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Diaphragmatic Breathing and its Effects on Motion Sickness

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This summer I have been working on a psychology project with Dr. Carlson that I will be continuing during the school year as my senior honors thesis. Generally speaking, we are interested in the effects of diaphragmatic breathing, a self-regulatory breathing strategy, in a seasickness-inducing environment. We expect diaphragmatic breathing will decrease seasickness symptoms through greater heart rate variability and physiological self-regulation. As we are at the beginning of the project, we are working on the details of the experiment. I have conducted an extensive literature review of the research area. I am specifically looking at different techniques to teach abdominal breathing. The goal is to make the breathing intervention as effective and efficient as possible.

Motion sickness is a common health issue for a large percentage of the population. Although, some medications may be beneficial many of the drugs are accompanied by negative side effects. The application of diaphragmatic breathing, a non-pharmacologic method, is a positive alternative. The effects of this specialized breathing have been explored by a number of experts in the field.

Paul Lehrer is a leading researcher in the area of breathing relaxation and has performed numerous experiments testing the effects of slow-paced, diaphragmatic breathing. His collection of studies has shown this breathing technique to be quite successful in reducing stress and increasing cardiac variability. We utilized his training manual as a template for our experimental script (Lehrer et al., 2000).

One specific area of interest in this field deals with prolonged, intense exercise, which can have damaging consequences. Specifically it can cause oxidative stress. Martarelli (2009) studied the effect of diaphragmatic breathing on the reduction of this stress. He recruited sixteen middle-aged males who agreed to bicycle for eight hours. They were randomly divided into experimental (performed diaphragmatic breathing in a quiet room for one hour after exercise) and control (sat/read in quiet room for one hour proceeding exercise) groups. Oxidative stress, biological antioxidant potential, (BAP) cortisol, and melatonin were all measured. Results showed the diaphragmatic breathing to significantly reduce the males' oxidative stress more than those in the control group (Martarelli et al., 2009). Results also indicated a diaphragmatic breathing effect in regards to significantly higher BAP levels, a significantly lower cortisol level (post-relaxation), and significantly higher melatonin levels. Overall, it was found that diaphragmatic breathing significantly reduced exercise induced oxidative stress.

Another study examined this breathing technique's relationship with the circulatory system (Byeon et al., 2012). Twenty subjects trained in diaphragmatic breathing (experimental group) were compared with twenty subjects with no exposure to abdominal-breathing. The experimental group used three different breathing techniques: slow abdominal respiration, slow abdominal respiration with inspiratory pauses, and normal respiration. Transthoracic echocardiography was used to measure the subjects' IVC and SVC diameter, IVC collapsibility index, SVC minute flow, and respiration time. The results showed the diaphragmatic breathing subjects' IVC diameter (min) and IVC collapsibility index to be significantly less than those in the control group. Within the experimental group it was found that the slow abdominal respiration with inspiratory pauses had the highest IVC collapsibility and allows for the most efficient venous flow.

Diaphragmatic breathing has also been applied to those suffering from Gastroesophageal Reflux Disease. These people often try to better their condition with lifestyle changes; however few have been proven as effective. This study examined the benefits of using diaphragmatic breathing amongst 19 adults suffering from GERD (Eherer et al., 2011). The participants were divided into two groups, one of which practiced diaphragmatic breathing for 4 weeks in conjunction with acid-suppressant drugs while the control group only took the drugs. Diaphragmatic breathing was taught through a series of exercises in a standing, sitting, and supine positions. After the initial 4 weeks the control group was then trained on diaphragmatic breathing and all participants were given the opportunity to voluntarily use the breathing techniques in the future. Results after the initial 4 weeks along with a follow up analysis 9 months later showed those who practiced the breathing had improved GERD symptoms shown by a Quality of Life score, pH-metry, and drug usage.

Cordova (2003) studied the effect of slow diaphragmatic breathing on blood pressure and Autonomic Nervous System (ANS) activity. It has been shown that there is an inverse relationship between ANS activity and pressure pain thresholds. Cordova expanded upon this notion to test the different effects of 5% and 3% end-tidal CO_2. The group of subjects in the 5% group was taught abdominal breathing, while the 3% group was trained in thoracic breathing. Thoracic breathing (3% $ETCO_2$) was shown to increase blood pressure and ANS activity. This led to less pain sensitivity. Although, the 5% $ETCO_2$ kept ANS activity low, results did not indicate diaphragmatic breathing to have a significant effect on pressure pain threshold.

Alex Zautra's research heavily contributed to the formation of our proposed study. Although, Zautra (2009) does not specifically use diaphragmatic breathing in his experiment, his manipulation of slow breathing is still quite relevant. He evaluated the effects of slow breathing on subjects' pain sensation. Participants consisted of healthy control subjects and age-matched subjects suffering from fibromyalgia syndrome (FM). The participants' pain threshold was evaluated in four trials consisting of mild and moderate pain stimuli in conjunction with normal and slow breathing.

Slow breathing was defined to be half of the subject's normal breathing rate. Zautra used a PowerPoint with visual command signals to help participants slow their breathing rate. The results indicated slow breathing to significantly reduce pain and negative affect ratings. The slow breathing had a stronger effect when moderate pain was administered.

After reviewing the literature we have crafted a unique experiment to further contribute to this area of research. We want to test the effects of diaphragmatic breathing in a seasickness-inducing environment. Based on past experiments and extensive research, we expect diaphragmatic breathing will decrease seasickness symptoms through greater heart rate variability and physiological self-regulation. Furthermore, we hope to extend this breathing technique, a self-regulatory strategy, to individuals outside of the laboratory. By creating an accessible training method, diaphragmatic breathing should provide a simple mechanism for controlling motion sickness.

Our specific experiment will be conducted in the fall and will utilize participants (Psych 100 students), high in motion seasickness vulnerability. The participants will come into the laboratory (in Kastle Hall) to watch a virtual reality video. The video involves continuous ocean swells and is meant to induce motion sickness. The participants will be randomly assigned to either the control or experimental group. The control group will watch a video while simply relaxing. The experimental group will be taught the diaphragmatic breathing technique, which is performed during the ten-minute sea motion video. The hypothesis associated with our study is that the participants in the breathing intervention condition, in comparison with those in the control group, will exhibit greater heart rate variability, reduced respiration rates, higher control of their physiological state, and be less prone to motion sickness during the video.

We are specifically working on finding the best technique to teach the abdominal breathing to the participants. Last year when Dr. Carlson ran a similar experiment the breathing was taught through an audio only video that walked the participant through the technique. However, practice of the actual breathing was limited and not well structured. So we are currently planning a more effective training process. We considered additional equipment such as a HeartMath machine to help monitor participants' breathing. The machine would allow for the student to see whether or not they were successfully performing the diaphragmatic breathing. However, after discussing the benefits and costs of the machine we decided it was unnecessary to purchase the HeartMath monitor.

As I mentioned before Dr. Zautra's paper, *The Effects of Slow Breathing on Affective Responses to Pain Stimuli: An experimental Study* (2009), was crucial to the formation of our breathing protocol. The paper had an interesting teaching method that involved using a PowerPoint to provide visual cues for the participant so they would know when to inhale and exhale. I have been in contact with Dr. Zautra and obtained his original PowerPoint used in his study. I have been working to modify this PowerPoint to use during our experiment. I have made two different slideshows, one for the control group and one for the experimental group. We also decided to add an auditory component to signal to the participant when to breath in and when to rest.

Most of the experimental design is finished and I have written a full proposal that has been submitted to the IRB for review. We will hopefully obtain permission to officially begin the experiment in the fall.

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