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The Influence of a Positive or Negative Mindset on Affect and Heart Rate Variability

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Project title: The Influence of a Positive or Negative Mindset on Affect and Heart Rate
Variability

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Abstract

The purpose of this study was to see whether the induction of a positive or negative mindset could influence measures of health and happiness, specifically heart rate variability and affect. 43 participants completed two short writing exercises intended to place them in either a positive or a negative mindset. During the entirety of the study, I measured their heart rate and calculated the variability between beats. Participants reported their affect before and after the manipulation. The results showed a clear relationship between mindset condition and heart rate variability and a possible link between mindset and affect. The positive mindset condition evoked more positive affect, less negative affect, and higher heart rate variability, with the negative mindset condition having the opposite effect. The study also looked at the relationship between trait optimism and resting heart rate variability and found that, contrary to expectation, pessimists had higher resting heart rate variability. Overall, the results indicate that there is evidence for a link between mindset and measures of health and happiness.

The Influence of a Positive or Negative Mindset on Affect and Heart Rate Variability

Aristotle described happiness as “the best, noblest, and most pleasant thing in the world” in *Nicomachean Ethics*, written around 340 BCE. Since before the Common Era, philosophers have been thinking about happiness, how to achieve it, and what it means for us. In more recent years, psychologists have begun to scientifically study happiness. This new field of research offers compelling evidence for the benefits of happiness in all domains of life.

The field of research on happiness is growing rapidly. From the 1980s to the 2000s there was a 17-fold increase in published articles on happiness, subjective well-being, and life satisfaction (Diener, 2009). In 2005, Lyubomirsky, King, and Diener conducted a literature review and found that reports of long-term happiness as well as momentary positive affect were associated with numerous beneficial qualities including a more positive view of self, increased sociability and popularity, healthier behavior, better immune functioning, and greater ability to cope with stress. These psychological and physiological changes go hand in hand. Neuroimaging technology such as PET scans and functional MRI scans have allowed researchers to discover which areas of the brain produce and respond to feelings of happiness, and which neurotransmitters are involved in these processes (Funahashi, 2011). Not only are biological changes occurring in the brain, but these changes have also been shown to have an effect on overall health. In a nationally representative sample of the United States, researchers found that those who reported being “not happy” had a 14 percent higher risk of death than those who reported being “very happy,” even after controlling for certain demographic, socioeconomic, and lifestyle factors (Lawrence, Rodgers, & Wadsworth, 2015).

The present research seeks to identify how different ways of thinking could impact happiness and overall health. It examines mindset as a more temporary state and optimism as a

more permanent trait, and looks to see how these two variables might alter affect and heart rate variability. By inducing a positive or negative mindset in participants, I tested whether focusing on the positive aspects of a situation improves measures of health and happiness in the short-term. In this way, mindset served as the state variable. Then, to also analyze a trait variable, I compared level of trait optimism to resting heart rate variability, to see if being optimistic about the future is associated with better health.

Mindset

One topic that has been connected with the happiness literature is mindset. Mindset became a topic of conversation when researcher Carol Dweck (2006) introduced the significance of a growth versus a fixed mindset and the implications it has on a person's success. While her theory focuses on a person's belief about whether their own abilities are malleable or set in stone, researchers since then have applied the term to different situations. Rucker and Galinsky (2016, p. 161) define mindset as "a psychological orientation that affects the selection, encoding, and retrieval of information." The way the current study looks at mindset is in regard to a positive or negative mindset in the present moment, and how it can affect health and happiness. This is different than focusing on positive aspects of the past or future, and is more about the psychological and physiological changes in the body in real time.

Through multiple research studies, a positive mindset has been shown to be beneficial, and importantly, changeable. Broomhead, Skidmore, Eggett, and Mills (2012), studied junior-high school singers and found that the induction of a positive mindset during practice improved subsequent expressive performance. Crum, Salovey, and Achor (2013) looked at the relationship between mindset and stress. Their study found that having participants watch a short video on either the enhancing or the debilitating effects of stress could change the way they thought about

it. They also found that the students who had the stress-as-enhancing mindset had more moderate cortisol reactions to acute stress, thus indicating that their mindset produced actual physiological changes. One study even linked higher positive affectivity with greater attention to positive information. This study found that participants who scored higher on a measure of positive affectivity showed attentional bias towards positive words when flashed on a screen, indicating the close relationship between higher levels of happiness and paying attention to positive aspects (Grafton & Macleod, 2016). Based on this research, I hypothesized that if people completed writing exercises that forced them to focus on positive aspects, then they would show more positive affect and less negative affect. If people wrote about negative aspects then they would show more negative affect and less positive affect.

Affect

Affect is a measure of emotionality that has been correlated with improved health (Pressman & Cohen, 2005). Watson, Clark & Tellegen (1988) define affect in terms of a two-factor approach, where positive and negative affect are on separate continuums. This means that a person high in positive affect does not necessarily need to be low in negative affect as well, though they might be. They developed a scale, called the Positive and Negative Affect Schedule (PANAS), which is widely used today. The positive affect items include terms like *interested*, *enthusiastic* and *alert*. The negative affect items include descriptors such as *upset*, *nervous* and *ashamed*. The full schedule can be found in Appendix A.

In a review of the link between positive affect and health, Pressman and Cohen (2005) found that high positive affect was correlated with reduced morbidity, increased longevity, and decreased pain in disease. They hypothesized that these health improvements are likely due to a variety of factors, but could be due to positive affect reducing stress, increasing social ties, and

improving health practices, all of which improve immune functioning and lower risk for disease. It is also possible that these health benefits are perceived rather than actually different. Many health surveys rely on self-report, so answers on surveys are altered by affective biases. One study found that negative affect specifically caused a larger change between objective and perceived health (Whitehead & Bergeman, 2016). Whether objective or perceived, it seems that affect plays a role in overall health.

Optimism

Optimism ties in nicely with affect and mindset. While affect is a shorter-term measurement of emotionality and mindset is a mental orientation affecting present information, optimism projects more into the future. In short, researcher Sonja Lyubomirsky (2008, p. 102) defines it as “anticipating a bright future.” For the purpose of this study, it will be defined in this way. Similar to mindset, optimism has been linked to several health benefits and increased aspects of happiness. Segerstrom and Sephton (2010) looked at optimism about the future in law school students. They found that the students who were more optimistic about their future had higher ratings of positive affect and even had improved immune responses. In another study, King (2001) asked participants to come into the lab four days in a row and write about their goals for the future and their “best possible selves” for 20 minutes. She found that the participants who completed this exercise, compared to controls, were more likely to report feeling happier and had less frequent visits to the university’s health center as far as five months after the writing exercise. Lyubomirsky (2008) conducted a similar study, but had participants write about their best possible selves at home, as often as they liked, for four weeks. Similar to King’s results, Lyubomirsky found an increase in mood of the participants who actively focused on the intervention during the four weeks. Based on this research, I predicted that people who rate

higher on a measure of optimism would have overall better health, measured through resting heart rate variability.

Heart Rate Variability

Much of the research focused on thus far has used survey variables to measure affect and overall happiness. The current study examined the relationship between happiness variables and a physiological measure, heart rate variability. The heart is controlled largely by the autonomic nervous system. It is innervated by both the sympathetic nervous system, responsible for speeding up the heart rate during times of action, and the parasympathetic nervous system, responsible for slowing down the heart rate in times of rest. While these systems perform opposite functions, they act upon the heart at the same time. Heart rate variability, or the variation in the time interval between heartbeats, is a measure of the balance between these two systems. A healthy heart is able to respond quickly to either system, and thus there is more variability in the time between beats. In contrast, low heart rate variability indicates one of the systems is controlling the heart more than the other (Thayer, Ahs, Fredrikson, Sollers, & Wager, 2012). This unhealthy balance is linked with an increase in mortality and is used as a marker for disease (Thayer & Lane, 2007).

More recently, research has come out that associates heart rate variability with psychological factors in addition to the physical factors previously described (Thayer et al., 2012). These links can be seen in heart rate variability as a trait or as something that changes in the short-term. For example, higher resting heart rate variability has been associated with a better capacity for emotional regulation (Appelhans & Luecken, 2006). It has also been demonstrated that heart rate variability increases with successful emotional regulation during tasks in a lab

(Butler, Wilhelm, & Gross, 2006). Therefore, it can be measured as a trait or during a particular state.

More specific to happiness, heart rate variability has been linked to a variety of factors. In one study, Oveis et al. (2009) found that respiratory sinus arrhythmia (RSA), a measurement of heart rate variability in association with respiration, was linked to a number of characteristics of positive tonic emotionality. Higher RSA was associated with higher levels of extraversion and agreeableness, two personality traits frequently linked to happiness. It was also positively correlated with enduring positive mood and trait optimism, though the results were mixed on characteristics of negative tonic emotionality. Koval et al. (2013) found that low heart rate variability was correlated with high instability in positive affect. Similarly, Kok and Fredrickson (2010) found connections between high heart rate variability and stability of positive affect. This longitudinal study analyzed vagal tone, a measure of parasympathetic activity, and reported positive emotions over an 8-week period. The researchers suggested that positive emotions influenced vagal tone and vagal tone influenced positive emotions in a sort of upward spiral.

Overall, the literature shows that high heart rate variability is associated with better health and positive emotional traits. It indicates a more adaptive and better functioning nervous system, which is correlated with improved health and higher positive affect.

Measuring Heart Rate Variability

There are two ways to measure heart rate variability: time domain or frequency domain. In 1996, the Task Force of The European Society of Cardiology and The North American Society of Pacing and Electrophysiology published a report establishing the standards of measurement. Time domain measurement is described as the simpler of the two, and involves calculating the time differences between successive QRS complexes, or normal beats of the

heart. Frequency domain is described as a measure of how variance is distributed as a function of frequency. The frequency domain measurement gives more information because it takes into account both frequency and amplitude to provide a more holistic measure of heart rate variability (Shaffer, McCraty, & Zerr, 2014). As stated in the Task Force report, the frequencies measured by spectral analysis include high frequency (HF), low frequency (LF), very low frequency (VLF) and ultra low frequency (ULF). Most relevant are HF and LF, as they are thought to measure parasympathetic and sympathetic input, respectively. However, there is some debate about to what extent LF-HRV really measures exclusively sympathetic activity. For this reason, the present research focuses on HF-HRV, a measurement of parasympathetic, or vagal, stimulation.

As of now, there has been no research done that specifically links mindset to heart rate variability. However, based on the evidence provided here, it seems likely that there could be a link that has not been discovered yet. My hypothesis was that the induction of a positive mindset would increase heart rate variability, and the induction of a negative mindset would decrease heart rate variability.

Present Research

The present study tested the effect of a positive or negative mindset on a person's affect and ultimately their heart rate variability. Based on previous research involving mindset, affect, and physiological changes, I think there is a link between mindset and heart rate variability. I predicted that inducing a certain mindset in the lab would lead to a change in mood and heart rate variability in participants. I made the following three hypotheses:

Hypothesis 1: Having a positive mindset would increase positive affect and a decrease negative affect. Having a negative mindset would have the opposite effect.

Hypothesis 2: Having a positive mindset would increase heart rate variability and having a negative mindset would decrease heart rate variability.

Hypothesis 3: Optimists would have significantly higher resting heart rate variability than pessimists.

Method

Participants

The participants were 43 undergraduate students (25 women and 18 men) enrolled in an introduction to psychology course. They volunteered for this particular study and received compensation with course credit. Of those, 26 were first years, 14 were sophomores, and 3 were juniors. Two participants' data had to be omitted because the heart rate monitor became unhooked during recording, so data from 41 participants remained.

Measures

Positive and negative affect. The 10-item Positive and Negative Affect Schedule (PANAS) with the time instruction for the present moment measured participants' affect before and after the manipulation (Watson, Clark, & Tellegen, 1988). It includes 10 items of positive affect and 10 items of negative affect, rated on a 5-point scale ranging from *very slightly or not at all* to *extremely*. The full schedule can be found in Appendix A.

Optimism. The 10-item Life Orientation Test (LOT) determined participants' levels of trait optimism. It includes 10 statements rated on a 5-point scale, six of which are used to score and four of which are filler items. The full test can be found in Appendix B. Because of restraints in the online recruitment system used, statements 2, 5, 6, and 8 did not appear in the revised measure. These items are distractors in the original scale, and are omitted when scoring, but did not appear in this version of the test.

Apparatus

The Biopac MP150 with three electrodes was used for data collection. I applied the three electrodes with electrode gel, and placed them under the collarbone on the left and right side and under the ribcage on the left side. Then I calculated heart rate variability using AcqKnowledge 4 software.

Procedure

Before participants arrived, I screened them using the Life Orientation Test. Only those in the top or bottom third of the optimism scale were allowed to volunteer for the experiment. Those in the middle were excluded from participating. These two groups served as the optimist group ($n = 23$) and the pessimist group ($n = 18$). During random assignment into the positive or negative mindset condition, level of trait optimism was not taken into account.

When participants arrived, they read the consent form and became acclimated to the room. I told participants the study was about decision-making, so that their focus would be away from the mindset they were in. Then I applied gel to the electrodes and gave participants instructions on how to attach them. Participants sat in a comfortable chair with the leads securely attached and connected to the Biopac. At this point, the Biopac recorded a five-minute baseline of their heart rate as the participant sat back in the chair and relaxed. After the five-minute baseline, I gave participants the PANAS to measure their pre-manipulation affect. Next, I showed them seven paintings. Each painting was by a different artist, but all were landscape sceneries and of similar color schemes. They were meant to be different enough for participants to choose between them, but not so different that they alter the participant's affect in different ways. I asked participants to put the paintings in order from the one they liked best to the one they liked least. Once they ranked the paintings, I took away all but the one that they ranked

fourth, directly in the middle. This was done so that participants would be looking at a painting they felt relatively neutral about, so that their opinions of it would interfere less with their focusing on the positive or negative aspects of it. At this point I randomly assigned participants to one of two conditions: the positive mindset condition ($n = 21$) or the negative mindset condition ($n = 20$). Both conditions wrote for five minutes in response to a few questions about the painting in front of them. The questions for the mindset conditions were as follows:

Positive Mindset Condition

Describe your favorite aspects of this print, and explain why.

If you had a friend that was interested in going to an art museum, what would you say about this painting to convince him or her to go see this specific one?

If your parents were planning to hang this print in your family home, what are some reasons why it could be a good addition to your home?

Negative Mindset Condition

Describe your least favorite aspects of this print, and explain why.

If you had a friend that was interested in going to an art museum, what would you say about this painting to convince him or her to go see a different painting instead of this one?

If your parents were planning to hang this print in your family home, what are some reasons why it would NOT be a good addition to your home?

I asked participants to write for the entire five minutes and to answer all the questions. The Biopac recorded their heart rate during this five-minute manipulation period.

When the first five-minute writing exercise was up, I asked participants to complete another short writing exercise, this time about their experience so far at college. The instructions

asked them to focus on answering the questions specifically as they were asked, rather than based on their overall impression of the school, to avoid participants changing the wording of the questions to support their overall feelings towards the school. Participants were in the same condition as they were for the first exercise. I reminded them again to write for the entire five minutes and to try to answer all the questions. The questions were as follows:

Positive Mindset Condition

Describe your favorite aspects of attending CSB/SJU, and explain why.

If you had a friend who was thinking about attending CSB/SJU, what would you say to convince him or her to choose this school?

What are some reasons why CSB/SJU is a good fit for you?

Negative Mindset Condition

Describe your least favorite aspects of attending CSB/SJU, and explain why.

If you had a friend who was thinking about attending CSB/SJU, what would you say to convince him or her to choose a different school?

What are some reasons why CSB/SJU might not be the best fit for you?

Once the five minutes were up, participants took the PANAS one more time to see if the manipulation changed their mood at all. After completing the measure of their affect, there was a five-minute return to baseline measure of their heart rate. I then unhooked the participants from the electrodes and debriefed them.

Results

After data collection, I calculated heart rate variability for participants' baseline, first writing exercise, second writing exercise, and return to baseline sections using AcqKnowledge

software. Automated analysis identified QRS complexes. I visually checked each set of data for accuracy of QRS labeling before calculating heart rate variability.

To test whether mindset could alter affect, I ran two ANOVAs, one for positive affect and one for negative affect. The dependent variable was change in affect, as measured by the difference between the first and second PANAS scores. Both results approached significance in the predicted directions. The positive mindset condition increased positive affect ($M = 1.36$, $SD = 1.16$) and decreased negative affect ($M = -.39$, $SD = .74$). The negative mindset condition decreased positive affect ($M = -1.59$, $SD = 1.12$), and increased negative affect ($M = 1.62$, $SD = .71$). The effects of mindset on positive affect approached significance, $F(1, 37) = 3.35$, $p = .075$, $\eta_p^2 = .083$. The effects of mindset on negative affect also approached significance, $F(1, 37) = 3.86$, $p = .057$, $\eta_p^2 = .095$. As predicted, the positive mindset condition increased positive affect and decreased negative affect and the negative mindset condition had the opposite effect. However, these results should be interpreted with caution because, despite showing medium effect sizes, the p-values did not quite meet the .05 standard for significance.

A 4x2x2 mixed ANOVA tested whether mindset or optimism affected heart rate variability. The different five-minute sections of the experiment served as the within-subjects variable and mindset and optimism served as the between-subjects variables. There were three significant main effects and no significant interactions. First, there was a significant difference in heart rate variability across the different five-minute sections of the experiment, $F(3, 111) = 3.55$, $p = .017$, $\eta_p^2 = .087$. To determine which sections were significantly different, I ran all possible combinations of paired t-tests between the sections (see Table 1). This determined that the third section, the task asking participants to write about their college experience, was significantly lower than all other sections. No other sections were significantly different from

one another. This evidence suggests that the manipulation did in fact alter heart rate variability across condition, with the second writing exercise working better than the first.

Table 1

Pairs	t	Sig. (2-tailed)
Baseline 1 ($M = .4, SD = .18$) – Painting ($M = .39, SD = .19$)	.75	.454
Painting ($M = .39, SD = .19$) – College ($M = .33, SD = .16$)	3.21	.003
College ($M = .33, SD = .16$) – Baseline 2 ($M = .38, SD = .16$)	-2.02	.050
Baseline 1 ($M = .4, SD = .18$) – College ($M = .33, SD = .16$)	3.03	.004
Baseline 1 ($M = .4, SD = .18$) – Baseline 2 ($M = .38, SD = .16$)	1.13	.266

As predicted, the positive mindset condition ($M = .44, SD = .03$) had significantly higher heart rate variability than the negative mindset condition ($M = .32, SD = .03$), $F(1, 37) = 7.74, p = .008$. The effect size for this result was large, $\eta_p^2 = .17$. Specific comparisons between groups showed that the differences between the positive and negative mindset conditions during the first baseline and the painting writing exercise were not significant. The differences between groups in the college experience writing exercise and the second baseline approached significance (see Table 2).

Table 2

Independent Samples	Mean Difference	Std. Error Difference	t	Sig. (2-tailed)
Baseline 1	.036	.055	.65	.517
Painting	.096	.057	1.68	.101
College	.092	.048	1.88	.067
Baseline 2	.096	.049	1.97	.056

Opposite of what was predicted, the pessimists ($M = .46, SD = .03$) had significantly higher heart rate variability than the optimists ($M = .30, SD = .03$), $F(1, 37) = 14.99, p < .001, \eta_p^2 = .288$.

Though the previous ANOVA showed that pessimists had higher heart rate variability across the entire study, I also wanted to explore specifically if the optimists and the pessimists had significantly different resting heart rate variability, as measured by the first baseline. The results of this ANOVA were significant as well, $F(1, 39) = 13.23, p = .001, \eta_p^2 = .25$, and still in the opposite direction than predicted. The pessimist group ($M = .50, SD = .04$) had higher resting heart rate variability than the optimist group ($M = .33, SD = .03$).

Discussion

The purpose of this study was to test whether the induction of a positive or negative mindset could influence measures of health and happiness, specifically heart rate variability and affect. I predicted that people who had a positive outlook, in both the short-term and long-term, would have higher heart rate variability, higher positive affect, and lower negative affect. These predictions were partially confirmed by the results of the present study. To summarize the results, mindset significantly altered heart rate variability in the direction predicted, and results on affect approached significance in the direction predicted. The study also found that the optimists had lower resting heart rate variability than the pessimists, and this was the opposite of what was predicted.

The present research showed that the positive mindset condition increased heart rate variability and the negative mindset condition decreased heart rate variability. This is an important finding because having high heart rate variability is linked to better health (Thayer & Lane, 2007). People are always looking for new ways to improve their health, help them live

longer, and make them feel better. If something like being mindful of the way you take in, interpret, and reflect on information helps, then it can serve as a realistic change people can make in their lives. By focusing on the positive aspects of situations, we could improve the quality of our lives.

Gratitude is a related and applicable concept that has received a lot of attention in recent years. Lyubomirsky (2008, p. 88) discusses it as a strategy for improving happiness, along with optimism, in the category of “practicing gratitude and positive thinking.” She cites multiple studies that show a causal link between practicing gratitude and increased happiness. In one study, participants wrote about five things in their lives that they were thankful for, while a control group wrote about five hassles. Each group wrote once a week for ten weeks. The researchers found that those who wrote about gratitude had higher self-reported well-being and less physical symptoms, such as headaches, than the control group (Emmons & McCullough, 2003). This would be a good way to incorporate the findings of the present study into daily life. By setting aside time to reflect and write about the positive events and experiences of the last week, mental and physical well-being could be improved. The results of the present study suggest that not only reflecting on past events, but also on current circumstances can be beneficial.

There was also evidence that the positive mindset condition increased positive affect and decreased negative affect, and that the negative mindset condition had the opposite effect. Though the results only approached significance, there was a medium effect size, indicating that the results should be further explored. This is an important finding because it indicates that having a positive mindset about something could improve a person’s affect. If positive affect measures positive emotionality of a person, then changing mindset could improve a person’s

mood in the short-term. This is exciting because feeling happier is associated with living longer (Lawrence et al., 2015), and short-term changes made over and over can lead to long-term results. So increases in positive affect would not only improve emotional well-being, but could also impact physical well-being.

Another finding of the present research was that the pessimist group tended to have higher heart rate variability than the optimist group. This was the opposite of what was predicted and does not align with previous research (Oveis et al., 2009). One explanation for this unexpected finding could be that the pessimists were more relaxed in the testing environment than the optimists. Evidence for this idea comes from Seligman's learned helplessness model (Abrahamson, Seligman, & Teasdale, 1978). It states that people with a pessimistic outlook eventually learn through repeated disappointment to submit to life circumstances. If this were true, pessimists might be calmer and experience less stress while in the testing environment. In other words, the pessimists would have more parasympathetic activation of their heart, which would translate to higher vagal tone. However, there are some mixed reviews of this theory in relation to pessimism (Helton, Dember, Warm, & Matthews, 1999), so it does not offer definitive evidence or support. It also contradicts previous research that has associated positive traits to high heart rate variability.

The LOT that participants took was meant to measure a trait variable about the person, rather than a state variable. Previous research has supported using trait variables to explore heart rate variability (Appelhans & Luecken, 2006), but that might explain why the results of this particular study differed between mindset, the state variable, and optimism, the trait variable. However, it does not explain why the results differed from the results reported by Oveis et al.

(2009) who also compared resting heart rate variability to LOT-measured optimism and pessimism.

One possible explanation is that the differing designs of the studies caused the differences in results. For one, it is possible that the distractor items that were removed from the LOT used in the present study affected participants scores enough that it changed their label. Since scale validity is dependent on item order, removing these distractor items might have changed the way participants answered the questions. If participants were improperly labeled as optimists or pessimists, then the comparison would be different. Secondly, the previous study used RSA as a measure, and only measured for 90 seconds. The present study used a different measure of HF-HRV and over a time span of five minutes.

Finally, it should be noted that the writing exercise that significantly altered participants' heart rate variability was the one about their college experience. This writing exercise differed from the first one in that it had a personal focus. Rather than just writing about a painting that they had never seen before, participants had to reflect on something that was meaningful in their life. It is likely that the personal tie is what made this writing exercise more salient in changing the physiological response of the participant. However, further studies would be necessary to offer more support for this theory.

In summary, previous research shows a clear link between high heart rate variability and good overall health (Thayer & Lane, 2007). High heart rate variability has also more recently been linked to certain happiness variables (Kok & Fredrickson, 2010; Koval et al., 2013; Oveis et al., 2009). The present research suggests that there is also a link between mindset and heart rate variability, and that there may be a link between mindset and affect. This is an important finding, because it implies that the mindset we adopt could play a major role in our happiness,

and potentially even our overall health. This is critical and exciting information, given the evidence that our mindset can be changed (Broomhead et al., 2012; Crum et al., 2013). Armed with this knowledge, people can focus on putting themselves in a more positive mindset, and potentially even improve their quality of life.

Limitations and Future Directions

A possible limitation of the experiment involves the use of the PANAS scale to measure affect. While it is a widely used and accepted scale, when using it in conjunction with a physiological cue such as heart rate variability, there may be some problems. In their review of measures of affect, Pressman and Cohen (2005) point out that the PANAS uses some descriptors that do not seem to reflect positive affect as we commonly think of it. For example, their scale includes items such as *strong* and *active*, but leaves off items like *happy* or *cheerful*. It also leaves off items such as *calm* or *relaxed*. Feelings of relaxation are often associated with high vagal tone (Shaffer et al., 2014), so the fact that the scale left off these measurements might explain why heart rate variability was influenced by mindset but only approached significance on measures of affect.

In future studies, it might be helpful to have a different measure of mood or affect. While the PANAS does tell us useful information about positive and negative affect, a measure that contains different items might be able to give us more information about how a positive or negative mindset might impact a person's mood. For instance, one that includes a distinction between calm and active states of positive and negative affect might be beneficial. The PANAS covers ten positive affect terms, but leaves off other desirable positive emotions such as feeling calm or at peace, happy, or joyful. It would be interesting to see if a scale that measured different affective states would offer different results or insight.

Another possible limitation involves the manipulation used. While the mindsets created were modeled after real questions people might use to reflect on items and events in their lives, most people do not engage in writing exercises like this one on a daily basis. It is possible then, that the changes in affect and heart rate variability would be different when applied to real life situations. For example, walking down the street and noticing the positive aspects of the scenery surrounding you might differ than sitting in a room and writing about the positive aspects of a picture. Similarly, mentally reflecting on the positive aspects of one's day might differ than making a list of the reasons why a person's college experience has been a good one. It may be the act of spending five straight minutes journaling about the positives that caused the increase in heart rate variability. However, even if the effects are specific to writing activities, there is research supporting the idea that journaling about positive events or feelings can improve happiness, so the information is still beneficial (King, 2001; Lyubomirsky, 2008).

It would be interesting to see this study done again, but with different manipulations, to see if the effects transfer to other situations. For example, a participant's heart rate could be measured using a portable heart rate monitor like a Holter monitor or exercise tracker. These devices would allow for more freedom in movement, and heart rate variability could be calculated while participants are outside of a lab setting. If participants' heart rates could be monitored while assessing their surroundings in the outside world, it would help us to understand whether the effects of the present study are generalizable beyond writing exercises in a lab. It would be beneficial to try different manipulations to see if the effects are specific to writing or reflection activities.

The present research emphasizes the importance of adopting a positive mindset, but it does not give much direction on how to go about adopting it. Future research in the area of how

to adopt and benefit from a positive mindset would make this study more applicable to daily life. Learning how to focus on the positive aspects of a situation would likely take time to be fully integrated into a person's lifestyle, so any strategies for this would be beneficial.

In the end, we need more research on the impact of a positive or negative mindset. While the literature is abundant on affect, and rapidly growing on heart rate variability, there is much less out there on mindset. If mindset is malleable and has the ability to improve health or happiness, then it could be used as a key to unlocking these highly sought-after benefits.

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Appendix A

The PANAS

This scale consists of a number of words that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to that word. Indicate to what extent you feel this way right now, that is, in the present moment. Use the following scale to record your answers.

1 – very slightly or not at all

2 – a little

3 – moderately

4 – quite a bit

5 – extremely

___ interested

___ irritable

___ distressed

___ alert

___ excited

___ ashamed

___ upset

___ inspired

___ strong

___ nervous

___ guilty

___ determined

___ scared

___ attentive

___ hostile

___ jittery

___ enthusiastic

___ active

___ proud

___ afraid

Appendix B

Life Orientation Test (LOT)

Please respond with the following scale:

Strongly				Strongly
Disagree	Disagree	Neutral	Agree	Agree
1	2	3	4	5

- ___1. In uncertain times, I usually expect the best.
- ___2. It's easy for me to relax.
- ___3. If something can go wrong for me, it will.
- ___4. I'm always optimistic about my future.
- ___5. I enjoy my friends a lot.
- ___6. It's important for me to keep busy.
- ___7. I hardly ever expect things to go my way.
- ___8. I don't get upset too easily.
- ___9. I rarely count on good things happening to me.
- ___10. Overall, I expect more good things to happen to me than bad.

Scoring:

Omit items 2, 5, 6, and 8

Reverse score items 3, 7, and 9