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A Neurophysiological Examination Of Stress Control In Martial Artists

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Master of Science, Biology

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ABSTRACT

The philosophies behind many martial arts often claim that by practicing martial arts individuals can gain better control over stress. We tested this idea by using controlled physical stressors to elicit an acute stress response from martial artists (n=15) and non-martial artists (n=18). To measure the extent of the stress response, we looked at changes in heart rate, respiratory sinus arrhythmia, and galvanic skin level. These three measures explore both parasympathetic and sympathetic responses, and changes in these variables continue to be explored in studies of stress and reactive aggression . In addition to our physical stressors we also exposed individuals to affective imagery from the International Affective Picture System (IAPS). Individual levels of aggression were also assessed using the Buss and Perry Aggression Questionnaire. Martial Artists elicited a stable galvanic skin level while being tapped upon the forehead, and there was a trend that indicated the martial artists were less aggressive.

This study is dedicated to life of Ip Man

LIST OF ABBREVIATIONS

GSL	Galvanic Skin Level
HR	Heart Rate
IAPS	International Affective Picture System
MA	Martial Arts Group
NMA	Non-Martial Arts Group
rHR	Resting Heart Rate
RSA	Respiratory Sinus Arrhythmia
rRSA	Resting Respiratory Sinus Arrhythmia
S1	Stressor 1
S2	Stressor 2
S3	Stressor 3
S4	Stressor 4
T1	Stressor Test 1
T2	Stressor Test 2

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INTRODUCTION

MARTIAL ARTS, AGGRESSION, AND STRESS

Many martial artists claim that the practice of martial arts will result in greater control over aggressive impulses and result in greater discipline. There is evidence to suggest that styles which include more traditional aspects of the style, such as katas or forms, have helped aggressive children to become calmer and more respectful towards their teachers (Twemlow & Sacco, 1998; Lamarre & Nosanchuk, 1999; Reynes & Lorant, 2004). *Katas* (Japanese) and *forms* (Chinese) are rehearsed exercises that are said to embody the style and demonstrate skill sets that are valued by the masters of the style.

Reynes and Lorant (2004) point out that the traditional styles, which emphasize the use of *katas* or *forms*, help to decrease aggressiveness in children (Judo in particular, had a negative effect on anger scores). In the Reynes and Lorant (2004) study, they tracked the responses of children training in Judo and Karate to the Perry Aggression Questionnaire (1992), which was repeatedly administered over two years (at the beginning of the first sports season, the beginning of the second sports season, and the beginning of the third season). Zivin et al. (2001), conducted a similar study with about 40 more participants than Reynes and Lorant (2004), and found that implementing a martial arts class in a middle school with a notably high delinquency rate resulted in a decrease in impulsiveness and socially unacceptable behavior among aggressive boys; teachers rated the students using the Sutter-Eyberg Student Behavior Inventory, another questionnaire that takes into account the frequency of aggressive behaviors (Zivin et al., 2001).

In contrast, some studies have found that the practice of martial arts increases rather than decreases the stress response. Endresen and Olweus (2005) found that adolescents involved in what they termed *power sports*, which included martial arts with no meditative/philosophical elements, such as wrestling and boxing, exhibited more antisocial behavior than the control group, and the longer the time the participants had practiced the power sport, the more antisocial they became. They even suggested that stopping participation in these activities might lead to a decrease in overall aggressive behavior. Endresen and Olweus (2005) used the Bergen Questionnaire (Bendixen & Olweus, 1999)to determine levels of antisocial behavior; this questionnaire takes into account the frequency with which the children acted as an aggressor towards other children.

In sum, the literature thus far is not clear on whether martial arts training leads to a change in aggressive behavior. In addition, the outcome measures in previous studies have been overall changes in aggressive or antisocial behaviors, not controlled measures of the stress response, thus making it difficult to discern the influences of environment on behaviors and whether the change is physiological, psychological or both.

I investigated the efficacy of martial arts practice in controlling the autonomic nervous system in the face of controlled stressors by measuring three physiological indicators of autonomic response. As aggressive behavior often comes from poor control over one's stress response, it is important to understand practices that can actively reduce aggressive outbursts.

Individuals vary in their behavioral response to acute stress. One response is reactive aggression. Reactive aggression, which results from a sudden escalation in heart rate due to stressful stimuli (Waschbusch, Pelham, Jennings, Tarter, & Moss, 2002) is considered to be an angry or defensive response to frustration or provocation (Crick & Dodge, 1996), and is considered to be the *fight* part of the *fight or flight* response (Blair, Mitchell, & Blair, 2010). Reactive aggression is frequently the cause of domestic abuse (Gottman, et al., 1995) and even suicide committed by the aggressor (Conner, Duberstein, Conwell, & Caine, 2003). Given that individuals who are susceptible to overactive autonomic responses can be dangerous to themselves and others in a stressful situation, any practice, such as martial arts, which could reduce the overactive response may have therapeutic implications.

My study compares male martial artists and male non-martial artists in terms of autonomic control in the face of controlled stressors rather than measuring broad level aggressive or antisocial responses to an uncontrolled environment.

MEASURING STRESS, AGGRESSION, AND PHYSICAL FITNESS

The main goal of this thesis was to explore the potential differences in autonomic activity between martial artists and non-martial artists in the presence of stressors (events that trigger autonomic activity and cause acute stress). To test potential differences, I designed a series of stressor tests that were delivered to participants at the same time as three autonomic measurements were recorded; heart rate (HR), galvanic skin response (GSR), and respiratory sinus arrhythmia (RSA). These three measurements provide indications of the level of activity in the autonomic nervous system during acute stress.

The Buss and Perry Aggression Questionnaire (Buss & Perry, 1992), which is a well-used and validated indication of personal aggression, was also used to assess the participants' level of aggression (Appendix 1). This questionnaire provides an overall score that can be broken down into physical aggression, verbal aggression, anger, and hostility. The scores on the Buss and Perry Aggression Questionnaire were used as a measure of aggression and used as a covariable when determining autonomic differences between martial artists and non-martial artists. This analysis allows me to parcel out an individual's tendency towards aggression as an influence on autonomic response. The scores on the Buss and Perry Aggression Questionnaire were also compared between groups to determine whether martial artists in general are less aggressive than non-martial artists.

To make sure physical fitness or age would not be major influences on any differences found between our martial artists and non-martial artists, I determined whether VO_{2max} and age differed between the groups. In order to assess the level of physical fitness of the participants I used the University of Houston Non-Exercise Test for predicting VO_{2max} (Jackson et al., 1990). This questionnaire accurately predicts maximum oxygen consumption, without subjecting the participants to exercise. VO_{2max} is an indication of the maximum capacity of an individual to transport and use oxygen, with higher volumes reflecting an elevated state of physical fitness. The University of Houston Non-Exercise Test for predicting VO_{2max} uses height and weight to calculate body mass index (BMI) and then modifies this score to take into account frequency of exercise, gender, and age. Jackson et al. (1990) found the correlation of their non-exercise test to the Astrand single-stage exercise test for determining VO2 to be strongly correlated ($r = 0.78$).

Resting Respiratory Sinus Arrhythmia (rRSA), which provides an indication of parasympathetic activity at rest, was also measured before the stressor tests to see if it could be used as a predictive measure of sympathetic activity. There is a growing body of evidence that suggests rRSA can be used to predict behavioral responses to changes in autonomic activity (Gyurak & Ayduk, 2008), and so this study sought to examine its predictive utility.

THE PHYSIOLOGICAL BASIS FOR THE STRESS RESPONSE

Acute stress in humans results from perceiving a threatening stimulus. This leads to the activation of a physiological response, such as increased heart rate, and sometimes, depending on the perceived severity, a behavioral response, such as fight or flight (McEwen, 1998). Stressors are interpreted and perceived in the frontal lobe, which communicates the threat to the hypothalamus and the amygdala. Together, these three parts of the brain control and mediate the autonomic response to stressors, and the level of response is positively correlated with the perceived nature of the stressor; the greater the perceived threat level of the stressor, the greater the autonomic response. If the perceived stress is large enough, the hypothalamus will communicate to the periaqueductal gray (PAG) in the brain, and a behavioral response to the stress will be initiated, which in humans is fight, flight, or freezing.

The autonomic nervous system (ANS), which is controlled by the frontal lobe, the amygdala and the hypothalamus, has two components; the sympathetic branch, which generally prepares the body for action, and the parasympathetic branch, which typically allows the body to return to homeostasis after arousal. If the environment suddenly demands an elevated response from any biological system within the body, the sympathetic nervous system will typically seek to further innervate this system, and parasympathetic innervation will decrease in order to allow the influence of the sympathetic nervous system. When the environment changes in such a way as to require the body to return to rest, the parasympathetic nervous system will typically innervate the same system, and the sympathetic response will decrease.

Humans also have an endocrine response to stress, which is largely mediated by the hypothalamic-pituitary adrenal axis (HPA), whereby the perceived threat prompts the hypothalamus to release corticotropin releasing factor (CRF), which in turn causes the release of adrenocorticotropic hormone (ACTH) from the anterior pituitary. ACTH then travels in the blood to the adrenal glands, which then secrete cortisol into the blood. Cortisol in humans is responsible for gluconeogenesis (Gatti et al., 1985; Lecavalier et al., 1990; Hucklebridge et al., 1999), which prepares the body for increased metabolism and cellular activity. The endocrine response to stress helps to bolster activity in the sympathetic nervous system.

Both branches of the ANS are intimately involved in the regulation of cardiac activity. Efferent fibers of the vagus nerve (a parasympathetic nerve), which originate in the brainstem, synapse in the Sinoatrial Node (SA) and act as a pacemaker (Beauchaine T. , 2001); the effect of vagal innervation in the SA is inhibitory and involves the release of acetylcholine into the myocardial cell membrane, which serves to reduce heart rate (Galper et al., 1977). Sympathetic innervation arrives from the thoracic spinal cord and synapses on the heart, and is usually measured by sympathetic neuronal firing rates and cardiac norepinephrine spillover (Kingwell et al., 1994). As well as controlling heart rate, the parasympathetic and the sympathetic nervous systems also mediate our breathing. Inhalation is stimulated by sympathetic activity and exhalation is stimulated by parasympathetic activity.

Monitoring heart rate can provide an indication of autonomic activity, but because the beating heart is controlled by the sympathetic and parasympathetic branches, an increased heart rate cannot tell us if sympathetic activity has increased over parasympathetic activity. Therefore it is useful to combine this measure with other physiological measures that provide an indication of mostly sympathetic activity or mostly parasympathetic activity.

As the parasympathetic branch oversees the body returning to rest, a measure of solely parasympathetic activity will provide us with an indication of how well a person can return to their resting state after being confronted by a stressor. One useful measure of solely parasympathetic activity is respiratory sinus arrhythmia (RSA). This measure has been used in numerous studies as an indication of parasympathetic activity (Kenney, 1985; Grossman and Svebak, 1987; Grossman et al., 1991; Crowell et al., 2006).

RSA can be calculated by subtracting the lowest heart rate during exhalation from the highest heart rate during inhalation (see Fig. 1), and provides an indication of vagal integrity (Sharma et al., 2011). If the parasympathetic response is weakened or insufficient it will be harder for the individual to relax, meaning that heart rate and breathing could remain elevated. If these states remain elevated, the potential for a stress response, such as fight or flight is also increased, especially if the individual's environment continues to provide exciting or stressful stimuli. In fact, poor parasympathetic innervation has been tied to aggressive behavior in children (Calkins et al., 2007).

Heart rate and RSA have both been used to test the autonomic responses of aggressive individuals, such as adults with Antisocial Personality Disorder (APD) (Raine et al., 2000; Sylvers et al., 2008), children with Conduct Disorder (CD) (Mezzacappa et al., 1998; Beauchaine et al., 2001; Vasilev et al., 2009), domestic batterers (Umhau et al., 2002; Murray-Close, 2011; Pinto et al., 2010), and delinquent teenagers (Calkins et al., 2007; Beauchaine et al., 2008).

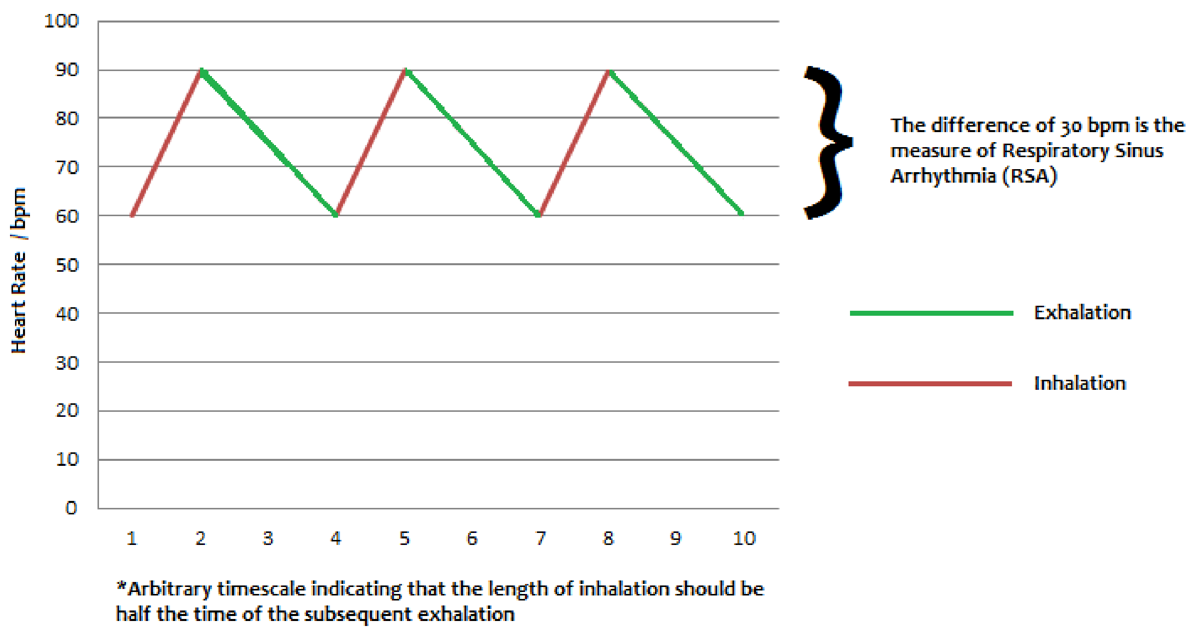

Fig. 1

This graph depicts Respiratory Sinus Arrhythmia in a healthy individual, where the length of inhalation is half the time of exhalation. During inhalation heart rate increases (measured in beats per minute / bpm) and is represented here by a red line, and during exhalation heart rate decreases, represented here as a green line. The parasympathetic nervous system has the job of causing a decrease in heart rate during exhalation before the sympathetic nervous causes the heart rate to increase again. How far bpm drops from the height of inhalation to the end of exhalation, therefore, is a measure of how well the parasympathetic nervous system has performed. In this study RSA was measured in milliseconds; the r to r interval at the peak of exhalation minus the r to r interval at the peak of inhalation.

Sweating, or galvanic skin level (GSL), provides us with a measure of autonomic activity that is solely the result of sympathetic activity (Darrow, 1936). Sympathetic neurons cause the sudorific tubules in eccrine sweat glands to fill with sweat in preparation for releasing sweat onto the surface of the skin. As the tubules fill with sweat, which contains numerous ions including sodium and chloride, the conductivity of the skin increases and this can be measured using recording electrodes. The electrodes are usually placed in areas of high sweat gland concentration, making an individual's finger tips the perfect area to place the recording electrodes.

Sweat glands are innervated as a response to a rise in temperature, but also when the organism is in the presence of an arousing visual stimulus (Bradley et al., 2001). Indeed, Bradley et al. (2001) found that galvanic skin response for positive stimuli is high when participants are confronted with erotic photos and low when faced with photos depicting adventurous behavior and sports, and for negative stimuli the galvanic response is high when the individual is faced with photos of animal or human attacks, and low when they were faced with photos of illness or pollution.

GSL has also been successfully correlated with levels of anxiety (Caprara et al., 2003) and an increase in sweating is also present as a result of fear conditioning (Davis et al., 2006). The nature of the stimulus (positive or negative) cannot be interpreted from GSL results alone, and positive or negative perception of the stimulus can only be assumed by the experimenter, given their own interpretation of the stimulus, or from using the valence levels that are provided with affective photo sets. The valence levels provided by Lang et al., (2008) for the

IAPS affective photo set runs from 0 to 10, where 0 is the most unpleasant and 10 is the most pleasant. These ratings can then be used to construct a spectrum of increasingly unpleasant or increasingly pleasant images.

GSL has also been used to measure the autonomic response to stimuli of reactively aggressive individuals (Gottman, et al., 1995; Raine et al., 2000; Babcock, 2005). Autonomic measures of these individuals to stressors or innocuous stimuli are useful for two reasons; firstly, reactive aggression is a behavioral outcome of the central nervous system (Blair, Mitchell, & Blair, 2010) and is simply the fight part of the *flight* or *fight* response to a threat. If individuals are reactively aggressive, therefore, autonomic activation using controlled stressors allows us to make comparisons between more aggressive and less aggressive individuals. Secondly, the level of activation of the autonomic nervous system can be compared with the relatively innocuous/threatening nature of the stimulus, allowing us to see how quickly and how far an individual's autonomic response will part from homeostatic levels in the face of a range of stimuli.

In order to test the differences in the physiological response to stressors, I designed two physical stressor tests (T1 and T2). With the exception of a five second burst of 105 dB of white noise before each stressor in T2, the tests were composed of exactly the same stressors, carried out in exactly the same way. 105 dB of white noise has been used as a negative stimulus in human studies (Meier et al., 2006) and was used to explore whether or not the physical stressors delivered after the white noise would result in any physiological differences when compared to the first test, which used no white noise.

The first three stressors in both T1 and T2 were designed in the light of the invasion of personal space literature, which was popular in the 1970s. When others stand in close proximity to an individual, it causes an elevation in sympathetic activity (Efran and Cheyne, 1974; Middlemist et al., 1976). The fourth and last stressor in the tests was implemented to see if the expectation of a light physical strike also causes a significant rise in the sympathetic response.

To complement the two physical stressor tests that I designed, I also exposed the participants to affective photos. The International Affective Photo System (IAPS) is widely used, and average physiological responses to each photo for typical male participants have been previously determined through extensive studies (Lang et al., 2008). By using photos from this set I could see the change in physiological response when each participant was exposed to increasingly negative imagery. This allowed us to explore responses to purely visual stressors, in addition to my test of stressors that invade the participant's personal space.

HYPOTHESES

I expected martial artists would show greater autonomic control over their sympathetic nervous system when faced with stressors, as compared to non-martial artists. Martial artists would show increased parasympathetic innervation after they have been exposed to the stressor, when compared to non-martial artists. I also thought that there would be a demonstrable difference in changes of heart rate between martial artists and non-martial artists when were exposed to stressors. All of these hypotheses are indicative of better control over the autonomic response to acute stress.

I also thought that martial artists would score lower on the Buss and Perry Aggression Questionnaire when compared to non-martial artists. If the martial artists did have better stress control, I also expected them to have better control over their own personal aggression. Subcomponents of the Buss and Perry Questionnaire are typically correlated, thus I expected to find correlations of subcomponents in my use of this test.

And finally, I thought that there would be a negative correlation between resting Respiratory Sinus Arrhythmia (rRSA) and aggression scores across groups (not factoring in martial arts training), and a negative correlation between rRSA and changes in sympathetic activity during stressor tests across groups (not factoring in martial arts training). In the literature it is thought that rRSA can be used as a predictor for aggression, with higher rRSA associated with lower aggression (Beauchaine T., 2001). I sought to test this by comparing rRSA to both aggression scores and sympathetic activation.

METHODS

These methods were approved for a thesis study by the Institutional Review Board (IRB) at the University of Mississippi (Protocol# 13-004).

MATERIALS

The software program *Acqknowledge 4.2* was used in conjunction with an MP150 module to record physiological waveforms for each participant. Attached to the MP150 were three additional modules: ECG100C with a three electrode leads attached to monitor heart rate; RSP100C with a respiration belt to track breathing cycles; GSR100C with two skin electrodes to measure galvanic skin activity. The Logitech X-530 speaker system was used to generate the 150dB of white noise to the participants.

After the experiment, the waveforms of each participant were analyzed to pull out average heart rate and RSA during rest and for each stressor. Heart rate was measured in beats per minutes, and RSA was measured in milliseconds. The change in GSL during the stressors was determined by taking the maximum GSL level during the stressor and subtracting the minimum GSL level during the stressor. This difference allows us to determine the stability of the GSL response, with small differences reflecting the most stability.

A SECA height rod was used to measure the height of the participants, and a SECA manual balance was used to determine the weight of the participants.

The Buss and Perry Aggression Questionnaire (Buss &Perry, 1992), as well as the University of Houston Non-Exercise Test (Jackson et al., 1990), were filled out by each participant before the stressor tests. The Buss and Perry Aggression Questionnaire provided me with aggression scores for each participant, and the University of Houston Non-Exercise Test (which uses height and weight, as well as age and sex) provided me with a prediction of physical fitness for each participant.

The IAPS photos system was used to create a neutral to negative spectrum of 8 photos, using the valence values provided by Lang et al. (2008) to assess negativity. Each photo was presented in order of increasing negativity for 10 seconds each. The IAPS photos used (in sequence) were: 2840, 2880, 2745.1, 2718, 2890, 3015, 3195, 3060. Physiological change was calculated by averaging the response for the first three photos (the most neutral) and subtracting it from the average of the last three (the most negative).

PARTICIPANTS

Martial artists were recruited from martial arts clubs in and around Oxford, Mississippi, USA. Fliers were placed in the clubs detailing the study and asking for volunteers who were male, 18 years and up, and had been practicing martial arts for 5 years or more. Fliers also encouraged any potential participant who had a history of a stress-related disorder not to partake.

The control group was recruited through the use of fliers on the University of Mississippi campus. The fliers included the same information as given to the martial artists with the exception that the participant had less than six months of martial arts training.

Women were not included in the study because it is difficult to control for the effects of the menstrual cycle on reaction to stressors (Cashdan, 2003; Dougherty et al., 1997; Ellis & Austin, 1971). The IAPS affective photo system was also used and it has been demonstrated that men and women perceive the images differently (Bradley et al., 2001).

PRE-TEST PREPARATION

Participants had their height and weight recorded. Before any pre-test questions the galvanic skin electrodes were strapped to the index and middle fingers on the participant's non-dominant hand, the ECG tabs were applied to the participant's torso (one to the participant's left clavicle, one just underneath the left pectoral muscle, and the last one to the right pectoral muscle), and a respiratory belt was strapped into place around the base of the ribcage of the participant. The participant was then asked to sit in front of the Logitech speaker system (no attention was drawn to the speakers), and the two galvanic skin electrodes were strapped to the tips of both the index and middle fingers on the participant's non-dominant hand.

The participants then filled out the Buss and Perry Aggression Questionnaire. Once this had been completed the participant was asked questions from the VO_{2max} questionnaire to assess their level of physical fitness. Then they were asked pre-test questions to gain an understanding of the martial art studied, their level of experience, and to confirm that the participant had no physical or mental health concerns (Appendix 2).

Resting RSA (rRSA) and resting heart rate (rHR) were then measured for five minutes as the participant was asked to sit calmly and relax.

THE FIRST STRESSOR TEST (T1)

The following stressor test was designed to mirror real-world stressors that have the potential to elicit an elevated stress response. The test comprised of four stressors (S1, S2, S3, and S4).

Before T1 began, the participant was instructed, "We're now going to begin a series of stressor tests. There will be a two minute break between each stressor. Just try and remain as calm as possible throughout the duration."

T1 was then administered and physiological measures recorded throughout the duration of the stressor tests.

Wearing a nitrile glove for hygiene purposes, Stressor 1 (S1) involved the experimenter's hand being held open in front of the participant's face so that the apex of the participant's nose was almost touching the center of the experimenter's hand. The hand was held in front of the participant's face for two minutes.

After two minutes, the hand was removed and the participant was allowed to rest for two minutes.

Stressor 2 (S2) was then delivered, which involved the experimenter's hand in the same position as before, only this time all fingers rested on the participant's face. This continued for two minutes before the hand was removed and the participant was allowed to rest for a further two minutes.

Stressor 3 (S3) involved the experimenter's open hand just in front of the participant's face (the apex of the participant's nose almost touched the center of the experimenter's hand), only this time the middle finger of the experimenter lightly tapped the participant's forehead every second for two minutes. After two minutes, the participant relaxed for a further two minutes.

Stressor 4 (S4) involved the participant being told that in the next thirty seconds they would receive a light slap to the cheek. After thirty seconds had expired the participant was informed that the slap would instead come at the end of the next stressor test.

This marked the end of the first stressor test. The participant was allowed to rest for five minutes before the next stressor test. Physiological equipment remained connected, but no data was gathered during this period.

THE SECOND STRESSOR TEST (T2)

This was exactly the same as the first stressor test, but for five seconds before each of the four stressors were delivered, the participant was exposed to 105 dB of white noise. After the last stressor was delivered, the participant was assured that they were never going to be slapped and would not be slapped.

The participant was then allowed to rest for five minutes.

EXPOSURE TO THE INTERNATIONAL AFFECTIVE PICTURE SYSTEM (IAPS)

Participants were then exposed to eight photographs from the International Affective Picture System (IAPS) on a computer screen. The participant was exposed to each image for ten seconds before it changed to the next image in the spectrum. HR, RSA, and GSL were recorded throughout exposure to the photographs.

The physiological equipment was then removed from the participant and a final post-test interview was conducted (Appendix 3). The purpose of the final interview was to gain an understanding of how the participant felt throughout the experiment. They were asked if any part of the experiment was unbearable, what parts of the test were the hardest to keep control over their autonomic response, and whether any breathing exercises were consciously used to remain calm.

STATISTICAL ANALYSIS

All of the statistical analysis was completed using SPSS. Multiple response variables were all checked for normality using the Shapiro-Wilk test. As some response variables were not significant for normality, each response variable was transformed using $\log^{10}$. Homogeneity of variance was insured by Levene's test.

Three separate MANCOVAs were used to test whether martial artists and the non-martial artists differed in changes in the response variables. Changes in HR, RSA, and GSL were noted for each participant during each stressor of each test, including exposure to IAPS photos.

One MANCOVA analyzed the variance in HR for each stressor of each test, including responses to IAPS photos, another analyzed the variance of RSA for each stressor of each test including exposure to IAPS photos, and the last analyzed the variance of GSL for each stressor of each test, including IAPS photos. The total aggression score for the Buss and Perry Aggression Questionnaire was used as a covariable in the analyses. If the MANCOVA was significant, I examined univariate ANCOVA scores for each physiological response, again using total aggression scores as the covariable.

The difference in aggression scores between the martial artists and non-martial artists was assessed using an independent t test.

In order to assess the correlation of rRSA with aggression scores, Pearson's r was calculated.

The correlation between subcomponents of the Buss and Perry Aggression Questionnaire were compared to the original study by Buss and Perry (1992), and correlations between physiological responses and aggression scores were also examined.

RESULTS

MARTIAL ARTS STYLES PRACTICED

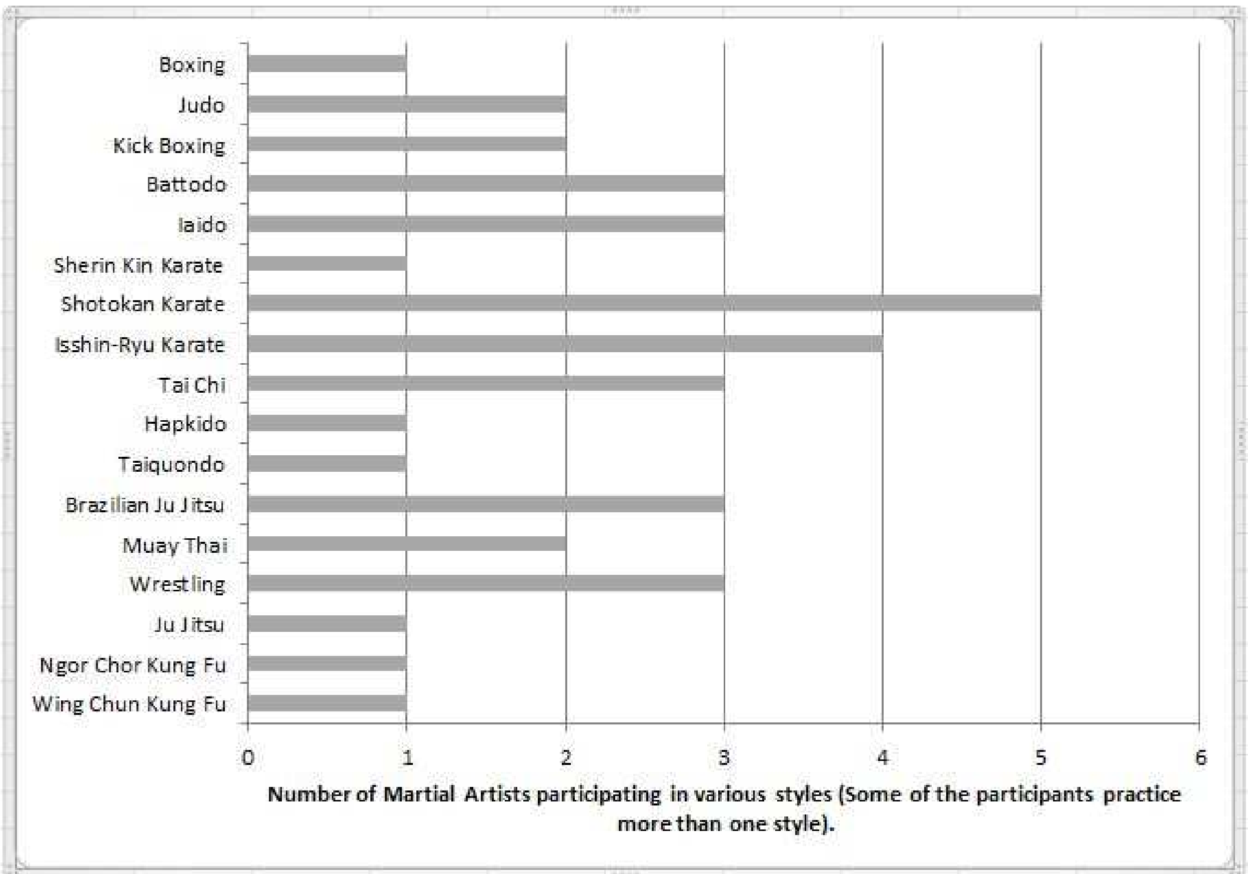

Fig. 2

This chart shows the popularity of each of the different styles. Some martial artists practiced more than one style.

The MA group was composed of 15 practitioners, some of whom practiced more than one style of martial arts (see *Fig. 2*). The most popular martial arts in the group were the

Japanese styles of Shotokan Karate, Isshin-Ryu Karate, Battodo and Iaido, as well as Tai Chi, Brazilian Ju Jitsu and wrestling.

In the pre-test questionnaire, all martial artists (n=15) claimed that their style helped them to control stress. All but 2 of the martial artists claimed that they practiced the traditional elements of their style. The post-test questionnaire, for all participants, revealed that nobody found any of the stressors to be unbearable or caused an uncomfortable amount of distress.

THE HEALTH AND AGE OF THE PARTICIPANTS

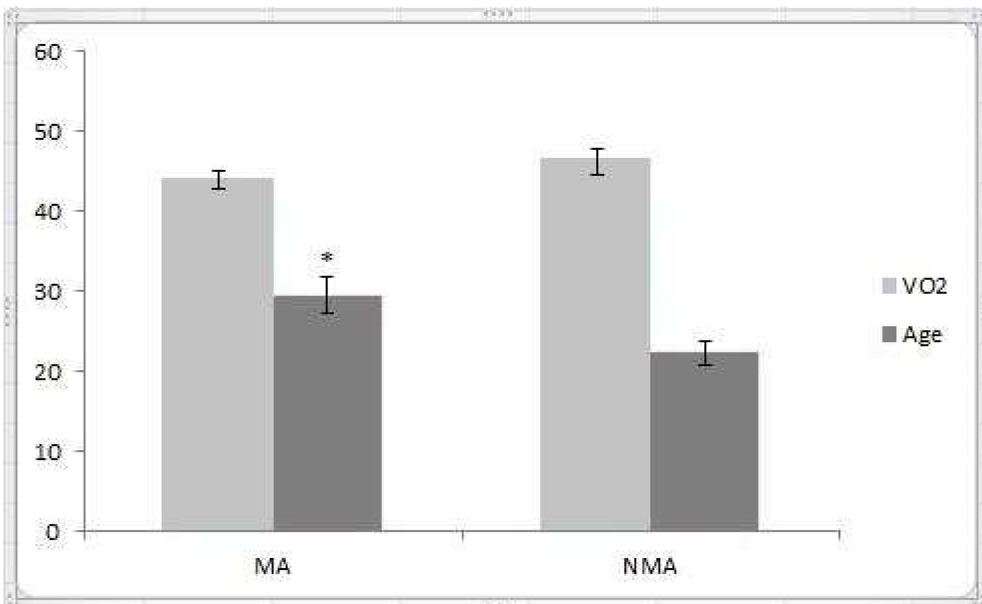

Fig. 3

This bar chart shows the mean age and the mean VO_2 of MA (n = 15), and NMA (n = 18). There was a significant difference in age (years) between MA and NMA. There was not a significant difference in $V0_2$ between MA and NMA.

No participants were dropped because of mental or physical health concerns. While there was a significant difference in age between MA (M = 29.5, SD = 9.49) and NMA (M = 22.5, SD = 5.15); $t(31) = 2.68$, p = 0.012, there was not a significant difference in the overall health of the participants as determined by VO_2, MA (M = 43.32, SD = 6.56), NMA (M = 46.08, SD = 7.13); *t(31) = -1.15, p = 0.26* (see *Fig. 3*). As there was a significant difference in age the initial MANCOVA included age to determine if it explained any of the stress response differences found between the two groups. Age had no impact; $F(9,22) = 1.658$, $p = 0.16$; Wilks' $\Lambda = 0.596$ and was thus dropped from all further analyses.

HYPOTHESIS ONE

Martial artists will show greater autonomic control over their sympathetic nervous system when faced with stressors, as compared to non-martial artists.

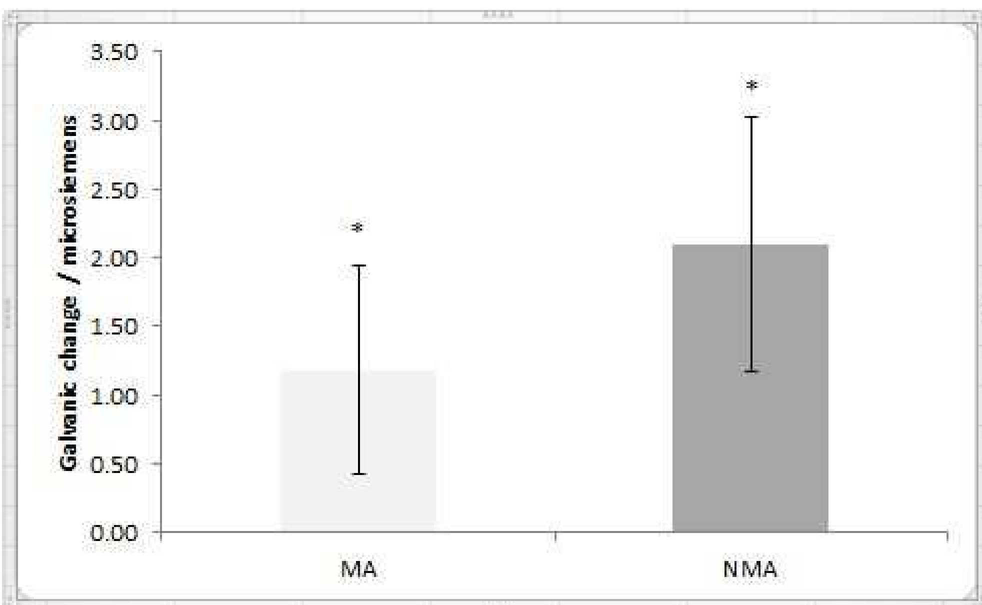

Fig. 4

*This chart shows the average galvanic skin change of MA (n=15) and NMA (n=18) when participants of all groups were exposed to S3 in T1 (tapping the forehead once every second for two minutes in the absence of white noise). * p = 0.05*

The MANCOVA looking at both physical stressor tests and IAPS exposure revealed that there was a difference in sympathetic response between MA (n = 15) and NMA (n = 18) during the stressor tests, taking into account the total aggression score from the Buss and Perry Aggression Questionnaire as a covariable; Between subjects differences for the MANCOVA, $F(7,24) = 2.436$, $p = 0.015$; Wilks' $\Lambda = 0.52$. To find out specifically in which stressor there was a difference, I examined univariate ANCOVAs for each dependent variable concerned with changes in GSL, again using total aggression as a covariable. There was only in difference between MA and NMA in changes of galvanic skin level and that was during S3 in T1 $F(1,30) = 12.74$, $p = 0.001$. (see *Fig. 4*). MA had a more stable response than NMA.

HYPOTHESIS TWO

Martial artists will show increased parasympathetic innervation after they have been exposed to the stressor, as compared to non-martial artists.

There were no significant differences in RSA between MA (n=15) and NMA (n=18) for any of the stressors in the physical tests or in the exposure to the IAPS negative photos; MANCOVA $F(9,22) = 0.423$, $p = 0.908$; Wilks' $\Lambda = 0.852$, partial $\eta^2 = 0.148$. Total aggression scores were used as the covariate. I failed to reject the null hypothesis.

HYPOTHESIS THREE

There will be a demonstrable difference in changes of heart rate between martial artists and non-martial artists when each are exposed to stressors.

Using a MANCOVA that examined all of the stressor tests collectively for changes in heart rate with total aggression scores from the Buss and Perry Questionnaire as a covariable, I discovered that there were no significant differences between MA (n=15) and NMA (n=18) for any of the stressors in the physical tests or in the exposure to the IAPS negative photos; $F(9,22) = 0.878$, $p = 0.574$; Wilks' $\Lambda = 0.674$, partial $\eta^2 = 0.326$.

HYPOTHESIS FOUR

There will be a demonstrable difference between scores on the Buss and Perry Aggression Questionnaire for martial artists and non-martial artists.

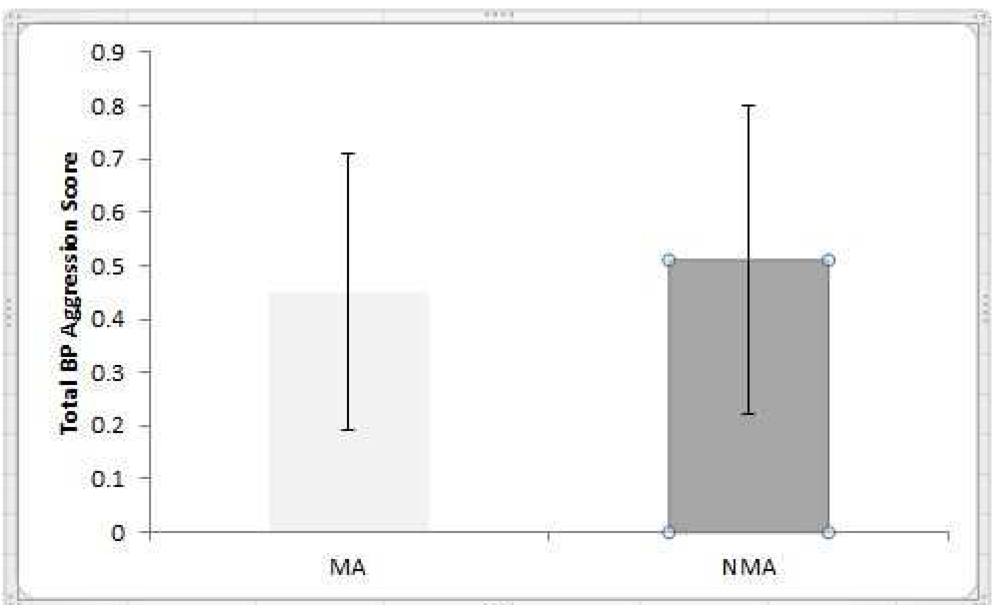

Fig.5

There was no significant difference between the total Buss and Perry Aggression Questionnaire scores between MA and NMA.

An independent t-test revealed that there was a trend for the MA to show a lower aggression score for the total Buss and Perry Aggression Questionnaire Scores between MA (n =

15) and NMA (n = 18); t(31) = -1.701, p = 0.099). MA reported lower aggression scores than NMA.

HYPOTHESIS FIVE

There is a relationship between resting Respiratory Sinus Arrhythmia (rRSA) and aggression scores or changes in sympathetic activity during stressor tests.

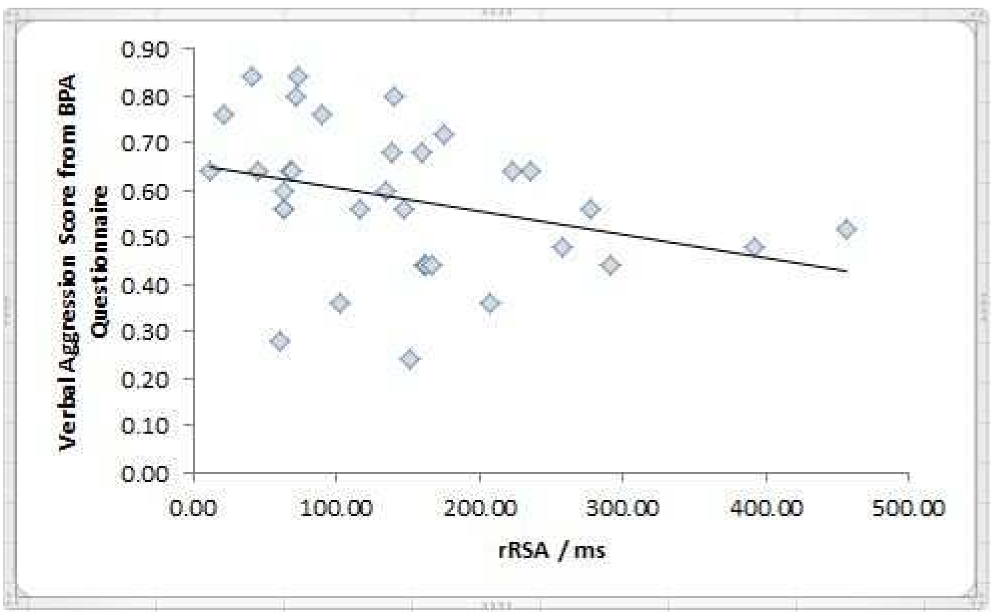

Fig. 6

There was a significant negative correlation between rRSA (milliseconds) and verbal aggression scores from the Buss and Perry Aggression Questionnaire, regardless of martial arts training (n = 33).

The only component of the Buss and Perry Aggression Questionnaire that correlated with rRSA was verbal aggression; r = -0.363, p = 0.05 (see *Fig. 6*). Total aggression, physical aggression, anger, and hostility did not significantly correlate with rRSA. There were no significant correlations between changes in galvanic skin activity and rRSA for any of the stressors on any of the tests.

CROSS CORRELATION OF THE COMPONENTS OF THE BUSS AND PERRY AGGRESSION QUESTIONNAIRE

	BPA Total	Physical Agg.	Verbal Agg.	Anger
BPA Total	1			
Physical Agg.	0.805**	1		
Verbal Agg.	0.77**	0.58**	1	
Anger	0.876**	0.593**	0.677**	1
Hostility	0.751**	0.367*	0.361*	0.583**

* p=0.05
** p=0.01

Table 1

This table shows how the total score and each component of the Buss and Perry Aggression Questionnaire correlated with each other, taking into account all participants regardless of martial arts training (n=33). Each box indicates an r value.

All components of the Buss and Perry Aggression Questionnaire correlated strongly with each other (see *Table 1*), especially with the overall total; Anger (r = 0.876, p = 0.01); Physical Aggression (r = 0.805, p = 0.01); Verbal Aggression (r = 0.77, p = 0.01); Hostility (r = 0.751, p = 0.01).

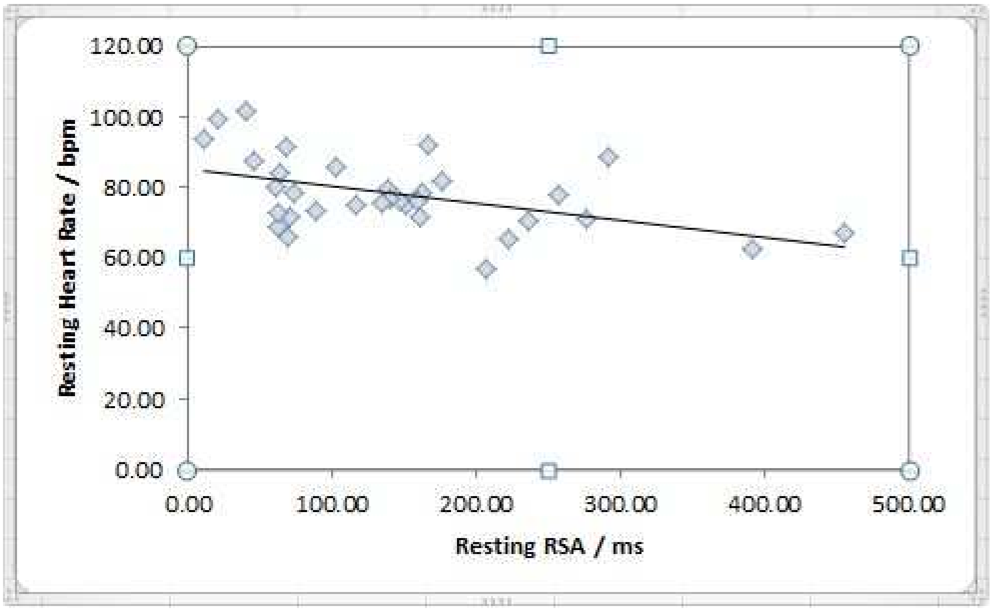

Fig.7

This graph shows the negative correlation between resting heart rate (rHR) and resting respiratory sinus arrhythmia (rRSA) for all participants, regardless of martial arts training (n=33).

As rRSA is calculated using rHR, it makes sense for these two variables to be correlated; r = -0.578, p = 0.01. *Fig. 7* shows the negative nature of this correlation; the higher rRSA, the lower the rHR.

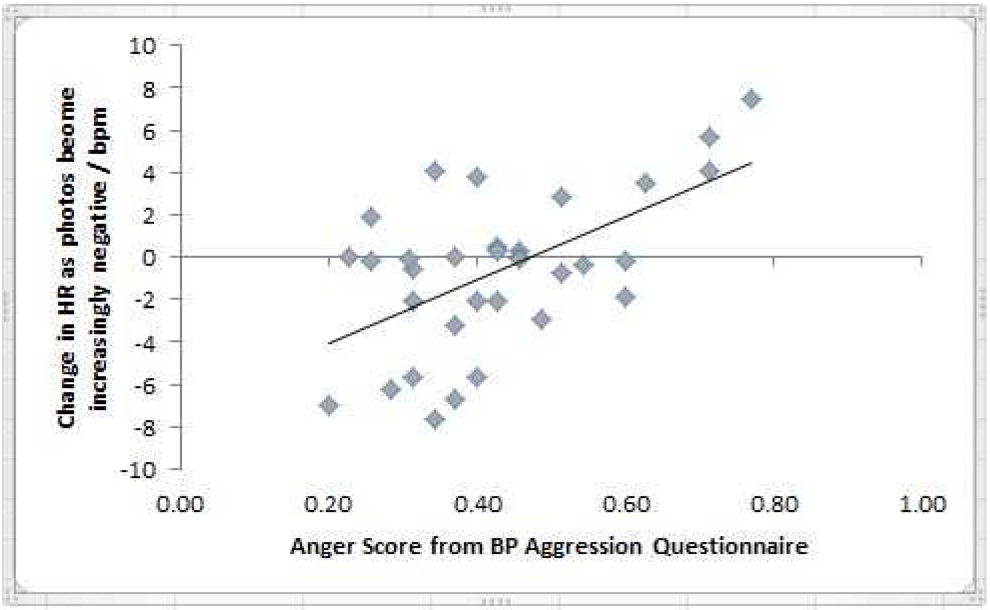

Fig. 8
This graph shows the strong positive correlation between anger scores on the Buss and Perry Aggression Questionnaire and changes in heart rate when participants (n = 33) were exposed to increasingly negative IAPS photos.

There is a strong correlation between participants' anger scores on the Buss and Perry Aggression Questionnaire and changes in HR when viewing increasingly negative photos; $r = 0.578$, $p = 0.01$. Those who scored higher for anger were more likely to exhibit an increase in heart rate as the photos became increasingly negative, whereas those who scored lower for anger were more likely to have a decrease in heart rate.

RESTING RESPIRATORY SINUS ARRYTHMIA CORRELATED WITH CHANGES IN RESPIRATORY SINUS ARRYTHMIA AS IAPS PHOTOS BECAME INCREASINGLY NEGATIVE

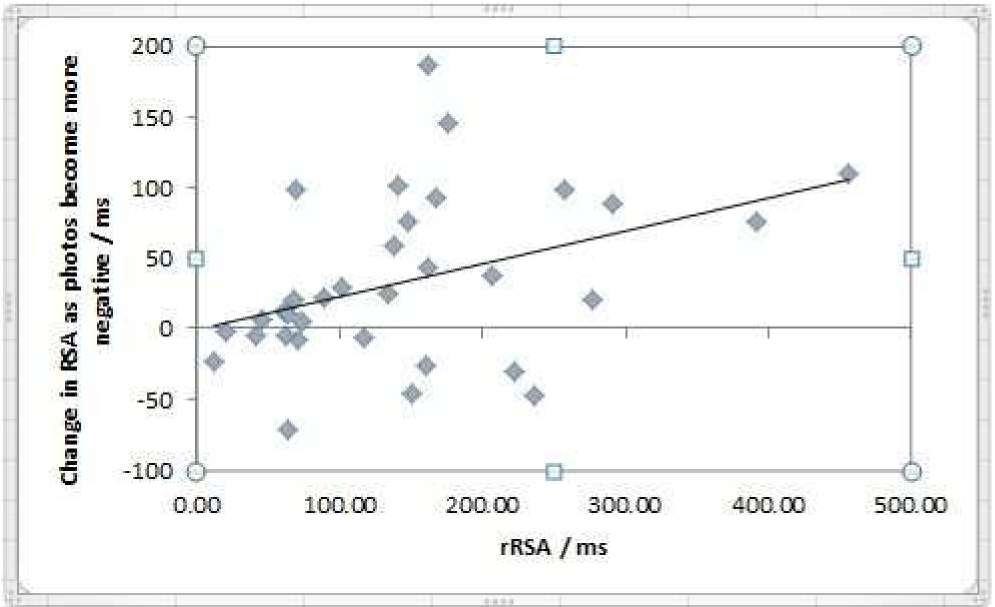

Fig. 9

This graph shows the positive correlation between rRSA and the change in RSA as participants (n = 33) viewed IAPS photos becoming increasingly negative.

There was a positive correlation between rRSA and changes in RSA as participants viewed IAPS photos becoming increasingly negative; *r* = 0.368, p = 0.05 (see *Fig. 9*). Therefore, if participants had a high rRSA at the beginning of the experiment, they were likely to have an increase in RSA as photos became more negative, indicating a high level of parasympathetic activity compared to those with lower rRSA. Those with lower rRSA even had a drop in RSA activity when viewing increasingly negative IAPS photos.

DISCUSSION

One physiological measure differed between martial artists and non-martial artists; T1 S3. The galvanic skin change while participants were tapped on the head was significantly larger in non-martial artists. There were no between group differences for heart rate or RSA at any point during the experiment.

There was a marginally significant difference in aggression scores between martial artists and non-martial artists, with martial artists reporting lower aggression scores than the non-martial artists. Resting RSA was correlated with verbal aggression, but it was not correlated with the total score or any other subcomponent of the Buss and Perry Aggression Questionnaire.

Each subcomponent of the Buss and Perry Aggression Questionnaire correlated strongly with each other, with every component correlating the strongest with anger. Resting RSA was negatively correlated with resting heart rate. Anger scores were positively correlated with changes in heart rate when viewing increasingly negative affective imagery. Resting RSA was positively correlated with changes in RSA as affective imagery became increasingly negative. Lastly, the change in GSL during T1 S3 was positively correlated with the change in GSL during T2 S3.

The main drive behind this experiment was to explore any differences in the neurophysiological response to stress between martial artists and non-martial artists. The martial artists in my study and in general claim that the practice of martial arts leads to increased self-control, discipline, and control over aggression. Only in the most stressful condition (S3) did martial artists maintain better control over their GSL response. This supports the idea that the practice of martial arts decreases aggression (Reynes & Lorant, 2004; Zivin, et al., 2001).

EFFECTIVENESS OF STRESSORS

The stressors were designed to mirror real world scenarios where the invasion of personal space can lead to aggressive outbursts. I wanted to design stressors that reflected an "all up in your face!" attitude, albeit in the confines of a controlled laboratory environment, where the participants expected to experience invasions of personal space. All of the results in this study, therefore, were elicited by participants who had the advantage of expecting to experience certain stressors. However, this expectation really functioned as another layer of control, because all participants had this advantage, and I can assume that had they not been informed of the stressors then their response would have reflected the experience of greater stress.

For the first three stressors, in Stressor Test 1 (T1) and Stressor Test 2(T2), I had attempted to make them increasingly stressful. The first one, the hand being held in front of the face, I considered the least invasive, followed by the hand on the face, and finishing with tapping (multiple hits) the participant on the forehead. With the exception of one martial artist who reported that the hand being held in front of the face was worse than the other two stressors, most participants claimed that none of the stressors were particularly stressful and were unable to say which one was the worst.

The last stressor in both T1 and T2 involved informing the participant that they would receive a light slap on the cheek in the next thirty seconds. The purpose of this stressor was to note any changes in physiological activity when the participant was expecting to receive a light slap to the face. However, the dialogue of informing the participant to expect a slap turned out to be relatively non-threatening, and despite the participant still expecting the slap, none of the participants reported at the end of the experiment that it caused any stress.

The five seconds of 105dB of white noise before each stressor in T2 had been included to induce an increased level of stress before the stressors were administered. This would allow us to see if an elevated level of stress changed how the person responded to the stressor test, and allow us to see if there would be a between group difference because of this heightened stress.

Finally, by using a spectrum of IAPS photos that ran from neutral to negative, I could note changes in neurophysiological output when each participant viewed each photo in sequence. The IAPS has been used many times for this very purpose (Bradley et al., 2001) and so was an ideal addition to the stressor tests that I created and used for the first time.

All of the statistical tests comparing response differences between martial artists and non-martial artists used the total aggression score of the Buss and Perry Aggression Questionnaire as a covariable. This allowed us to rule out any difference due to the participant's natural level of aggression, and to test whether only aggressive people are drawn to the martial arts. I also statistically compared VO_{2max} scores between the martial artists and non-martial artists to determine if one group was simply in better physical shape than the other, after all, martial arts practice often involves physical exercise. There was no significant difference between the groups. (see *Fig. 3*).

I did find, however, that there was a significant difference in age between the two groups (see *Fig. 3*) but this did not affect responses to T1, T2, or the IAPS exposure. It has been noted elsewhere that older people view negative affective imagery as more negative than younger people (Gruhn & Scheibe, 2008), but out of the 33 participants in this study, only 4 were over 35. Gruhn and Scheibe (2008) were looking at older people aged 63 and over. None of our participants were over the age of 50.

CHANGES IN GSL AS A RESPONSE TO STRESSORS BETWEEN MARTIAL ARTISTS AND NON-MARTIAL ARTISTS

I predicted that martial artists would demonstrate less change in GSL as they were subjected to individual stressors. There was only one stressor where a difference in the groups was significant and that was for Stressor 3 in Test 1. For this stressor, the participant was tapped in the head once every second for two minutes, and martial artists did show a reduced change in GSL when compared to non-martial artists. Martial arts training, therefore, seems to promote a more stable response to stressors that involve repeated taps to the body. Many martial artists practice by striking each other with controlled hits, which could mean that they have been exposed to similar stressors to S3, repeatedly, during training. A more stable response means that their GSL level at the end of stressor is closer to their GSL level at the beginning of the stressor, when compared to the non-martial artists, perhaps meaning that the stressor has less of an influence on the martial artists. To my knowledge, this is the first time such a finding has been demonstrated. Tapping the head of a participant has been used previously to explore the vestibular system (Brantberg, Löfqvist, & Westin, 2008), but I am unaware of any studies that used tapping of the head as a means to elicit a change in the stress response.

As I found this difference in GSL activity between the groups, it would be interesting to try and follow up with a longitudinal study that tracked responses as martial artists progressed in their training. I mandated that our martial artists had five or more years of training, but some may have stopped briefly, some practiced different styles, and some practiced far more frequently than others in the group. If a large group of martial artists practicing the same style with the same training regimen could be found to partake in a longitudinal study, I could garner more ideas for what might cause a difference in this particular stress response. Slightly different stressors might have to be used, however, as a longitudinal study using the same stressor would allow the martial artist to become familiar with the experience of that particular stressor and develop a coping mechanism that might not be related to the martial art.

HR AND RSA IN RESPONSE TO STRESSORS BETWEEN MARTIAL ARTISTS AND NON-MARTIAL ARTISTS

I did not find any significant changes in HR or RSA between martial artists and non-martial artists when the participants were subjected to the stressors. This could mean simply that martial arts training does very little to impact HR and RSA, or that the effect size is simply so small that I need to do a much larger study including more participants (power analysis revealed 780 individuals with a small effect size).

A COMPARISON OF PERSONAL AGGRESSION BETWEEN MARTIAL ARTISTS AND NON-MARTIAL ARTISTS

I predicted that there would be a difference in levels of aggression when comparing martial artists and non-martial artists, and martial artists would be less aggressive. There was a difference between martial artists and non-martial artists, but only a trend (see Fig. 5). Still, it does suggest that martial artists are in fact less aggressive than non-martial artists in terms of their aggression scores. This supports the results found by Reynes & Lorant, (2004) and Zivin et al., (2001), rather than the results found by Endresen & Olweus (2005).

THE RELATIONSHIP BETWEEN rRSA AND AGGRESSION

I predicted that there would be a correlation between resting RSA (rRSA) and aggression levels as measured by the Buss and Perry Aggression Questionnaire. rRSA was measured for five minutes before the participant was exposed to any of the stressors; the participant was asked just to sit as calmly and relaxed as possible while this measurement was recorded.

I found a negative correlation between verbal aggression scores and rRSA, but not for any of the other aggression scores. Participants who had a high rRSA, indicating high parasympathetic activity (low stress) were likely to have low verbal aggression, and vice-versa, which meant that I could reject our null hypothesis. This correlation is interesting because it has been stated that men are more physically aggressive than verbally aggressive (Bjorkqvist, 1994). If physical aggression is not correlated with the resting measure of parasympathetic activity, it could mean that physical aggression in men is more instrumental, i.e. it is not the final instinctual reaction to stress, but rather the result of planning to achieve a goal through its use. I have not found verbal aggression to be specifically related to rRSA in the literature, but aggression in general is linked to poor resting levels of rRSA (Gyurak & Ayduk, 2008).

Measures of RSA have long been considered as useful for studies in aggression because it is a measure of parasympathetic activity and this part of the autonomic nervous system typically helps the body to return to rest after stressful or exciting occurrences. Therefore, if parasympathetic activity is lacking, the individual will experience states of stress or arousal for longer periods of time, increasing the probability of an aggressive outburst (provided the context of the stress or arousal is negative). For this reason, a number of studies have looked at RSA in the context of those with conduct and affective disorders (Beauchaine et al., 2008; Friedman & Thayer, 1998; Rechlin et al., 1994), who all found reduced baseline levels of RSA in aggressive individuals.

rRSA is of particular interest when looking at stress and aggression, because rather than looking at RSA changes or average RSA responses during stressful experiences, it speaks to the integrity of the parasympathetic nervous system (vagal integrity) during rest. It has been hypothesized that if integrity during rest is low, then stressful circumstances are likely to elicit an elevated stress response because of the lack of control (Beauchaine, 2001), and has been considered of extreme importance in children when examining the development of aggressive personalities (Eisenberg et al., 2012). I found that low rRSA does predict low RSA when viewing stressful affective imagery, thus bolstering the findings of Beauchaine (2001). Even though my study looked at adults, it is still likely that low rRSA in children can be used as an indication of how that child might respond in a visually negative provocative scenario.

INTRA-ANALYSIS OF THE BUSS AND PERRY AGGRESSION QUESTIONNAIRE

The Buss and Perry Aggression Questionnaire was created in 1992 in an effort to improve researchers' abilities to assess personal levels of aggression. In fact, Buss and Perry claim that factor analysis (statistical analysis of aggressive behaviors and characteristics), was not rigorous enough in the creation of many of the questionnaires that preceded their questionnaire. The Buss and Perry Questionnaire was initially tested with 1,253 participants, and among other analyses the four components that make up the questionnaire (physical aggression, verbal aggression, anger, and hostility) were correlated to note any relationship between each aggressive trait. Buss and Perry (1992) found that *anger* strongly correlated with the other traits; physical aggression, $r = 0.48$; verbal aggression, $r = 0.48$; hostility, $r = 0.45$.

In this study, I examined the inter-correlations all of the components of the Buss and Perry Aggression Questionnaire ($n=33$), and found that *anger*, more so than any other trait, correlated the most strongly with the other traits (see *Table 1*); physical aggression, $r = 0.593$; verbal aggression, $r = 0.677$; hostility, $r = 0.583$. These correlations are stronger than the initial findings of Buss and Perry (1992), but this could be a reflection of sample size, gender inclusion (Buss and Perry also included women), and age distribution of the sample (Buss and Perry recruited mainly from between the ages of 18 and 20). Despite these differences, it was satisfying that our study mirrored a major finding of Buss and Perry in the use of their aggression questionnaire and thus further validates the use of this questionnaire.

The fact that anger is the most strongly correlated with the other components perhaps speaks to the idea that anger is some kind of driving-force or pre-requisite behind aggressive outbursts and hostile behavior. The questions that pertain to anger on the questionnaire all speak to temperament and an emotional state prior to related behavior, such as how quickly one flares up and how much one struggles with controlling their temper (Buss & Perry, 1992).

ANGER IS CORRELATED WITH CHANGES IN HEART RATE WHEN VIEWING NEGATIVE AFFECTIVE IMAGERY

There was a strong positive correlation between anger scores on the Buss and Perry Aggression Questionnaire and changes in heart rate when the participants viewed negative imagery (see *Fig. 8*). The imagery spectrum was composed of eight photographs, and using IAPS guidelines a spectrum from neutral imagery to negative imagery was created.

This correlation is very interesting, because those who reported higher anger levels show an elevated heart rate when viewing traumatic imagery when compared to those with lower anger levels, and those with the lowest anger levels actually showed a reduction in heart rate. Anger has been linked to elevated levels of heart rate and blood pressure (Goldstein et al., 1988). Clearly, working to reduce one's anger, therefore, is highly beneficial. If coming into contact with traumatic sights in life will elevate one's heart rate it could eventually begin to take its toll on the integrity of the cardiac tissue, which could result in cardiac problems earlier in life than expected, even mortality (Eaker et al., 2004). It is hard to know whether the anger causes the elevation in heart rate or the increased heart rate leads to increased anger, but there are treatments that can lead to a reduction in both, such as anger management, healthy eating, and a decent physical fitness regimen (Aubert et al., 2001).

RESTING RESPIRATORY SINUS ARRHYTHMIA CORRELATED WITH RESPIRATORY SINUS ARRHYTHMIA WHEN VIEWING INCREASINGLY NEGATIVE IAPS PHOTOS

There was a positive correlation between rRSA and the RSA output of each individual when viewing increasingly negative IAPS photos (see *Fig. 9*). This means that those who had a higher resting level of RSA were also likely to have a high RSA output when viewing traumatic affective imagery. This could be very beneficial, because high parasympathetic activity should allow one to stay in control during crisis situations, which can result at any time during the course of one’s life. In order to prepare oneself for these situations, particularly if one works in a career that increases the likelihood of encountering traumatic scenarios, working at improving overall rRSA would be beneficial. RSA can be improved through regular physical exercise (Furlan et al., 1993).

THE CORRELATION BETWEEN RESTING RESPIRATORY SINUS ARRHYTHMIA AND RESTING HEART RATE

There was a very strong correlation between rRSA and rHR (see Fig. 7).. As heart rate is controlled by both the sympathetic and the parasympathetic branches of the autonomic nervous system, it stands to reason that high parasympathetic activity, as measure by rRSA, would lead to a lower resting heart rate. A complementary future study could be done to also determine sympathetic activity directly related to heart rate (GSL is sympathetic, but does not control heart rate), such as cardiac norepinephrine spillover (Kingwell et al., 1994). By comparing sympathetic cardiac neuronal firing rates during rest, I could see if high parasympathetic activity is coupled with lower sympathetic activity, or if the sympathetic activity is still high, but the effects of the vagal nerve help to reduce its impact.

DIRECTIONS FOR FUTURE RESEARCH

This study examined the stress response of martial artists while they were remaining static in a chair. A more dynamic study could perhaps involve them practicing their style either immediately before the study or at intermittent periods during the study. It is possible that the stress relieving effects of martial arts could be at their peak during training or for a brief period afterwards. This would allow for a comparison between immediate effects of practice and overall years of dedication to the style.

As women respond differently to stressors than men (Beauchaine et al., 2008; Bradley et al., 2001) and score slightly differently on the Buss and Perry Aggression Questionnaire (Buss & Perry, 1992), a study looking at female martial artists would also be useful to see if martial arts training has any differing effects on their autonomic response when exposed to the same stressors.

It was hoped during this study that I would find more martial artists to allow for an intra-group analysis, especially between schools of martial arts that no longer emphasize the traditional or meditative aspects and those schools who do still practice these elements. Our martial arts group mainly consisted of traditional martial artists, all of whom practiced *katas* or *forms* quite regularly during training. As Mixed Martial Arts (MMA) remains popular in the United States and is known for excluding traditional elements of various styles, it would be interesting to compare the traditionalists with these non-traditionalists.

In conclusion, martial arts training appears to reduce the change in GSL response during a high level stressor but does not have a major impact on other physiological measures or during minor stressors. I also found that martial artists scored lower for aggression on the Buss and Perry Aggression Questionnaire, and rRSA was correlated with the level of verbal aggression as indicated by the Buss and Perry Aggression Questionnaire.

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LIST OF APPENDICES

APPENDIX 1

Buss-Perry Scale

Please rate each of the following items in terms of how characteristic they are of you. Use the following scale for answering these items.

1	2	3	4	5	6	7 extremely
						extremely
	uncharacteristic					
	characteristic of me					of me

1) Once in a while I can't control the urge to strike another person.
2) Given enough provocation, I may hit another person.
3) If somebody hits me, I hit back.
4) I get into fights a little more than the average person.
5) If I have to resort to violence to protect my rights, I will.
6) There are people who pushed me so far that I came to blows.
7) I can think of no good reason for ever hitting a person.
8) I have threatened people I know.
9) I have become so mad that I have broken things.
10) I tell my friends openly when I disagree with them.
11) I often find myself disagreeing with people.
12) When people annoy me, I may tell them what I think of them.
13) I can't help getting into arguments when people disagree with me.
14) My friends say that I'm somewhat argumentative.
15) I flare up quickly but get over it quickly.
16) When frustrated, I let my irritation show.
17) I sometimes feel like a powder keg ready to explode.
18) I am an even-tempered person.
19) Some of my friends think I'm a hothead.
20) Sometimes I fly off the handle for no good reason.
21) I have trouble controlling my temper.
22) I am sometimes eaten up with jealousy.
23) At times I feel I have gotten a raw deal out of life.
24) Other people always seem to get the breaks.
25) I wonder why sometimes I feel so bitter about things.
26) I know that "friends" talk about me behind my back.
27) I am suspicious of overly friendly strangers.
28) I sometimes feel that people are laughing at me behind me back.
29) When people are especially nice, I wonder what they want.

1-9 Physical Aggression; 10-14 Verbal Aggression; 15-21 Anger; 22-29 Hostility

Buss, A. H., & Perry, M. P. (1992). The aggression questionnaire. *Journal of Personality and Social Psychology, 63, 452-459*

APPENDIX 2

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A Neurophysiological Examination of Stress Control in Fighters
Pre-test Questionnaire

(To be filled out by experimenter)

Questions about health

1. How old are you?______ years
2. Have you ever been clinically diagnosed with heart problems or hypertension?

   (Yes / No)

3. Do you suffer or have you ever suffered from chronic pain or heightened pain sensitivity?

   (Yes / No)

   If "yes", for how long? Do you still suffer from chronic pain or heightened pain sensitivity?

   ____
   ____

4. Have you ever been hospitalized because of a head injury?

   (Yes / No)

   If "yes", when were you hospitalized and for how long?

   ____
   ____

5. Have you ever been diagnosed with a mental illness?

   (Yes / No)

   If "yes", when were you diagnosed and with what illness?

____
____

6. Have you ever been diagnosed with a stress disorder, such as acute stress disorder or post traumatic stress disorder?

   (Yes / No)

   If "yes", when were you diagnosed?
   ____
   ____

7. Have you ever been on active duty in the military? If so, for how long and when?

   (Yes / No)

   If "yes", how long? When were you on active duty?
   ____
   ____

8. Do you suffer from latex allergies?

   (Yes / No)

Questions about style

6. What style do you practice?____

7. How long have you practiced?____

8. Do you still practice? If so how many hours a week? (Yes / No)

   1-2 2-4 4-6 6-8 8-10 10+

9. How much time do you spend doing forms/katas/or meditating in a week?

   Time in minutes / hours:______________________________

10. How much time do you spend sparring with training partners in a week?

Time in minutes / hours:____________________________

How aggressive would you say the sparring is?

Non-contact / Light contact / Moderately Aggressive / Aggressive / Very Aggressive (1-5)

11. What were your primary reasons for starting your style of fighting? (Fun, self-defense, fitness)

____
____

12. Are they still the same reasons that you continue in your style? (Yes / No)

13. Did your reasons for continuing in the style change as you became more experienced? If so, how did they change?
(Yes / No)
____
____

14. Do you think your style helps you to control stress? (Yes / No)

15. Is remaining calm under pressure and keeping your cool part of your style's philosophy? (Yes / No)

16. Do you think there are some situations, such as if somebody is trying to take your life, where it is okay to lose your cool and let your rage help you?

(Yes / No)
____
____

17. How often do you get injured (split lip / black eye) because of a stray punch or lack of control?

Never / Infrequently / Sometimes / Frequently / All the time (1-5)

18. Have you ever been hospitalized because of an injury while sparring or fighting?
    (Yes / No)

19. In your late teen years or adult life have you been in any full blown fights that do not include professional sporting events? (If so, how many? Why did it happen?)
    (Yes / No)
    How many?_________________
    Why?____
    ____

20. What is your opinion of Mixed Martial Arts or Professional Boxing?

    Hate it / Dislike it / No opinion / Like it / Love it (1-5)

APPENDIX 3

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A Neurophysiological Examination of Stress Control in Fighters
Post-test Questionnaire

(To be filled out by experimenter)

1) At any point during the experiment, did you feel that the stress was unbearable?
   (Yes / No)
   If "yes", when?
   ____
   ____
   ____
   ____

2) During the experiment, which aspects of the test were the most challenging to remain calm? Why?
   ____
   ____
   ____
   ____

3) In order to help you to remain calm, did you consciously try to control your breathing?
   (Yes / No)
   If "yes", do you feel like it worked?
   ____
   ____
   ____
   ____

VITA

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