationships between strength, muscle mass, and BMD. Muscular strength will be determined for a variety of different exercises including lateral pull downs, shoulder press, chest press, leg press and seated row, using the 1 repetition maximum (1 RM) method with weight machines. Subjects will precede the strength testing session with warm up and light stretching. All strength measures will be obtained twice during the study, and the highest value for each exercise noted as the 1 RM. Muscular endurance will be determined for the leg press and chest press by having the subjects complete as many lifts as possible, with proper form, at 60% of the 1 RM.

Pulmonary Function Testing. Basic pulmonary function testing will take place in a Medical Graphics 1085DL plethysmograph, using the technique of air displacement plethysmography. During testing, measurements of Maximal Ventilatory Volume (MVV), diffusing capacity, forced expiratory capacity, 1.0 (FEV1.0), inspiratory and expiratory pressures will be measured, in addition to static lung volumes. These measures have been targeted, as they have been reported to be affected in those with mitochondrial dysfunction (Flaherty, Wald et al. 2001).

Fitness assessment. Cardiorespiratory fitness will be determined to enhance the understanding of the cardiovascular and ventilatory responses to exercise in women with the 16519t>C polymorphism. Prior to the test, resting blood pressure will be measured. A symptom limited VO2MAX test on a cycle ergometer will be administered using open-circuit, indirect calorimetry, on a MedGraphics CardiO2 Metabolic Cart in the Department of Kinesiology. A 12-lead EKG will be monitored both prior to and during exercise. Subjects will begin the test at 20 Watts, with workload increased by 20 Watts every 2 minutes. Subjects will terminate the test at the point of volitional fatigue. During the test, a Vivometrics LifeShirt monitoring device will be worn, to determine cardiac
output (TCG method) and heart rate variability. Additionally, prior to the test, a Cardiodyne BioZ will be utilized to assess resting cardiac output (via impedance cardiography) and systemic vascular resistance, to validate the resting LifeShirt values.

**Psychometric Instruments.** Each subject will complete several psychometric instruments (the majority are listed below) and complete an attachment interview. The selection and number of psychometric instruments will vary based on the specific questions explored by a particular graduate student. Some of the tests will be repeated in all sessions while others may be given to only a select sample of performing artists and athletes (and controls if used). See Appendix 1 for samples (Please not that some of the psychometric self-report instruments are on order and are not included in the appendix at this time and the standard DSM diagnostic interview instruments are not included because they are standard interviews).

**Creativity Measures**

**Inventory of Childhood Memories and Imaginings (ICMI)**

The ICMI is a self-report instrument that was developed by Wilson and Barber (Lynn, 1988; Wilson, 1983). It is a dichotomous, paper-and-pencil questionnaire consisting of 52-items that probe for experiences and memories from childhood and currently such as when I was a child I enjoyed fairytales, at the present time I am very imaginative, when I was a child I lived in a make-believe world, as an adult I still occasionally live in a make-believe world. This instrument has adequate reliability and validity and discriminates between high fantasy-prone (scores above 40), medium fantasy-prone (scores in the mid to high 20’s) and low fantasy-prone (scores below 10) individuals. The scoring is a simple total of all items endorsed by the subject.

**Other Self-Report measures that may be incorporated include:**

Creative Experience Questionnaire
Religious-Mystical-Aesthetic Experiences Inventory
Curious Experience Survey
Creative Imagination Scale
Mad Genius Endorsement Scale
Tellegen Absorption Scale
Dispositional flow Scale
Flow-State Scale

**Stress Measures**

**Traumatic Life Events Questionnaire.** The TLEQ has excellent content validity (since the TLEQ identifies important traumatic experiences that are not detected by other measures) and stable temporal test-re-test reliability. It is a 21 item paper-and-pencil self-report instrument that validly assesses respondents’ exposure across a diverse spectrum of traumatic events. When used in conjunction with a brief measure of PTSD symptomatology it is an excellent screening instrument in clinical settings. The limitations of the TLEQ include the obvious inability to verify the accuracy of positive endorsement of traumatic events against independent sources such as police reports, hospital reports or interviews.
with other person’s who might have an awareness of the relevant events. As with any self-report instrument, the usefulness of the TLEQ depends on factors that affect self-disclosure. This instrument has been standardized on veterans and undergraduate students and has excellent psychometric properties. It can be completed in 10 to 15 minutes and the reading level, according to the Flesch Grade level, is sixth grade.

**Posttraumatic Stress Diagnostic Scale (PDS).** The PDS consists of 49 self-report items. The instrument contains four parts: Part 1 surveys exposure to 11 traumatic events, as well as a 12th unspecified event; Part 2 examines characteristics of what the subject identifies as the most traumatic event listed in Part 1; Part 3 lists 17 symptom items corresponding to the DSM-IV symptomatic criteria for PTSD and Part 4 examines the level of impairment of functioning. These four parts correspond to the diagnostic profile necessary for DSM-IV PTSD Criteria A through F. The PDS has strong psychometrics with good test-retest reliability (kappa = .74), high internal consistency (alpha = .92 for the 17 symptom items) and good sensitivity (.82) and excellent specificity (.82) for SCID diagnosis of PTSD. The instrument is regarded as an excellent choice as a PTSD screener (clinician interviewer is required to confirm this diagnosis). The PDS can be completed in approximately 10 – 15 minutes and is prepared for an eight grade reading level.

**The Traumatic Events Questionnaire (TEQ)** The TEQ, created by Dean Lauterbach and Scott Vrana (Lauterbach, 2001), is a dichotomous 11-item instrument that assesses nine specific types of traumatic events (accidents, natural disasters, crime, child abuse, rape, adult abusive experiences, witnessing death/mutilation of someone, being in a dangerous/life-threatening situation, and receiving news of an unexpected death of a loved one). These events are believed to have the potential to evoke posttraumatic stress symptoms as defined in the DSM-IV-TR and as reported in the empirical literature. The final two items probe for any other traumatic event not listed and for traumatic event(s) that were too difficult to discuss with anyone.

**Coping Inventory for Stressful Situations (CISS)** The CISS, created by Norman Endler and James Parker, measures three types of coping styles (task-oriented coping, emotion-oriented coping, avoidance-oriented coping) and two scales that measure distraction and social diversion. It is appropriate for individuals over 18 years of age and was normatively sampled from a diverse population. It is a 21 item brief paper and pencil self-report instrument.

**Survey of Pain Attitudes (SOPA)** (approximately 10 – 15 minutes to administer) The 57 item inventory consists of seven scales that are divided into two domains – the Adaptive Beliefs Domain and the Maladaptive Beliefs Domain. The Adaptive Belief Domain is made up of the Control Scale which assesses the extent to which a patient sees himself/herself as having control over pain; and the Emotional Scale, which assesses the patient’s belief that emotions have an impact on pain. The Maladaptive Beliefs Domain is composed of the Disability Scale which assesses the extent to which a patient believes he or she is disabled by pain; the Harm Scale which assesses a patient’s belief that pain is a signal/sign of physical damage and that in the presence of pain, exercise/activity should
be avoided; the Medication Scale which assesses a patient’s belief that medications are an appropriate treatment for pain problems; the Solicitude Scale, which assesses the extent to which a patient believes that others should be helpful/solicitous in response to his/her pain; and the Medical Cure Scale which assesses the extent to which a patient believes that a cure will be found for his/her pain and that the primary responsibility for the management of pain rests with the physician. T scores and percentiles are included for calculating scores, a validity scale is included to measure inconsistency of responses and reliable change scores are included to assist in determining if there are significant differences between scores obtained on two different scoring occasions. The instrument, created by Mark Jensen and Paul Karoly, is appropriate for individuals 21 to 80 years of age.

**Other Self-Report measures that may be incorporated include:**
- Acute Stress Disorder Scale
- Global Measure of Perceived Stress
- Sexual and Physical Abuse Questionnaire
- Child Abuse and Trauma Scale

**Mood and Dissociative Measures**

**Hamilton Rating Scale for Depression - Revised (RHRSD).** This brief paper-and-pencil 76 item true or false scoring assessment tool is a diagnostic instrument to evaluate major depressive symptoms. It is one of the best known, most reliable and most widely used tools for evaluating depressive symptoms in adult clinical psychiatric settings. The Self-Report Problem Inventory is written at a fourth-grade reading level and is completed by the research participant in approximately 10 to 20 minutes. The instrument provides a Total Score that reflects the severity of depressive illness, a diagnostic confirmation of a Major Depressive Episode and evaluation of Melancholic features based on DSM-IV criteria and two validity checks (validity score and inconsistency index). Like all self-report instruments, a clinician interview is necessary to conclusively diagnosis a disorder. The psychometric properties of the RHRSD includes strong internal consistency (Cronbach’s alpha at .81). Since the RHRSD probes for a more clinical symptom profile, including somatic complaints, its average correlation of .67 with the Beck Depression Index (BDI) reflects overlaps in the two instruments. However, the RHRSD was normed on a medical patient population; whereas, the BDI was developed on a non-clinical or out-patient population.

**Beck Depression Inventory – II (BDI-II).** The BDI-II (Beck, 1967) consists of 21 items to assess the intensity of depression in clinical and normal populations. Each item is a list of four statements arranged in increasing severity about a particular symptom of depression. This self-report is widely used to assess the attitudes and symptoms of depression and dysphoria and measures statements that best describe how the individual felt during the last 2 weeks prior to assessment. The internal consistency reliability estimate for the BDI-II is .92. It is appropriate for individuals between the ages of 13.0 to 80.0 years and requires approximately 5 minutes to administer.
Beck Anxiety Inventory (BAI). The BAI assesses the severity of patient anxiety. It is a self-report 21 item instrument that measures how much the respondent was bothered by the symptom in the past week, ranging from 0 (not at all) to 3 (severely). Each item is descriptive of subjective, somatic or panic-related symptoms of anxiety. The internal consistency reliability estimate for the BAI is .94. It is appropriate for individuals between the ages of 13.0 to 80.0 years and requires approximately 5 minutes to administer.

Affective Neuroscience Personality Scales (ANPS) This 110 question self-report tool, created by Kenneth L. Davis, Jaak Panksepp and Larry Normansell (Davis, 2003), attempts to monitor the more primal subcortical emotions in human temperamental variability. It is currently considered a work in progress and it does not claim to be a comprehensive representation of human personality. The ANPS focuses on ancient mind/brain processes that may serve as a foundation for many “higher” mental attributes and abilities and serves as an instrument that attempts to bridge neuroscience and depth-psychology. These affective concepts are built on the theory of hierarchical structures in the brain and in the self/ego. The instrument is an attempt to gather relevant self-report data concerning major affective tendencies that may be important for understanding the emotional variability of the members of our species. There are 6 scales that are measured in this self-report test and a set of norms have been developed. Presently, the ANPS has received a ‘first-pass’ study in which significant correlations have been drawn between the basic emotional systems as described by Jaak Panksepp’s neuroscience research and the Five Factor Model (FFM) for personality dimensions. The 7 scales include: playfulness, seeking, caring, fear, anger, sadness, spirituality. Other emotions such as dominance, embarrassment, guilt, greed, disgust, jealousy, shame and pride are still neurologically not sufficiently understood and so were not included in the self-report instrument. The more ‘motivational’ emotions such as sex, hunger, thirst and temperature regulation were not included as well since they appear to be less specifically related to our traditional understanding of what constitutes human personality. This instrument has strong correlations to the Five Factor Model of Personality created by Goldberg and built from Eysenck’s dimensions of personality.

State-Trait Anger Expression Inventory-2 (STAXI-2) (5 – 10 minutes to administer) Appropriate for individuals 16 years or older, this 57 item assesses the dimensions of anger and anger expression. The State Anger scale assesses the intensity of anger as an emotional state at a particular time (includes 3 subscales). The Trait Anger scale measures how often angry feelings are experienced over time (two subscales). The Anger Expression and Anger Control scales assess four relatively independent anger-related traits (anger expression out, anger expression in, anger control out, anger control in). The self-report paper and pencil instrument is written at a sixth grade reading level and was based on a large and diverse normative sample. Created by Charles Spielberger, the inventory provides a 4-point rating scale to assess both intensity of anger at a particular time and the frequency with which anger is experienced, expressed and controlled. Raw score to T-score and percentile conversions are provided for all scales/subscales by gender.
State-Trait Anxiety Inventory (STAI) (10 minutes to administer) Created by Charles Spielberger, this self-report inventory is appropriate for adolescents and adult populations. It differentiates between states and traits, with the State Anxiety scale evaluating feelings of apprehension, tension, nervousness, and worry, which increase in response to physical danger and psychological stress. The Trait Anxiety Scale assesses anxiety problems that may influence behavior. It is a 40 item test with 4-point rating scale, written at a sixth grade reading level and provides normative tables for working adults, high school student, college students and military recruits.

State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA) (10 minutes to administer) Created by Gros, Simms, Antony and McCabe, this self-report instrument is believed to be a purer measure of anxiety symptomatology than is the State-Trait Anxiety Inventory. This instrument separates cognitive and somatic symptoms of anxiety. It has strong convergent and discriminant validity patterns and is regarded to have good reliability and validity. It is a paper-and-pencil self-report test of 42 items.

Internalized Shame Scale (ISS) The ISS, created by David Cook, evaluates the extent to which the negative affect of shame becomes magnified and internalized. It reflects feelings of inferiority, worthlessness, inadequacy, and alienation. The key areas measured include shame and self-esteem.

Profile of Mood States (POMS) (15 – 20 minutes) The POMS is appropriate for individuals 18 years of age or older. It provides a fast method of assessing transient, fluctuating active mood states. The key areas measured include tension-anxiety, vigor-activity, confusion-bewilderment, anger-hostility, depression-dejection, fatigue-inertia. The POMS, created by Douglas McNair, Maurice Lorr and Leo Droppleman, is written at a seventh grade reading level and normative data was collected from a diverse population.

Coping with Health Injuries and Problems (CHIP) The self-report inventory helps identify individual’s with typical coping styles and suggests strategies that will best help the individual cope with and overcome health problems. Created by Norman Endler and James Parker, the inventory measures distraction, palliative, instrumental and emotional preoccupation.

Dissociative Experience Scale – II (DES-II) (10 minutes to administer) The Dissociative Experience Scale-II (DES-II) (Bernstein & Putnam, 1986; Waller, Putnam & Carlson, 1996), is a 28-item self-report measure that asks subjects to indicate the frequency of dissociative experiences such as; 1) loss of memory for important periods in your life, 2) feeling that your body does not belong to you, 3) becoming so absorbed in watching television or a movie that you are unaware of what is happening around you. Persons who are administered the DES-II are asked to endorse experiences that were not related to situations when the subject was under the influence of alcohol or drugs. Each item is given a score between 0 (never) to 100 (always) and takes approximately 10 minutes to complete.
The DES-II and all of its sub-scales have very high internal consistency scores (Cronbach’s α), implying that they contain a fair amount of redundancy. The entire DES-II has an α of 0.96, the Amnestic scale consists of eight items with an α of 0.90, the Absorption/Imagination scale also consists of eight items and has an α of 0.90, the Depersonalization/Derealization scale consists of six items and also has an α of 0.90, the Absorption/Changeability scale consists of 10 items and has an α of 0.91, and the Taxon scale consists of eight items with an α of 0.88. A bivariate correlation matrix reveals moderate to high correlations between the scales (range: 0.77 – 0.99, \( p < 0.05 \) for all correlations). Further, the DES-II as well as each of the scales supplies a clinical mean cut-off score endorsing further clinical assessment.

**Somatoform Dissociation Questionnaire (SDQ-20).** (5 – 10 minutes to administer) The 20 item SDQ-20 evaluates the severity of current somatoform dissociation. The SDQ-20 items are supplied with a Likert-type 5-point scale, ranging from ‘1 = this applies to me NOT at all’ to ‘5 = this applies to me EXTREMELY’. The respondent is also asked to indicate whether a physician has connected the symptoms or bodily experiences with a physical disease. The SDQ-20 score, which may range from 20 to 100, is obtained by summation of the individual item scores, with cutoff scores indicating differential dissociative disorders. The SDQ-20 has excellent reliability (Cronbach’s alpha 0.95) and it discriminates between (i) Dissociative Identity Disorder, (ii) Dissociative Disorder Not Otherwise Specified; (iii) Somatoform Disorders; and (iv) other psychiatric diagnostic categories, including bi-polar mood disorder.

**Stroop Color and Word Test** (5 minutes to administer) This neuropsychological assessment, created by Charles Golden, is appropriate for individuals ages 15 – 90 years. It measures cognitive processing and provides valuable information on brain dysfunction, cognition and psychopathology. It is based on the observation that individuals can read words much faster that they can identify the name of color. The cognitive dimension tapped by the Stroop is associated with cognitive flexibility, resistance to interference from outside stimuli, creativity, and psychopathology – all of which influence the individual’s ability to cope with cognitive stress and process complex input. The Stroop Color and Word Test consists of a Word Page with color words printed in black ink, a Color Page with Xs printed in color, and a Color-Word Page with words from the first page printed in colors from the second page (the color and the word do not match). The test-taker looks at each sheet and moves down the columns, reading words or naming the ink colors as quickly as possible within a time limit. The test yields three scores based on the number of items completed on each of the three stimulus sheets. In addition, an Interference score, which is useful in determining the individual’s cognitive flexibility, creativity and reaction to cognitive pressures also can be calculated. A stopwatch is required to administer each test.

**Other Self-Report measures that may be incorporated include:**
Negative Mood Regulation
Sleep Disturbance Screening
Depersonalization Severity Scale
Eating Disorder Inventory
Eating Screen
Symptom Checklist – 90

Relational and Personality Measures

Parenting Relationship Questionnaire (PRQ) (10 – 15 minutes to administer) The paper and pencil questionnaire, written at a third grade reading level helps capture a parent’s perspective on the parent-child relationship, including dimensions such as attachment, communication, and involvement. It also presents information of parenting style, parenting confidence, stress and satisfaction. The scales a validity index, attachment, communication, discipline practices, involvement, parenting confidence, satisfaction with school and relational frustrations. Reports can be given in T scores and percentiles based on a general population. The instrument, created by Randy Kamphaus and Cecil Reynolds, provides information useful across a variety of settings and is appropriate for mothers, fathers and other major caregivers.

Quality of Life Inventory (QOLI) (5 minutes to administer) The paper and pencil inventory, created by Michael Frisch, is written at a sixth grade reading level and is suitable for individuals 18 years or older. The 32 item instrument includes a 3-point rating scale for importance and a 6-point rating scale for satisfaction. The 16 items addressed in the QOLI include; health, self-esteem, goals and values, money, work, play, learning, creativity, helping, love, friends, children, relatives, home, neighborhood, community and an overall score. A profile report presents overall quality of life score and a weighted satisfaction profile for the 16 areas assessed. It also incorporates areas of dissatisfaction that may need further exploration. The normative data was collected on a non-clinical racially diverse population. It is regarded as a measure of positive health.

IDEAS: Interest Determination, Exploration and Assessment System (IDEAS) (approximately 35 minutes to administer) The 128 item self-report paper and pencil instrument, created by Charles Johansson, is written at a sixth grade reading level and is appropriate for individuals 18 years and older. The IDEAS inventory normative data was collected from a diverse population across the United States. It has 16 basic scales that are organized according to widely accepted themes. They include; Realistic (mechanical/fixing, protective services, nature/outdoors), Investigative (mathematics, science, medical), Artistic (creative arts, writing), Social (community service, educating, child care), Enterprising (public speaking, business, sales), Conventional (office practices, food service). Results are scored on a grid for ease of profiling.

NEO Five Factor Inventory (NEO-FFI) (10 – 15 minutes to administer) The shortened version provides quick, reliable and accurate measures of the five domains of adult personality. Created by Paul Costa and Robert McCrae, It provides five domain scales (Neuroticism, Extraversion, Openness, Agreeableness, and Conscientiousness) and is written at a 6th grade reading level. Profile grids enable T-score plotting. It is regarded as one of the major personality testing instruments for research and clinical practice.
Tennessee Self-Concept Scale: Second Edition (TSCS:2) (10 – 20 minutes to administer)
The TSCS:2 is appropriate for individuals from 7 – 90 years of age. The test gives 15 scores: Self-Concept Scores (physical, moral, personal, family, social, academic/work), Supplementary Scores (identity, satisfaction, behavior), Summary Scores (total self-concept, conflict), and Validity Scores (inconsistent responding, self-criticism, faking good, response distribution). The self-report, created by William Fitts and W. L. Warren, is easy to administer, easy to score and provides a short form option if only the first 20 items are completed. The adult form is written at a third grade reading level and is designed for individuals 13 years of age or older.

Multidimensional Perfectionism Scale (MPS) Created by Paul Hewitt and Gordon Flett, the MPS measures three trait dimensions of perfectionism. It explores the motivational, interpersonal and cognitive aspects of perfectionistic behavior and relates those characteristics to mental and physical health problems, relationship problems and achievement difficulties. The key areas measured include self-oriented, other-oriented and socially prescribed.

Boundary Questionnaire (BQ) Ernest Hartmann devised a 145 item instrument which addresses 12 different content areas; sleep dreams wakefulness (14 items), unusual experiences (19 items), thoughts, feelings and moods (16 items), impressions of one’s own childhood, adolescence and adulthood (6 items), interpersonal distance, openness and closeness (15 items), sensitivity (5 items), preference for neatness and opinions about differences between children and adults (8 items), opinions about organizational lines of authority (0 items), opinions about boundaries between groups, peoples and nations (14 items), and opinions about the identities between beauty and truth and other abstract concepts (7 items). Participants answer each item on a 5-point Likert scale ranging from 0 (not at all true of me) to 4 (definitely true of me). Eight-seven of the questions are worded in a “thin” direction so that endorsement (4) is “thin” and failure to endorse (0) is “thick”. The remaining 58 items are worded in the opposite directions so that (4) is “thick” and failure to endorse (0) is “thin”. Sum bound measures the thin or thick boundary characteristics of the individual.

Other Self-Report measures that may be incorporated include:
Parent Behavior Inventory
Personal Situations Survey
Multidimensional Fatigue Inventory
Illinois Self-evaluation Questionnaire
Past-Future Orientation Scale
Everyday Mental Activities Scale
Conceptions of Truth Inventory
Caregiving Questionnaire
Relationship Style Questionnaire
Attachment Style Questionnaire
Adult Attachment Questionnaire

Interviews
**Adult Attachment Interview (AAI).** (45 – 60 minutes to administer) It is a semi-structured interview, developed by Main and Goldwyn (Main 2002), that focuses on the individual’s description and evaluation of early attachment experiences and the effects these experiences have on current personality and functioning. The interview, which runs between 45 minutes to one hour, is transcribed verbatim from an audio-taped interview and is analyzed via a highly specialized scoring and classification system. The coding of the AAI is a complex process requiring several steps; each transcript is rated on fourteen 9-point scales and then each subject is coded for a secure or insecure classification, a main attachment category (autonomous, dismissing, preoccupied, unresolved) as well as a subcategory within this main category. The AAI explores remembered experiences of childhood, but a clear awareness is maintained that recalled experiences are highly subject to distortions and inaccuracies – what is actually assessed in the AAI is the form in which an individual’s history is presented and discussed.

Twenty questions are asked with appropriate probes given within each question. Some of the twenty questions include; “Could you describe your relationship with your parents as a young child, starting from as far back as you can remember?; I’d like you to choose five adjectives that you feel describe your early relationship with your mother and then I will ask you about why you chose each one?; When you were upset as a child what would you do?; What is the first time you remember being separated from your parents?; Did you experience the loss of a parent or other close loved one when you were a child?; and Is there any particular thing you feel you’ve learned above all from you childhood experiences?”

To date there have been multiple studies conducted around the world confirming high test-retest reliability, inter-rater reliability and validity of the AAI as a robust instrument for predictive attachment classifications for infants and couples (Hesse 1999). This is the most reliable and widely used attachment instrument for subjects who are 10 years of age or older and recurrent reliability checks are conducted on approved coders within the field to maintain its high standard.

**Other Interview Instruments that may be included:**
Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I)
Structured Clinical Interview for DSM-IV Axis II Personality Disorders (SCID-II)
Structured Clinical Interview for DSM-IV Dissociative Disorders (SCID-D)

**Statistical analysis.** The psychological and physiological data will be related to functional conditions utilizing standard regression techniques, adjusted for possible confounding factors. Descriptive analysis will be conducted for all sub-studies within the larger research project. Analysis of variance to be used to determine differences in physiologic and psychological variables as they relate to self-regulation. Spectral analysis will be used to analyze the data gathered from the Vivometric LifeShirt, including heart rate variability. Data will be stored in Access, and analyzed using SPSS 15.0 for Windows (SPSS, Inc., Chicago IL) and Vivo Logic software for statistical analysis of LifeShirt ambulatory monitoring.

**Data Storage and Confidentiality.**
All staff will be briefed in the respect for subject confidentiality, and will be instructed not to discuss subject results. Staff will be trained in and understand HIPPA requirements, including the mandated reporting policy as determined by the State of California and the California Board of Psychology. Upon completion of participation, subject files will be anonymized, with all personal identifiers and decoding information removed from the subject files and stored in a locked file cabinet in the office of the PI for a minimum of 5 years after study completion.

Financial Compensation for Participation: There is no financial compensation for participation in this study.

**SUBJECT IDENTIFICATION, RECRUITMENT AND CONSENT/ASSENT**

**Method of Subject Identification and Recruitment:** Our recruitment efforts will include advertisements in newspapers, personal recruitment sessions in CSUN classrooms and dormitories, and recruitment during orientation sessions for new students. Outside recruitment for elite/professional performing artists and athletes will include advertisements in newspapers, workshops and training facilities. Our project director will coordinate all recruitment efforts.

**Subject Competency:** Subjects recruited must be competent to provide written informed consent.

**Process of Informed Consent:** Potential study subjects who pass the screening process will be invited to visit the laboratory of the principal investigator for an appointment to discuss the study, its purpose, procedures to be employed, the potential risks and benefits of participation. During this session, the individual will be provided with an opportunity to ask questions about the study. The candidate will then be given the consent form to take home and a subject information sheet, and will be encouraged to discuss the trial with friends and family members. The subject will return for the first study visit, which will again begin with a discussion of the study. When subjects have provided written informed consent, they will be enrolled in the study.

**Subject or Representative Comprehension:** Subjects will be encouraged to bring significant others and family members to the informed consent sessions. Both the subjects and their representatives will be encouraged to ask questions and to help evaluate the potential subjects’ risk/benefits relationship. During both sessions, the subjects and their representatives will be queried to ascertain whether they understand the purpose of the study, the testing procedures, potential risks and benefits, to ensure that the subject comprehends the study and his/her responsibilities.

**Information Purposely Withheld:** No information will be withheld from the participant; however, raw data will not be supplied. A written summary of results will be given upon request.
Documentation of Consent/Assent: Paula Thomson, PsyD (investigator), S. Victoria Jaque, PhD (co-investigator) and student assistants (to be named) will document the acquisition of the signed informed consent/assent. All student assistants will take part in HIPPA training and mandatory reporting requirements as defined by the State of California and California Board of Psychology.

Proprietary Interest Disclosure: The investigators and study team have no proprietary interest that would influence this study.

Privileges/Certifications and Licenses: Psychophysiological tests will take place in the Department of Kinesiology, where the staff are licensed and trained, respectively, to perform the procedures. Dr. Victoria Jaque is an Associate Professor of Kinesiology and will be responsible for supervising the physiological assessments and Dr. Paula Thomson is an Associate Professor of Kinesiology and a Clinical Psychologist and will be responsible for supervising the psychological assessments.

B. BACKGROUND AND SIGNIFICANCE
Self-report measures/questionnaires have been the traditional assessment instruments used to gather patient and research subject information (Fahrenber, Myrteck, Pawlik & Perrez, 2007). Although they tend to be quick to complete and relatively easy to score, best-practice policies often recommend the administration of semi-structured interviews to accurately diagnose/assess patients/subjects who may lack insight or cannot engage in the level of perspective-taking necessary to accurately judge their own symptomatology (Roisman, G.I., Holland, A., Fortuna, K., Fraley, R.C., Clausell, E. & Clarke, A., 2007; Hopwood, et al., 2008). Further, it has been observed that subjective self-report instruments are vulnerable to perceptual distortions, hence they are less objective. They also assess the experience or behavior retrospectively, at a different time and place from where the behavior or experience actually occurred (Westmeyer, 2007). Since the 1980s, portable microcomputer systems and physiological recorders/analyzers have been employed to provide ambulatory assessment, while a participant undergoes normal daily activities (Fahrenber, et al., 2007). These ambulatory instruments frequently include a diary where subjective symptom patterns can be entered and integrated with the ongoing physiological measures. These ambulatory assessment instruments provide profiles of temporal dynamics within a subject, and although questionnaires are still preferred, primarily because of cost-effectiveness, research studies need to be conducted to determine if these popular self-report instruments accurately reflect the underlying physiological behaviors of the individual (Fahrenber, et al., 2007; Westmeyer, 2007).

The inclusion of the Vivometric LifeShirt in all aspects of this research study is to capture the autonomic measures of the performing artist or athlete (or control) during performance. Since physiological and psychological regulation is a complex feedback-feedforward dynamic interaction that involves complex neural circuitry, it is very challenging to evaluate regulatory systems involved during stress-induced performance events. One of the major focuses in this study is to evaluate the participant’s psychophysiological autonomic nervous system regulation. We hope to examine its
response during both internal and external stress. Lately, the regulation of the sympathetic branch by the parasympathetic branch, especially the vagal control of heart rate, has received considerable attention (Sahar, Shalev & Porges, 2001). One of the best-practice evaluations of this dynamic regulation is to measure changes in autonomic nervous system activity through heart rate variability (Weinstein, Deuster & Kop, 2007). Further, heart rate variability is frequently an important dependent measure in psychophysiology and behavioral medicine. Indeed, heart rate variability is considered a powerful tool for the clarification of relationships between psychological (emotional, behavioral and cognitive variables) and physiological processes (Berntson, et al., 1997). Much attention has been given to standardize the measurement and clarify the interpretation of heart rate variability (Malik, et al., 1996) and with this clarification new measuring instruments have been designed to accomplish this task (Ebner-Priemer & Kubiak, 2007). One of the best instruments to date is the Vivometric LifeShirt (Wilhelm, Roth & Sackner, 2003; Heilman & Porges, 2007).

Although psychophysiological research is expanding rapidly, there remains inadequate research investigating the relationship of the autonomic nervous system to stress disorders (Sahar, Shalev & Porges, 2001; McDougall, Widdop, Lawrence, 2005; Morgan III, Aikins, Steffian, Coric & Southwick, 2007), exercise tolerance/withdrawal (Nuissier, Chapelot, Vallet & Pchhon, 2007; Weinstein, Desuter & Kop, 2007), mood (Anderson & Lawler, 1995; Barret, Bliss-Moreau, Quigley, Aronson, 2004; Kalisch, et al., 2005), personality traits (Riese, Rosmalen, Ormel, Roon, Oldenhinkel & Rijsdijk, 2007; Ebner-Priemer & Sawitzki, 2007) and creativity (Bechtereva, Danko & Medvedev, 2007). Since the autonomic nervous system is critical in homeostasis, it is regarded as a significant physiological regulatory process. Like all biological systems, the autonomic nervous system is directly influenced by environmental experiences. Given this relationship, this study hopes to add to the understanding of self-regulation, and by extrapolation, resilience. Resilience refers to “a phenomenon characterized by good outcomes in spite of serious threat to adaptation or development” (Masten, 2001). One of the findings from this research study may be to observe the autonomic nervous system, and in particular, heart rate variability during participant ‘good out-come’ responses during stress and how dysregulation in the autonomic nervous system increases risk for poor self-regulation and subsequently a lack of resilience.

The proposed research study is designed to address psychological variables and how they relate to physiological regulation. By including heart rate variability assessment in a population of performing artists and athletes, we hope to gain greater understanding about the nature of self-regulation. Comparing self-report measures and semi-structured interviews, designed to probe for mood, creativity, and coping strategies (cognitive, behavioral, affective, personality), to physiological autonomic responses will facilitate a clearer profile of psychophysiological regulation and dysregulation. Further, comparing self-report and interview instruments with ambulatory physiological measures may provide greater validity to the self-report and interview instruments. And gaining understanding about underlying physiological regulatory processes can potentially inform subsequent studies focused on improving training procedures and treatment protocols.
Lastly, this research project will contribute significantly to the field of creativity, since the science of psychophysiology of creative engagement is in its infancy (Bechtereva, Danko & Medvedev, 2007).

2. Describe the Projected outcomes and how they relate to the hypothesis:

Fundamentally, this research project will provide essential information about the relationship between self-report, interview and ambulatory assessment. The empirical research provided from this study (and its graduate student sub-studies) will offer insight into the psychophysiological behaviors of professional / elite performing artists and athletes (and controls). No study to date has measured, correlated and conducted a predictive analysis on the psychophysiological variables in these populations. With greater understanding about the interactions of autonomic functioning and the psychological behaviors of creativity, stress, mood, personality and relationships, enhanced clarity about self-regulation strategies can be highlighted. Since physiological and psychological markers of stress/dysautonomia can be identified in vivo within this project, common approaches used by performing artists and athletes to re-regulate will be directly observed and measured. These regulatory strategies can support recommendations for training and education. Future research directions will be amplified based on findings from this study such as the need to find and/or develop new instruments designed to accurately measure self-regulation. Further, a pattern of rate and severity of injury may manifest as a by-product of the longitudinal repeated measures methodological approach. Presently no study has successfully predicted injury rate or developed protocols to reduce injury rate in a dance population (Weigert, 2007). Based on the physiological measures gathered in this study subsequent studies may be designed to determine variables that may correlate to rate and severity of injury and/or level of success.

A secondary outcome will occur within the course, Directed Research – Dance Psychophysiology. Students enrolled in this course will work in conjunction with the research team to formulate specific research questions to be studied during the course. With repeated course offerings more psychophysiological profiles of these two populations will emerge. Students will gain invaluable experience in a research setting. Enhanced understanding about recruitment procedures, scientific relevance, subject selection that is fair and without coercion, and a deepening appreciation for the risk-benefit ratio favorable to participants will be practiced by students training in research policies within this course. Further, students will understand the practice and policies of informed consent, Bill of Rights, and the necessity for strict adherence to maintaining confidentiality and privilege. Although these are not direct outcomes from the project, they are certainly student learning outcomes that are integral to this graduate course. When graduate students agree to engage in this research study, and their supervisor supports their thesis/dissertation proposal, their names will be added to the IRB approval protocol. And if their proposal falls outside the parameters of this IRB protocol, then a new IRB proposal will be prepared and submitted for review by the Committee.
3. List of potential risks to participants:

Potential Risks: Risks to subjects include potential emotional distress that might be elicited by some of the questions included in the self-report questionnaires and the semi-structured interviews. Boredom and/or fatigue may result during the completion of the questionnaires, although they are relatively short self-report instruments. Participants may request to be debriefed individually by a member of the research team when the self-report instruments are returned. All participants of the semi-structured interviews will be de-briefed at the completion of the interviews. Wearing the Vivometric LifeShirt is comfortable and extremely lightweight; however, attaching electrodes to the chest wall and abdomen may cause some mild distress. Physiological risks during exercise might occur such as muscular fatigue or light-headedness, although a careful screening for level of fitness will reduce frequency of risk within the participants.

Protection Against Risks: There exists the possibility of abnormal blood pressure, fainting, disorders of heartbeat, and very rare instances of heart attack during the exercise testing. In some individuals, muscle soreness may occur for a brief period after strength testing, and on rare occasion, a muscle pull that will usually resolve after a few days of rest. Every effort will be made to minimize the risks encountered during exercise testing by the preliminary examination and by observations during testing. If, during any exercise, there is apparent danger to the subject, the test will be terminated.

There also exists the risk of embarrassment while answering sensitive questions. Every effort will be made by the interviewer to avoid embarrassment while administering sensitive questions. A licensed psychologist will be on site if any participants wish to debrief after they have completed the self-report tests and interview. If self-report instruments or interviews indicate signs of depression, the participant will be referred to a licensed clinical psychologist at his/her own expense. Information disclosed by the participant is generally confidential and will not be released to any third party, except where required or permitted by law. Confidentiality is broken in specific circumstances such as in cases of child, elder and dependent abuse, when there is imminent danger to the participant or others, including serious threat of suicide or threat of violence towards a reasonably identifiable victim. As legally mandated reporters, members of the research team are required to insure the safety of minors, elders and dependents and to protect the safety of the participant and identifiable victims. If a mandated report for abuse to a minor, dependent or elder is given and accepted by the appropriate government agency an investigation will be conducted. Every effort to protect the participant will be insured by the agency and the research team. Further, researchers will provide a list of contact numbers of CSUN and local community resources such as crisis hot lines and counseling mental health centers who work with trauma survivors. De-briefing training for researchers administering the psychometric instruments will include plans to make appropriate follow-up inquiry or referrals, depending on the respondent’s answers and requests.
Risks will be minimized by making participation voluntary and by ensuring subject confidentiality. *Subjects can withdraw from the study at any time without penalty.* Confidentiality will be assured by assigning a code number to the raw data and participants can self-elect to not include any identifying information. Confidentiality will be maintained throughout the study and in subsequent scientific paper/presentation preparations.

*Potential Benefits to the Subject:* The investigators cannot and do not guarantee any specific benefit to the subjects from their participation in this study. All subjects will receive the results from their repeated measures tests.

*Potential Benefits to Society:* This study may help us better understand the relationship between self-report instruments, interviews and ambulatory assessment. This research project is a repeated measures longitudinal design that is conducted during multiple rehearsal / training / performance settings, and as a result we will gain an enhanced understanding about an individual’s psychophysiological variables associated with regulation and dysregulation. These variables associated with regulation may be incorporated into subsequent training and treatment recommendations.

*Risk/Benefit Relationship:* The risks of questionnaire administration, interviews, strength testing, and aerobic exercise testing and ambulatory physiological assessment have been listed above. During study participation, every effort will be made to minimize potential risks to the subjects. Careful screening and testing procedures will be employed to ensure subject safety during the study procedures. The potential benefits of the study have been listed above, and include information about psychophysiological regulation. After carefully weighing the risk/benefit relationship, the investigators feel that the ratio favors study enrollment.

4. **Significance of Research Study to Discipline, Department, University, Community:**

Determining the relationship between autonomic nervous system response during the administration of self-report instruments, interviews and exercise testing will clarify the dependent measure of heart rate variability and how it is influenced by multiple performance variables. Establishing psychophysiological profiles on professional / elite performing artists and athletes will increase our understanding about the nature of self-regulation and resiliency. The project will have significance to the field of psychology/psychiatry, add to the growing findings in the field of creativity research and help the department of Kinesiology and the College of Health and Human Development at CSUN since they will be identified in scientific journals and presentations.

Students from the Department of Kinesiology graduate program, enrolled in the Experimental Topics course KIN 695 Directed Research - Dance Psychophysiology will have the opportunity to participate in formulating research questions, gather data, analyze and prepare journal articles. Students will be encouraged to join in the data collecting, data entry into SPSS-15, and where appropriate, contribute to journal article writings and
presentations at conferences. Active involvement in faculty research projects provides undergraduate and graduate students rich research experience. This experience will potentially strengthen their application to doctoral university school programs.

Further the results of the project will hopefully help the wider academic, mental health and arts community. We plan to offer insight into curriculum development for arts and athletic programs. It is the investigators’ hope to provide recommendations, prepare articles and promote programs that focus on enhancing self-regulation. Research projects of this breadth and scope are made possible by the collaboration of researchers from diverse backgrounds. The Department of Kinesiology at CSUN offers opportunities for such collaboration. The publication of results on the psychophysiologival responses of performing artists and athletes, and the interaction between self-report, interview and ambulatory physiological assessments are all considered under developed research, in fact, the science of psychophysiology in these domains remains in its “infancy” (Bechtereva, Danko & Medvedev, 2007).

5. Summary of Qualifications to conduct project (include prior research)

Paula Thomson, Psy.D., is a licensed clinical psychologist and an internationally recognized expert in the field of dissociative disorders and complex PTSD. She has worked for the past 5 years as the Principle Investigator, with Dr. Barry Keehn, Ph.D., Psy.D. and Dr. Thomas Gumpel, Ph.D., on a research study examining a psychological profile of performing artists that was approved by the Human Rights Ethics Committee at York University, Canada. The preliminary results of the research study were presented at the 2006 Conference for the International Society for the Study of Trauma and Dissociation. The article “Generators and Interpreters: Dissociation, trauma, fantasy proneness and affective states in a performing artist population” is presently in press with Creativity Research Journal. Subsequent follow up data collection in this project is currently underway. Athletes and dissociative disordered patients are now being given the self-reports. Dr. Thomson is incorporating a second track of research analysis on these three populations, in which the Adult Attachment Interview is given to assess state of mind about attachment. The results will provide further information on the coherence and resilience of the individual being interviewed and the degree of resolution for past trauma and loss. This project should be completed by late 2008 and a manuscript should be ready for submission by late 2009.

Further, as a reliable coder in the Adult Attachment Interview, Paula is a member of the research team with Rebecca Turner from California School of Professional Psychology/AIU, San Francisco, and Kelly Forrest from University of Washington. This team is investigating attachment classification and resilience in a college freshman poverty sample.

Finally, the principal investigator is Professor Emeritus at York University, Associate Professor at CSUN and a licensed clinical psychologist. She has extensive experience working and training professional artists and is considered an internationally recognized specialist in the field of dissociation, attachment and trauma. Dr. Thomson is rated a highly reliable coder on the AAI as determined internationally by Dr. Mary Main and Dr.
Erik Hesse, University of California, Berkeley. Although no funding has been secured for these projects, the research team is committed to completing this work and to continue their work in this field of study.

S. Victoria Jaque, Ph.D. is an Associate Professor in the Department of Kinesiology, California State University, Northridge, with expertise in the value of physical exercise as an intervention method to enhance bone accretion and muscular strength during maturation. She has designed and implemented studies on the relation of exercise, ovarian hormones, adrenal androgens, genes regulating ovarian hormones and bone mineral density in young women. From these projects, she has presented a number of abstracts, published manuscripts and has manuscripts in preparation. Strength testing, exercise testing and the assessment of bone mineral density are areas of expertise for Dr. Jaque. For almost 20 years, Dr. Jaque was involved in a study of over 200 master athletes, ranging in age from 40-100 years, during which she performed maximal exercise testing, muscular strength and endurance testing, and bone mineral density testing. In addition, she has been involved in the design and completion of intervention studies to enhance muscle mass in HIV and age-related sarcopenia. As with her previous investigations, she will oversee the acquisition, analysis and interpretation of all exercise testing data obtained from each subject throughout the study.

Currently Dr. Jaque and Dr. Thomson are co-investigators in a CSUN IRB approved research study, Migraine and Psychophysiology. This study is concluding the pilot phase of data collecting.

The proposed research study, Psychophysiological Study of Performing Artists and Athletes, grew from the initial experiences of Dr. Jaque and Dr. Thomson, when they worked with the Vivometric LifeShirt during the Pilot phase of the Migraine and Psychophysiology study. The ability to measure dynamic temporal autonomic responses, facilitated by the LifeShirt, has fostered an expansion and integration of these two professors’ areas of expertise, exercise physiology and psychology, respectively. Further, both professors have significant background experiences in the performing arts, and in particular, dance. The convergence of these experiences has resulted in the creation of the Kinesiology Graduate course, Directed Research – Dance Psychophysiology and the plans for this proposed research study. Based on past and current practices, it is highly likely that Dr. Thomson and Dr. Jaque will adequately complete this project, including conducting data collection at the highest levels of research standards.

Research of this breadth and scope are made possible by the collaboration of researchers from diverse backgrounds. The Department of Kinesiology at CSUN offers opportunities for such collaboration. This research project will provide graduate students in the Department of Kinesiology a rich opportunity to participate in this integrative study. The publication of the results will promote greater awareness of the correlation between self-report, interview and ambulatory assessment. Increased awareness of the relationship between dynamic temporal autonomic responses during heightened performance settings will enhance awareness of the integrative nature of regulation and resilience and will address the need for greater clinical understanding and recognition.


