EFFECTS OF EQUINE-ASSISTED THERAPY ON DEPRESSION AND ANXIETY

By

ALEXA RAE LINK

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Approved by:

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Dr. Ann Baldwin
Department of Physiology

Abstract

The aim of this study is to determine the effects that equine-assisted therapy in the form of heart-focused breathing can have on the heart rate variability (HRV) and symptoms of individuals suffering from depression and/or anxiety. HRV measurements, questionnaires, experimental questions, and a brief exit interview were used for a sample size of nine subjects. The subjects in the experimental group worked with one of two horses for three sessions that took place over the course of three weeks and had their HRV measurements taken before, during, and after each of these interactions using the Zephyr BioHarness and the HeartMath emWave2 as a backup. Questionnaires for depression, anxiety, and self-esteem were administered before and after the set of three equine-therapy sessions during the first and fifth week of the study. The results demonstrate that, on average, heart-focused breathing in the presence of a horse produced improvements in the HRV and self-reported symptoms of individuals suffering from depression and anxiety.

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Introduction

Application:

Animal-assisted therapy and its therapeutic applications has been a major topic of interest, especially in the context of psychological disorders (Drinkhouse et. al., 2012). More recently, equine-assisted therapy has become a popularly studied and applied therapeutic technique for a variety of psychological disorders including posttraumatic stress disorder (Earles et al., 2015). Although a significant amount of research has been conducted to evaluate the effectiveness of equine-assisted therapy techniques, there is limited research regarding the effects that equine-assisted therapy has on the heart-rate variability of individuals suffering from psychological disorders such as depression and anxiety.

Recent studies show that interactions between humans and horses can result in changes in the balance between the sympathetic and parasympathetic branches of the human autonomic nervous system. This balanced state is referred to as “coherence” and leads to increased heart rate variability (HRV). HRV is the physiological phenomenon that describes the variation in inter-beat intervals of the heart rate and is useful in evaluating the balance of the autonomic nervous system. Reaching high levels of HRV is associated with many health benefits including improved brain function, immune system function, and cardiovascular function (Heart Rate Variability, 1996). With equine-assisted therapy, these measurements have revealed a deeper insight between the mind-body connection in a human-horse relationship.

Heart-focused breathing is a practice that involves taking deep, slow breaths at a frequency of about six breaths per minute. Previous research has shown that this type of paced breathing can lead to maximal improvements in the amplitude of the oscillations of the heart rate, and therefore optimal heart rate variability (Vaschillo et al., 2006). In this study, this type of paced breathing was used in conjunction with equine-assisted therapy in order to determine the potential benefits for individuals suffering from depression and/or anxiety.

The goal of this study is to evaluate the effectiveness of equine-assisted therapy in the form of heart-focused breathing for individuals suffering from depression and/or anxiety. If we discover that this intervention improves self-reported symptoms of anxiety and depression as well as optimizes HRV parameters, this has the potential to offer a new alternative or supplemental treatment for anxiety and/or depression.

Context:

Psychological disorders are thought to be largely affected by improper functioning or imbalances of the autonomic nervous system. Previous research has demonstrated that autonomic dysfunction has links to depression and anxiety, which is largely responsible for the reduced HRV, increased heart rate, and the sympathetic arousal that is seen in individuals suffering from these psychological problems (Karavidas, 2008). Similarly, abnormal activity of certain brain regions including the amygdala are associated with psychological disorders. For example, abnormal activity of the amygdala is often seen in individuals suffering from anxiety and depression (Thomas, 2001). Hyperactivity and

hypo-activity of the amygdala are both associated with lower HRV and depressed psychological stability, often resulting in the symptoms that manifest with common psychological disorders.

Objective:

Due to the fact that improvements in sympathovagal balance and HRV are associated with psychological disorders like anxiety and depression, equine-assisted therapy in conjunction with heart-focused breathing may bring improvements in individuals dealing with anxiety and/or depression due to the benefits that are associated with working with horses. Therefore, there is a clear clinical relevance of examining the potential benefits of equine-assisted therapy and heart-focused breathing for individuals suffering from one or both of these problems.

Materials and Methods

Human Subjects Approval:

This study was approved by the University of Arizona Institutional Review Board for Human Subjects Research.

Animal Subjects Approval:

This study was approved by the University of Arizona Institutional Animal Care and Use Committee.

Participants:

A total of nine subjects between the ages of 18 and 70 participated in this study. Of the none subjects, there were two males and seven females. Each participant had been diagnosed with depression, anxiety, or both. The study participants were recruited using both printed and electronic flyers that were distributed around the University of Arizona campus, at various medical offices, and online on sites such as Facebook. Potential participants were informed of the five-week schedule for the study and were invited to a consenting and baseline session. At this session, participants were provided with detailed information about the study, had the opportunity to ask questions, and were asked to a sign a consent form that detailed the purpose of the study, the experimental protocol, the measurements that would be obtained, as well as the possible risks and benefits of their participation in the study.

Demographic Information for All Participants

Subject	Age	Gender	Ethnicity	Diagnosis
1	18-20	Male	White	Depression and Anxiety
2	18-20	Female	White, African American or Black	Depression and Anxiety
3	21-30	Female	White, Hispanic	Anxiety
4	21-30	Female	White	Depression and Anxiety
5	21-30	Male	White	Anxiety
6	41-50	Female	Hispanic	Anxiety
7	51-70	Female	White	Depression and Anxiety
8	21-30	Female	White	Depression
9	21-30	Female	Asian, Hispanic	Depression and Anxiety

Table 1.1: Demographics information for each of the human subjects that participated in this study.

There were two horses that were used in this study. These horses were stabled at the University of Arizona Equine Center, which is located at 4101 North Campbell Avenue, Tucson, AZ 85719.

Experimental Design:

Subjects (n=9) were randomly assigned to either the experimental or control group for this study. All subjects completed a baseline session in an office where baseline HRV measurements were taken. They were then asked to complete three short questionnaires to evaluate their depression, anxiety, and self-esteem. The questionnaires that were used were the Beck Anxiety Inventory, the Beck Depression Inventory, and the Rosenberg Self-Esteem Scale. Following this baseline session, subjects completed three equine therapy sessions with one of the real horses, or an image of one of the horses projected onto a wall in an office for the control condition.

During the first sessions, individuals were coached in heart-focused breathing before beginning their session with the horse or image. Baseline HRV measurements were obtained before the interaction and the HRV was measured during a seven-minute session with the horse or image. During this interaction, subjects were allowed to stand at a comfortable distance in front of the horse, but were asked not to touch the horse until after the interaction. For seven minutes, the subject completed heart-focused breathing with the horse, imagining that their breath was coming from their heart out to the horse's heart and back (see Figure 1.1). After the interaction, subjects were given a few minutes to interact with and pet the horse if they were interested. Post-baseline

HRV measurements were taken after the interaction with the horse or image. Finally, following the three equine therapy sessions, subjects were asked to attend a final post-baseline session back at the office where a final HRV measurement was taken, they were asked to complete each of the three questionnaires for a second time, and they were asked a few short questions in the format of an exit interview.

Figure 1.1: One experimental group subject doing heart-focused breathing with one of the horses for a duration of seven minutes.

Before and after each of the sessions with the horse or horse image, subjects were asked to provide their answers to a short pre- and post-experimental question. The pre-experimental question was, “What are your initial feelings about doing this experiment?” and the post-experimental questions was, “What are three words that you would use to

describe how you are feeling after your interaction?". The answers to each of these questions were compiled for each session with each subject in the control and experimental groups. The responses were then analyzed for the number of positive, negative, and neutral words using the procedure describes below.

Experimental Measures:

Heart Rate Variability Testing Protocol

Heart rate variability measurements were collected using the Zephyr BioHarness, which consists of a chest strap that is fastened around the subject and contains an electronic sensor module. This module records and stores heart rate, respiration rate, and other vital sign and body activity data (BioHarness 3.0 User Manual, 2012). Backup measurements were taken using the HeartMath emWave 2, a device with a sensor that attaches to the ear lobe and measures heart rhythms in order to provide HRV data including levels of coherence (emWave2 Quick Start Guide for PC and Mac, 2016). The initial baseline session involved one, five-minute measurement that was taken in an office before the subject had participated in any of the sessions with the horse or horse image. During the following three equine-therapy sessions, HRV measurements were taken before and after each session with the horse or horse image for a duration of five minutes. In between these two measurements, a seven-minute recording was taken during the duration of the subject's interaction with the horse or horse image. After the three equine-therapy sessions or control conditions sessions with the horse image had been completed, each subject attended a post-baseline session back at the office. At this session, a five-minute post-baseline HRV measurement was taken.

These HRV data that were obtained were extracted using the BioHarness Log Downloader or the emWave2 software when these data obtained from the BioHarness was not usable. These data were analyzed using the Kubios HRV program, which provided information about a series of HRV parameters in the time and power domains.

Heart Rate Variability Parameters and Analysis

The Kubios HRV platform allowed for the interpretation and analysis of the following parameters in the time domain (Heart Rate Variability, 1996):

1. **Heart Rate:** The number of heart beats per minute.
2. **SDNN:** The standard deviation of the inter-beat interval, which reflects the amplitude of heart rate variability.
3. **RMSSD:** The root mean square of the successive differences (in seconds) between the inter-beat intervals. This parameter reflects parasympathetic tone.

These HRV data were also analyzed for a series of parameters in the frequency domain. The following frequency domain parameters are reflective of the degree of modulation found between the sympathetic and parasympathetic nervous system tones (Heart Rate Variability, 1996):

1. **Very Low Frequency Power (%VLF):** The level of modulation of the sympathetic tone, [<0.003 – 0.04 Hz (ms^2)]
2. **Low Frequency Power (%LF):** The level of modulation of the parasympathetic and sympathetic tone, [0.04 – 0.15 Hz (ms^2)]
3. **High Frequency Power (%HF):** The level of modulation of the parasympathetic tone, [0.15 – 0.40 Hz (ms^2)]

Questionnaire Scoring and Analysis

The questionnaires that were used for this study were the Beck Anxiety Inventory (BAI), the Beck Depression Inventory (BDI), and the Rosenberg Self-Esteem Scale. Both the BAI and BDI are scored on a scale of 63 where a higher score indicates increasing levels of anxiety or depression, respectively ("Beck Scales | Beck Institute for CBT.", n.d.). The Rosenberg Self-Esteem Scale ranges from a score of zero to a score of 30. On this scale, scores from 15 to 25 fall within the normal rage, while scores that are lower than 15 may suggest lower self-esteem (Rosenberg Self-Esteem Scale (SES), 2017).

Experimental Questions Word Analysis

The experimental question responses were analyzed to determine the frequency of positive, neutral, and negative words that were used in the responses. This was done using a list of words that are used to describe emotions, feelings, and sensations that was compiled and sorted into either positive, neutral, or negative words using information from an external resource (Hand, n.d.). For the pre-experimental question, the open-ended responses were analyzed by highlighting all words that were used to describe emotions or feelings, and then classifying the descriptive words used as either positive, negative, or neutral. The percentage of each classification of words was determined with respect to the total number of adjectives scored for each response.

For the post-experimental question that asked the subject for three words to describe how they were feeling following their interaction with either the horse or the projected

horse image, the three words were classified as positive, negative, or neutral. Then, the number of each classification of words was totaled for each session and for each subject in both the experimental and control groups. The average number of positive, neutral, and negative words out of the three words chosen to describe how they were feeling for each session was calculated.

Exit Interview

At the post-baseline session with each study participant, a brief exit interview was conducted and recorded for later analysis. The following questions were asked to each participant while their response was recorded on a recording device:

1. What did you notice during and after your sessions with the horses?
2. When did you first notice this?
3. Is there anything else that you would like to add or share with us?

The responses to each of these questions were transcribed following the exit interview. Each response was then analyzed and words that described emotions or feelings were highlighted. These words were then classified as positive, neutral, or negative using a similar method to that described above for the experimental questions. The fraction of words in each category was determined for each subject's exit interview responses.

Results

Human Interaction HRV Data:

Human Baseline and Post-Baseline HRV Measures – Experimental Group

Parameter	Subject	Baseline	Post-Baseline	Change	Average Change for All Subjects
HR	1	87.73	102.47	14.74	2.23
	2	103.90	107.16	3.26	
	3	108.90	91.70	-17.20	
	4	82.10	90.20	8.10	
SDNN	1	39.30	36.60	-2.70	-4.45
	2	47.00	42.10	-4.90	
	3	30.20	24.30	-5.90	
	4	69.00	64.70	-4.30	
RMSSD	1	18.50	11.60	-6.90	-13.50
	2	57.90	20.70	-37.20	
	3	28.20	15.00	-13.20	
	4	33.10	36.40	3.30	
%VLF	1	50.10	66.30	16.20	6.23
	2	35.60	25.30	-10.30	
	3	16.60	52.50	35.90	
	4	41.80	24.90	-16.90	
%LF	1	33.80	28.10	-5.70	15.85
	2	18.30	66.10	47.80	
	3	34.80	38.00	3.20	
	4	38.20	56.30	18.10	
%HF	1	16.10	5.60	-10.50	-21.95
	2	46.00	8.70	-37.30	
	3	48.50	9.50	-39.00	
	4	19.80	18.80	-1.00	

Table 2.1: Baseline and post-baseline measurements for the HRV parameters for each experimental group subject. Average change of each parameter for all experimental group subjects is also shown.

Human Baseline and Post-Baseline HRV Measures – Control Group

Parameter	Subject	Baseline	Post-Baseline	Change	Average Change for All Subjects
HR	5	84.23	74.22	-10.01	1.28
	6	94.05	90.81	-3.24	
	7	75.62	80.23	4.61	
	8	92.20	76.37	-15.83	
	9	83.57	114.44	30.87	
SDNN	5	62.70	97.20	34.50	24.84
	6	29.70	54.90	25.20	
	7	19.20	31.00	11.80	
	8	33.70	59.40	25.70	
	9	55.30	82.30	27.00	
RMSSD	5	32.40	108.90	76.50	19.44
	6	20.60	28.90	8.30	
	7	11.30	14.90	3.60	
	8	18.90	33.60	14.70	
	9	24.10	18.20	-5.90	
%VLF	5	20.80	31.50	10.70	4.88
	6	40.50	60.90	20.40	
	7	17.20	28.70	11.50	
	8	72.20	38.50	-33.70	
	9	72.60	88.10	15.50	
%LF	5	65.80	30.40	-35.40	-4.04
	6	29.30	23.80	-5.50	
	7	69.70	67.50	-2.20	
	8	16.90	44.90	28.00	
	9	15.30	10.20	-5.10	
%HF	5	13.40	37.90	24.50	-0.88
	6	30.20	15.30	-14.90	
	7	13.00	3.70	-9.30	
	8	10.90	16.60	5.70	
	9	12.10	1.70	-10.40	

Table 2.2: Baseline and post-baseline measurements for the HRV parameters for each control group subject. Average change of each parameter for all control group subjects is also shown.

Human Pre and During Activity HRV Measures – Experimental Group

Parameter	Subject	Average Pre (from 3 sessions)	Average During (from 3 sessions)	Average Change	Average Change for All Subjects
HR	1	96.24	88.26	-7.98	-5.51
	2	101.09	99.43	-1.66	
	3	98.77	86.69	-12.08	
	4	88.65	88.33	-0.323	
SDNN	1	58.20	83.97	25.77	21.89
	2	53.30	55.97	2.67	
	3	30.17	66.95	36.78	
	4	50.90	73.23	22.33	
RMSSD	1	44.67	43.70	-0.97	18.18
	2	43.03	47.90	4.87	
	3	13.20	65.17	51.97	
	4	27.3	44.17	16.87	
%VLF	1	30.23	7.20	-23.03	-8.32
	2	34.10	43.67	9.57	
	3	40.70	21.97	-18.73	
	4	29.00	27.93	-1.07	
%LF	1	53.77	89.40	35.63	7.77
	2	34.10	35.10	1.00	
	3	52.77	46.27	-6.50	
	4	55.00	55.93	0.93	
%HF	1	16.00	3.43	-12.57	0.53
	2	31.73	21.17	-10.57	
	3	6.50	31.67	25.17	
	4	16.03	16.10	0.07	

Table 3.1: Results of the HRV parameters for each experimental group subjects before and during their sessions with the horses. Average change of each parameter for all experimental group subjects is also shown.

Human Pre and During Activity HRV Measures – Control Group

Parameter	Subject	Average Pre (from 3 sessions)	Average During (from 3 sessions)	Average Change	Average Change for All Subjects
HR	5	96.19	87.19	-9.00	0.67
	6	103.96	104.90	0.95	
	7	80.77	82.41	1.64	
	8	80.37	83.39	3.02	
	9	99.65	106.38	6.73	
SDNN	5	45.43	90.80	45.37	13.69
	6	30.27	31.63	1.37	
	7	48.67	61.33	12.67	
	8	56.30	52.20	-4.10	
	9	33.90	47.03	13.13	
RMSSD	5	21.93	43.00	21.07	4.11
	6	31.23	25.77	-5.47	
	7	41.13	50.80	9.67	
	8	29.77	26.93	-2.83	
	9	16.23	14.37	-1.87	
%VLF	5	22.00	3.83	-18.17	-7.91
	6	25.63	33.87	8.23	
	7	16.47	16.07	-0.40	
	8	35.43	13.40	-22.03	
	9	69.37	62.17	-7.20	
%LF	5	57.20	92.70	35.50	14.79
	6	31.67	37.27	5.60	
	7	66.80	64.47	-2.33	
	8	51.10	78.00	26.90	
	9	23.23	31.50	8.27	
%HF	5	20.77	3.47	-17.30	-6.82
	6	42.60	28.87	-13.73	
	7	16.47	19.27	2.8	
	8	13.43	8.57	-4.87	
	9	7.27	6.27	-1.00	

Table 3.2: Results of the HRV parameters for each control group subjects before and during their sessions with the projected image of the horse. Average change of each parameter for all experimental group subjects is also shown.

The results obtained from the HRV measurements show that, on average, there was a decrease in the heart rate and an increase in the SDNN and RMSSD for the experimental subjects both from pre- to post-baseline, and when comparing the pre- and during measurements that were obtained at each equine therapy session. Similar, but less significant changes were seen in the control group, with the exception of the heart rate, which showed a very slight average increase when comparing the pre- and during measurements obtained at each equine therapy session.

For the HRV power spectrum, there was an increase in the VLF% power when comparing the pre- and post-baseline measurements that was evident in both the experimental and control groups. However, in both groups, the VLF% showed an average decrease when looking at the pre-equine therapy measurements compared to the during measurements. In the experimental group, there was an average increase the the LF% power in both comparisons that were made. However, this average increase was not seen when comparing the pre- and post-baseline measurements for the control groups. Finally, both comparisons show an average decrease in the percent HF power for the experimental group, while there is a very minor increase in this power percentage for both comparisons when looking at the control group.

Questionnaire Responses:

The baseline and post-baseline questionnaire scores for each subject were averaged for the experimental group and the control group (shown below in tables 4.1 and 4.2). The changes from the average baseline to average post-baseline scores for each group were then graphed (shown in figure 2.1 and 2.2 below). These results demonstrate that

the experimental group subjects experienced decreases in their self-reported symptoms of anxiety and depression. Similar decreases were all seen in the control group, but were less pronounced than those seen in the experimental subjects, on average. The experimental group also demonstrated a significant average increase in self-esteem that was not evident in the control group.

Average Questionnaire Responses (Experimental Group)

	Baseline	Post-Baseline
Beck Anxiety Inventory	31.75	13.0
Beck Depression Inventory	22.0	7.75
Rosenberg Self-Esteem Scale	16.25	21.75

Table 4.1: Average questionnaire responses for all subjects in the experimental group from their baseline and post-baseline sessions.

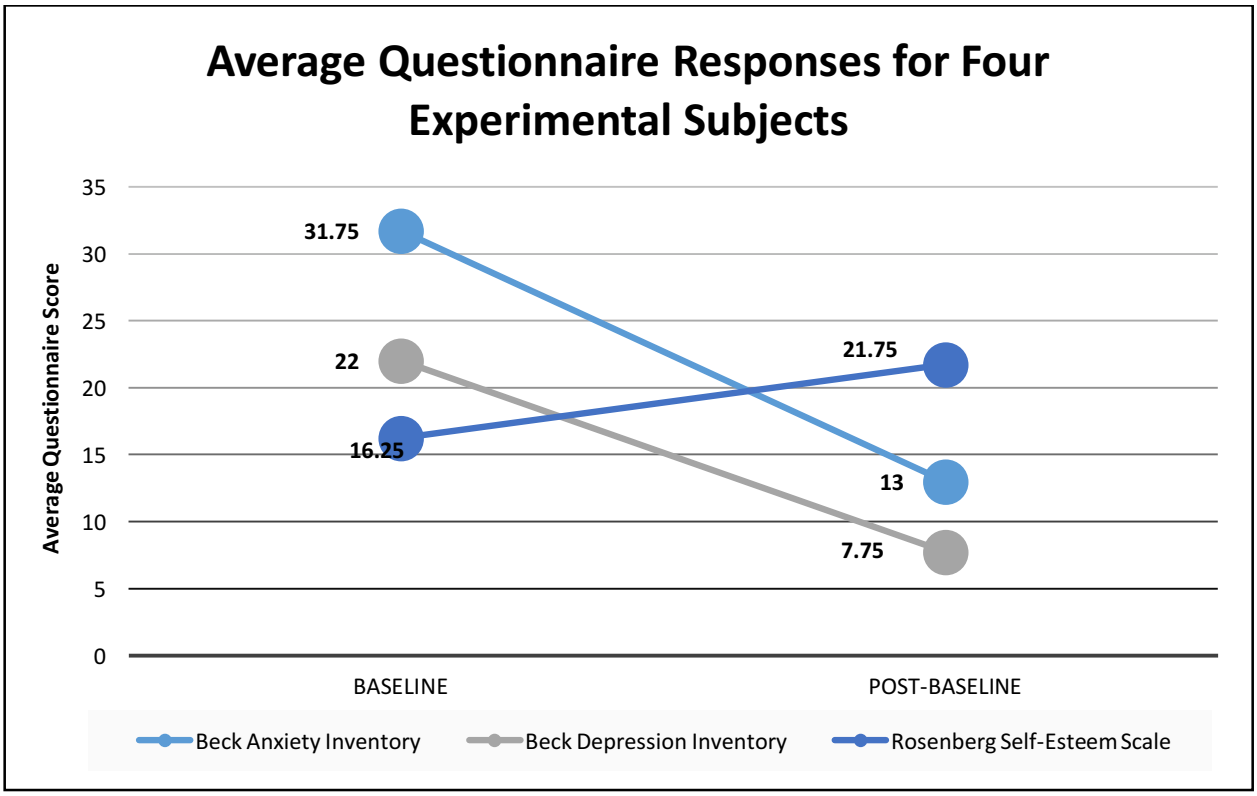

Figure 2.1: Average change in questionnaire responses for the four experimental subjects from baseline to post-baseline sessions.

Average Questionnaire Responses (Control Group)

	Baseline	Post-Baseline
Beck Anxiety Inventory	27.2	18.0
Beck Depression Inventory	21.8	11.0
Rosenberg Self-Esteem Scale	16.2	19.8

Table 4.2: Average questionnaire responses for all subjects in the control group from their baseline and post-baseline sessions.

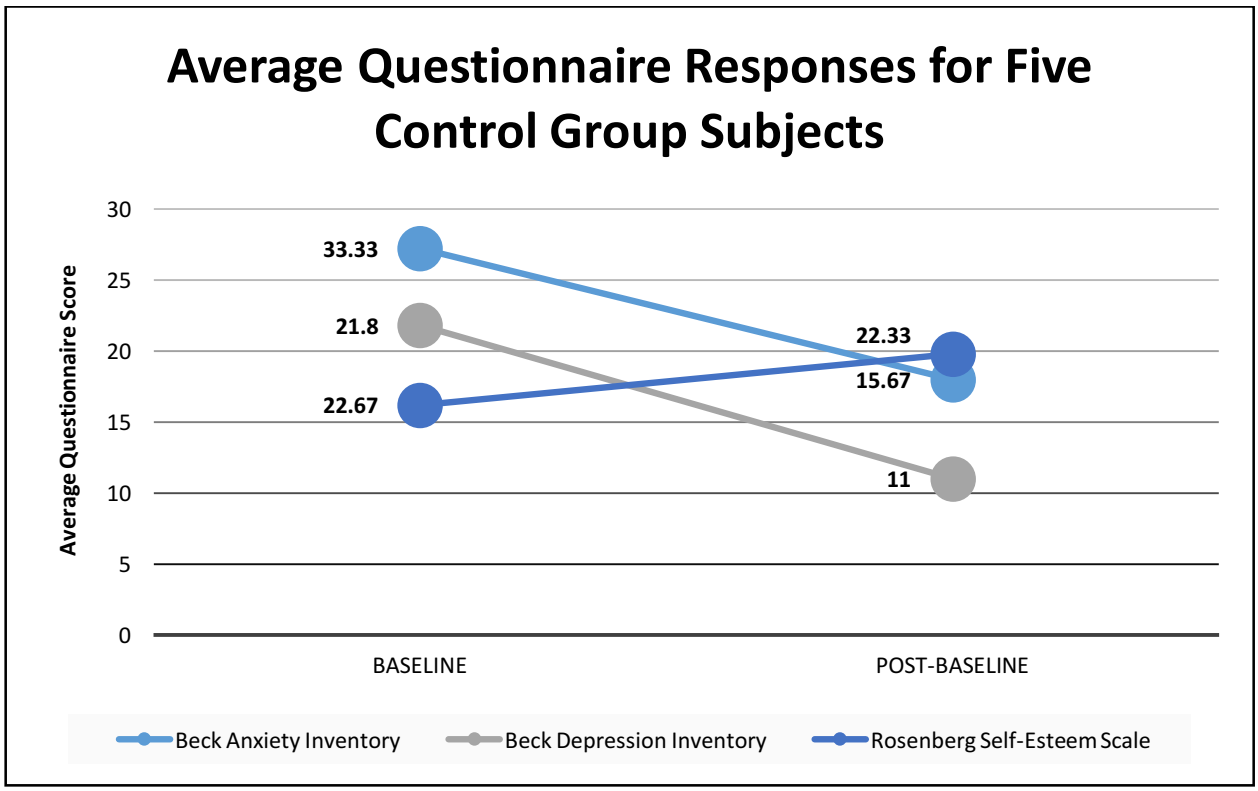

Figure 2.2: Average change in questionnaire responses for the five control group subjects from baseline to post-baseline sessions.

Experimental Question Responses:

The experimental question responses were recorded and analyzed. For the pre-experimental question, the responses were analyzed and all words that described emotions were highlighted. These highlighted words were then classified as either positive, neutral, or negative. The following table shows the fraction of words that were

used for each classification and shows that the number of positive, neutral, and negative words that were used in the pre-experimental question response did not differ significantly between the experimental and control groups. The p-values demonstrate the differences in the responses for the control group and experimental group were not statistically significant.

Word Comparison: Average Fraction of Pre-Experimental Question Responses

	Positive	Neutral	Negative
Horse Image (Control)	0.73 ± 0.25	0.15 ± 0.22	0.12 ± 0.16
Real Horse (Experimental)	0.73 ± 0.21	0.08 ± 0.17	0.19 ± 0.24
p-value	0.979	0.624	0.795

Table 5.1: The average fraction of words used for each classification (positive, negative, or neutral) for all of the experimental and control subjects.

For the post-experimental question, the three words that were recorded after each session with either the projected horse image or the real horse were classified as positive, negative, or neutral. Then, the number out of the three words that fell into each category was averaged across the three sessions for each of the subjects in either group. These averages were then used to determine the average number of positive, neutral, and negative words given in the total of three descriptive words for the post-experimental question for the four experimental group subjects and the five control group subjects. These results show that the average number of positive words that were used was higher in the experimental group and the number of neutral and negative words that were used were lower compared to the control group. The p-values demonstrate the differences in the responses for the control group and experimental group were not statistically significant.

Word Comparison: Average Post-Experimental Question Responses

	Positive	Neutral	Negative
Horse Image (Control)	1.73 ± 1.26	0.8 ± 0.73	0.47 ± 0.65
Real Horse (Experimental)	2.25 ± 0.82	0.5 ± 0.43	0.25 ± 0.32
p-value	0.439	0.468	0.538

Table 6.1: The average number of words used for each classification (positive, neutral, or negative) on the post-experimental question for all of the experimental and control subjects.

Exit Interview Analyses:

Each participant was asked a brief series of exit interview questions that allowed them to share what they noticed during and after their sessions working with the real horse (experimental condition) or the horse image (control condition). Each individual's responses were analyzed and any words that were used to describe their feelings were highlighted. These highlighted words were then classified as either positive, neural or negative using a compiled words list that was created using a series of external resources.

One the emotion words had been identified and the number of words in each classification were totaled, the fraction of words in each classification were calculated for each individual subject. Then, these fractions were averaged for all of the subjects in the experimental group. The same was done for the sum of subjects in the control group. The average fraction of each classification of words that were used in the exit interview responses for each group are shown below in table 5.1. The p-values demonstrate the differences in the responses for the control group and experimental group were not statistically significant.

Word Comparison: Average Fraction of Words Used for Exit Interview Responses

	Positive	Neutral	Negative
Horse Image (Control)	0.63 ± 0.47	0.35 ± 0.45	0.03 ± 0.06
Real Horse (Experimental)	0.83 ± 0.19	0.17 ± 0.19	0.0 ± 0.0
p-value	0.400	0.439	0.374

Table 7.1: The average fraction of words used for each classification (positive, negative, or neutral) for the compiled exit interview responses for all subjects in each condition group (control or experimental).

Discussion

Overall, the equine therapy sessions seemed to offer improvements in autonomic balance as well as feelings of anxiety, depression, and self-esteem. These improvements were much greater, on average, for the experimental group compared to the control group who worked with a projected image of a horse.

For each subject in the experimental group, there was a decrease in the score for the BAI and BDI, indicating improved feelings of depression and anxiety. There was also an increase in the score on the Rosenberg Self-Esteem Scale, indicating an increase in self-esteem following the sessions with the horses. There were also improvements in the heart rate variability parameters when comparing the post-intervention measurements to the initial measurements that were taken for each subject. On average, participants experienced an increase in the SDNN, RMSSD, and %VLF when compared to the baseline measurements. This increase may be attributed to the higher baseline %VLF that is commonly seen in horses.

Although improvements in the HRV parameters that were analyzed were seen in both the short-term and longer-term measurements that were obtains, the results of this study demonstrate that the improvements in HRV are more short-term improvements. This is shown by the consistent improvements of the pre to during comparisons of the HRV parameters for each of the experimental subjects. These improvements, however, are less consistent over a longer duration as shown by the baseline to post-baseline comparisons for each experimental subject.

The results obtained in this study show similar improvements in depression and anxiety that are demonstrated by other, similar studies. A study on the effects of equine-assisted therapy for anxiety and posttraumatic stress conducted at the Atlantic University also found that a six-week equine therapy regimen led to improvements in the symptoms of anxiety, posttraumatic stress, and depression (Earles et al., 2015). Another study that evaluated the effects of HRV biofeedback for depression demonstrated that slow, rhythmic breathing at a rate between 4.5 and 6.5 breaths per minute lead improvements in the somatic symptoms of depression when compared to the control group. There were also noted increases in the LF power of HRV in the measurements that were taken during the breathing sessions. These increases in the percentage of LF power reflect changes in sympathovagal balance (Karavidas, 2008).

Limitations:

After the first few sessions of the study, it was discovered that the Zephyr BioHarness would occasionally have glitches or errors that produced HRV results with artifacts that

rendered these data inaccurate and unusable. As a result of this finding, we began using both the Zephyr BioHarness and the emWave2 as a backup. However, because we had not anticipated this type of technological error, only some of the participants were available to come back for an additional session to make up for these unusable data. So, there are two subjects who have at least one HRV measurement from one of the sessions that is unusable.

Future Directions:

The findings from this study indicate that there may be benefits to using equine therapy as a treatment for individuals suffering from anxiety and/or depression. In order to further demonstrate this, future research will need to be conducted. First, other methods of equine-assisted therapy can be explored in order to determine which types of equine-assisted activities are the most beneficial. Further studies can also recruit larger numbers of subjects in order to provide a larger data set that supports the benefits demonstrated by the results of this pilot study.

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Appendix A

The questionnaire responses for each individual subject in the experimental and control groups are shown in the tables below. These data were averaged for each group and are shown above in Table 4.1 and Table 4.2.

Beck Anxiety Inventory – Experimental Subject Scores

Subject	Baseline Score	Post-Baseline Score
1	33	4
2	18	7
3	25	15
4	51	26

Table 8.1: Individual Beck Anxiety Inventory scores from the baseline and post-baseline sessions for each subject in the experimental group. Scores range from zero to 63, with higher scores indicating increasingly severe levels of anxiety.

Beck Anxiety Inventory Scores – Control Subject Scores

Subject	Baseline Score	Post-Baseline Score
5	32	13
6	22	12
7	46	22
8	11	11
9	25	32

Table 8.2: Individual Beck Anxiety Inventory scores from the baseline and post-baseline sessions for each subject in the control group. Scores range from zero to 63, with higher scores indicating increasingly severe levels of anxiety.

Beck Depression Inventory Scores – Experimental Subject Scores

Subject	Baseline Score	Post-Baseline Score
1	29	0
2	18	7
3	14	10
4	27	14

Table 9.1: Individual Beck Depression Inventory scores from the baseline and post-baseline sessions for each subject in the experimental group. Scores range from zero to 63, with higher scores indicating increasingly severe levels of depression.

Beck Depression Inventory Scores – Control Subject Scores

Subject	Baseline Score	Post-Baseline Score
5	5	2
6	13	7
7	36	12
8	30	12
9	25	22

Table 9.2: Individual Beck Depression Inventory scores from the baseline and post-baseline sessions for each subject in the control group. Scores range from zero to 63, with higher scores indicating increasingly severe levels of depression.

Rosenberg Self-Esteem Scale – Experimental Subject Scores

Subject	Baseline Score	Post-Baseline Score
1	18	30
2	24	26
3	15	20
4	8	11

Table 10.1: Individual Rosenberg Self-Esteem Scale scores from the baseline and post-baseline sessions for each subject in the experimental group. This scale is scored from a range of zero to 30. Scores that are lower than 15 may suggest lower self-esteem.

Rosenberg Self-Esteem Scale – Control Subject Scores

Subject	Baseline Score	Post-Baseline Score
5	30	28
6	21	21
7	17	18
8	6	18
9	7	14

Table 10.2: Individual Rosenberg Self-Esteem Scale scores from the baseline and post-baseline sessions for each subject in the control group. This scale is scored from a range of zero to 30. Scores that are lower than 15 may suggest lower self-esteem.

Appendix B

The word classifications for the total of three pre-experimental question responses (one from each of the three sessions with the real horse or horse image) for each individual subject in the experimental and control groups are shown in the tables below. These raw data were used to find the average fraction of words used and for all of the subjects in each of the groups, which is shown above in Table 5.1.

Pre-Experimental Question Responses for the Experimental Group Subjects

Subject	Positive Words	Neutral Words	Negative Words
1	2	1	0
2	3	0	0
3	3	0	1
4	3	0	3

Table 11.1: Sums of word classifications for each experimental subject's responses to the pre-experimental question (totaled from all three sessions with the horses).

Pre-Experimental Question Responses for the Control Group Subjects

Subject	Positive Words	Neutral Words	Negative Words
5	7	0	0
6	2	2	0
7	2	1	1
8	7	0	0
9	2	0	1

Table 11.2: Sums of word classifications for each control subject's responses to the pre-experimental question (totaled from all three sessions with the horse image).

The word classifications for the total of three post-experimental question responses (one from each of the three sessions with the real horse or horse image) for each individual subject in the experimental and control groups are shown in the tables below.

These raw data were used to find the average number of words (out of the three given as a response to the question) that were used for three subjects, which are shown above in Table 6.1.

Post-Experimental Question Responses for the Experimental Group Subjects

Subject	Positive Words	Neutral Words	Negative Words
1	6	3	0
2	9	0	0
3	6	1	2
4	6	2	1

Table 12.1: Sums of word classifications for each experimental subject's responses to the post-experimental question (totaled from all three sessions with the horses).

Post-Experimental Question Responses for the Control Group Subjects

Subject	Positive Words	Neutral Words	Negative Words
5	9	0	0
6	1	4	4
7	2	4	3
8	9	0	0
9	5	4	0

Table 12.2: Sums of word classifications for each control subject's responses to the post-experimental question (totaled from all three sessions with the horse image).

Appendix C

The word classification totals for the exit interview responses for each individual subject in the experimental and control groups are shown in the tables below. These raw data were used to find the average fraction of words used and for all of the subjects in each of the groups, which is shown above in Table 7.1.

Word Classification Totals: Exit Interview Responses for Each Subject in the Experimental Group

Subject	Positive Words	Neutral Words	Negative Words
1	2	1	0
2	6	0	0
3	4	0	0
4	2	1	0

Table 13.1: Sums of word classifications for each experimental subject's responses to the exit interview questions.

Word Classification Totals: Exit Interview Responses for Each Subject in the Control Group

Subject	Positive Words	Neutral Words	Negative Words
5	4	0	0
6	0	1	0
7	2	5	1
8	5	0	0
9	7	1	0

Table 13.2: Sums of word classifications for each control subject's responses to the exit interview questions.

Appendix D

The compiled word list that was used to classify words as positive, neutral or negative was created using lists of English adjectives from external sources that had been classified (Hand, n.d.). This word list was used for the experimental question analyses and the exit interview analyses are shown in the table below.

Positive Words			
Accepting	Cute	Grace	Pleasure
Amazed	Enjoy(ing)	Great	Reciprocity
Appreciating	Excitement	Happy	Relaxed
Awesome	Exquisite	Honorable	Respect
Balanced	Extraordinary	Hug	Settled
Beautiful/Gorgeous	Fascinating	Interesting	Smile
Bond/Connection	Fun	Love	Soft
Calm(ing)/Serene	Funny	Mirth	Soothing
Charming	Gentle(ness)	Nice/Delightful	Sweet
Close	Giggle	Open(ness)	Trust
Comfortable	Good/Content	Playful	

Table 14.1: List of positive adjectives that describe emotions or feelings.

Neutral Words	
Anticipation	Focused
Aura	Force
Awareness	Glow
Bouncing	Goosebumps
Communicate/Communicating	Heart
Concentrated/Attentive	Heavy
Conversation	Intense/Intensity
Cool(er)	Layer
Dense	Magnetic

Different/Change	Movement
Dramatically	Neutral
Energy	None/Nothing
Extreme	Power
Field	Pressure
Flow/Flowing	Pulsating

Table 14.2: List of neutral adjectives that describe emotions or feelings.

Negative Words
Apprehensive
Awkward
Concerned
Dead/Dead Matter
Fear
Nervous(ness)
Nothing
Overwhelmed
Stressed
Worry/Worried

Table 14.3: List of negative adjectives that describe emotions or feelings.