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J Camosun Psyc Res. (2021). Vol. 3(2), pp. 17-27.
Submitted Winter 2021; accepted July 2021.

How Gratitude Improves the Biological Health and Well-Being of Students

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ABSTRACT

In this paper, I sought to understand how gratitude activities could improve the biological health and well-being of students and decrease the students' stress-level. Previous research has found that gratitude increases oxytocin, sleep quality, and activity in the medial prefrontal cortex and anterior cingulate cortex. In my correlational study, I tested the strength of these relationships by examining naturalistic daily changes in their variables longitudinally over a two-week period. I inferred the oxytocin level by measuring my average blood pressure and the frequency of feelings of caring/sympathy each day, rated sleep quality by the sleep score recorded in Fitbit after monitoring the sleep each night, determined prefrontal cortex activity by the score in the PEBL Bivalent Shape Task, and measured gratitude activity by the frequency of the gratitude feelings each day. Data gathered in my correlational study showed no significant correlations of gratitude activity with oxytocin level, prefrontal cortex activity, or sleep quality. The result of this study will serve as guidelines on which substitute methodologies are not effective in correlating the gratitude activity to the well-being of the students.

1. Introduction

1.1 Research Problem

Students in different parts of the world face many challenging situations like examination and school requirements, financial difficulties, relationships, and anticipation of what will happen to their future. These challenging situations increase the students' stress-level that affects their health and well-being negatively. When the health and well-being of the student are affected negatively, the student's motivation to better himself or herself academically also decreases. Increased stress-level causes the students' immune system to lower which causes sickness. The decrease in well-being and health, in turn, causes a lack of energy, low mood, and mental health issues. Also, when the health and well- being of students are affected negatively due to high stress-level, their drive to pursue their dreams and passions decreases. I wish to know how gratitude work could help the students decrease their stress-level through the improvement of their biological health and well-being so their total well-being is at its optimum while they are pursuing their dreams.

1.2 Literature Review

One factor that can improve students' biological health and well-being is the social bonding that they form. The research conducted by Algoe and Way (2014) provides evidence regarding the biological effect of expressed gratitude in forming human bonds in adults. In this study, 77 heterosexual romantic couples who were part of the larger Carolina Couples Study were asked to choose something specific that they felt grateful for in their partner in their second visit to the laboratory. The participants were asked to thank their partner for almost 5 minutes to demonstrate gratitude, and their partner showed the receiving of gratitude tasks. Afterwards, the partners exchanged their role in the activity. Their saliva was collected after the gratitude activities and was analyzed for its CD38 content. CD38 is a substance that plays a role in oxytocin signaling and social processes. Their study showed that CD38 gene expression is associated with the quality and how often grateful behaviour is directed toward a partner. The polymorphisms of CD38, rs6449182, were associated with many building blocks on which gratitude facilitates social bonds. The consistent pattern in their finding of CD38 and its polymorphism, which indirectly links the oxytocin system with the quality and quantity of expressed gratitude, adds to the growing evidence by which oxytocin may influence human pair bonds. This study showcases that expressed gratitude could increase the oxytocin system activity, which affects social bond in a relationship.

Another factor that could improve the health and well-being of people is the quality of their sleep. Wood et al. (2009) have conducted a study relating gratitude to sleep. In their study, participants were asked to answer questionnaires that measure their gratitude, pre-sleep cognitions by rating their thoughts before sleeping, and their sleep quality using the Pittsburgh Sleep Quality Index. Their study showed that the participants' thoughts before sleeping affected the quality of sleep. In particular, the gratitude positive pre-sleep cognitions or the positive thoughts that the subject thinks before sleeping are positively correlated to sleep quality ($r = .21$, $p = .001$) but negatively correlated to the negative thought before sleeping ($r = -.11$, $p = .001$). The result of their study provides evidence that pre-sleep cognitions affect sleep. In their research, grateful people think less negative thoughts before sleeping, which reduces impairment in sleep. On the other hand, gratitude increases positive pre-sleep cognition, which leads to the best sleep quality. This study shows that grateful people can improve their health and well-being because of the superior sleep quality.

The grateful subjects' brain activity gives pieces of evidence why gratitude improves people's health and well-being. In the study conducted by Kini et al. (2016), recruited participants doing clinical counselling were assigned to either a gratitude intervention group or a therapy-as-usual control group. The gratitude intervention group participants were asked to write a letter to someone expressing gratitude for 20 minutes during their first, second, and third week of counselling. Participants in both groups answered the six-item Gratitude Questionnaire (GQ), the three-item Gratitude Adjectives Scale-3, and the Behavioral Health Measure-20 scale, which assesses the mental health of the participants, including anxiety and depression. Three months after counselling, participants in both groups underwent fMRI measurements. The results showed that the gratitude scores of participants in the gratitude intervention group showed a

significant increase after one week of intervention compared to the therapy-as-usual control group (Gratitude = 1.27, Control = 0.06, $t(40) = 2.25$, $p = 0.015$, one-tail). However, even though participants in the gratitude intervention group showed more significant improvement than the therapy-as-usual control group in their Behavioral Health Measure-20 scores, the results were not significant (Gratitude group increase = 0.36, Control group increase = 0.17, $t(39) = 1.44$, $p = 0.08$, one-tail). The fMRI results showed that participants in the gratitude intervention group had increased activity in the perigenual anterior cingulate cortex. The perigenual anterior cingulate cortex is the region of the brain associated with empathy. Also, participants in the gratitude intervention group showed a lasting increase in the pregenual anterior cingulate responsiveness to gratitude, even after three months. This study showed that those who do gratitude activity increase the neural activity of their responsiveness to gratitude.

In another study about the brain's neural activity conducted by Fox et al. (2015), participants were immersed in the Holocaust events wherein someone showed them help as the stimulus. Then they were asked to reflect and rate afterwards how much gratitude they have felt in response to the situation. The brain activity was measured during the reflection period of the experiment. The result showed the Holocaust scenario increased brain activity in the right occipital cortex, the left superior frontal gyrus, the left and right caudate, the left and right temporal pole, the thalamus, the left superior temporal sulcus and the left middle frontal gyrus. On the other hand, when the participants were doing their gratitude rating, the increased brain activity was recorded in the medial prefrontal cortex of both hemispheres, including a cluster within the frontal pole and the peri-genual anterior cingulate cortex. The result of the experiment showed that a region of the medial prefrontal cortex, specifically the ventral and subgenual areas, are active when the participant showed gratitude to gifts given to them. Social reward and interpersonal bonding are associated with activity of the medial prefrontal cortex (Fox et al., 2015). The Fox et al. (2015) and Kini et al. (2016) studies provide evidence on which regions of our brain are active during gratitude activities.

1.3 Hypotheses

Based on the above literature review, I predicted the following hypotheses:

- Hypothesis #1: If gratitude activity increases then oxytocin will increase.
- Hypothesis #2: If gratitude activity increases then sleep quality will increase.
- Hypothesis #3: If gratitude activity increases then neural activity in the medial prefrontal cortex will increase.

2. Methods

2.1 Participant

The author of this paper served as the sole participant in its studies. The participant's age was 38 years old and identified as a cisgender woman. The participant was an undergraduate student at Camosun College who completed the current studies as an assignment for Psyc 215 ("Biological Psychology") and chose this topic due to her interest in the effects of gratitude on the biological health and well-being of students.

2.2 Materials and Procedure

The researcher performed a correlational study to test concurrently all of the hypotheses by examining naturalistic daily changes in their variables longitudinally. The participant kept a study journal with her at all times over this study's two-week period in order to record self-observations of the following four variables: (1) gratitude activity, (2) oxytocin level, (3) sleep quality, and (4) prefrontal cortex activity.

To measure the gratitude activity, the participant recorded in her study journal the number of times she felt grateful throughout the entire day by recording in her journal every time she felt grateful. At the end of the day, before going to bed she tallied the total times she felt grateful and recorded it.

To measure oxytocin level, which has previously been associated with increased social bonding (Algoe & Way, 2014) and blood pressure (Petersson et al., 1997), the participant recorded in her study journal the number of times she felt caring and sympathy towards other people and also measured her blood pressure. The participant measured her blood pressure using a digital arm blood pressure monitor. She recorded her blood pressure three times a day: in the morning, at midday, and before going to sleep at night. She then calculated her average blood pressure for the day.

To measure the sleep quality, the participant recorded in her study journal her sleep score after each night's rest. The sleep score was monitored by wearing a Fitbit tracker while sleeping. The overall sleep score is a combination of the duration of time spent asleep/awake across the whole night, how much time is spent in deep and REM sleep, sleeping heart rate, and behavioral restlessness. The sleep score ranges are: 90-100 = Excellent, 80-89 = Good, 60-79 = Fair, and less than 60 = Poor (Fitbit, n.d.).

To measure the activity of the prefrontal cortex, specifically the anterior cingulate cortex, the participant recorded in her study journal the score of her PEBL Bivalent Shape Task which she did at the end of the day. The PEBL Bivalent Shape task score includes her response time to identify incongruent, neutral, and congruent shapes with its color in pure and mixed conditions. Also the score comprises her accuracy in doing the task in incongruent activities in mixed conditions. The researcher selected PEBL Bivalent Shape Task as the dependent measure of speed and accuracy in this task is associated to the anterior cingulate cortex activity (Mueller & Esposito, 2014). See the Appendix for the possible shapes and colors used in this task.

To assess the strength and statistical significance of associations between variables predicted by my three hypotheses, I performed Pearson product moment correlations of their predictor variable (number of grateful activities) with their outcome variable (oxytocin level, sleep quality, and prefrontal cortex activity). For testing Hypothesis #1, I correlated the total number of grateful activities of the participant for each day with the participant's average blood pressure on those same days and separately with the participants frequency of feelings of caring/sympathy on those days. For testing Hypothesis #2, I correlated the total number of grateful activities of the participant for each day with the participant's sleep score the next morning after a night's rest. For testing Hypothesis #3, I correlated the total number of grateful activities of the participant for each day with the participant's score in the PEBL Bivalent Shape Task. A correlation coefficient was considered statistically significant if the

probability of its random occurrence (*p*) was < .05 (i.e., less than 5% of the time expected by chance alone).

3. Results

As shown in Table 1, gratitude activity was not statistically correlated with any of the outcome variables measured in this study. Oxytocin level, measured by either diastolic or systolic blood pressure, was not correlated with gratitude activity (with diastolic measure: r = -.14, p = .54; with systolic measure: r = .01, p = .97; see Figures 1&2). Similarly, oxytocin level, measured by the frequency of feelings of caring and sympathy, was not significantly correlated with gratitude activity (r = .20, p = .38; see Figure 3). Also, no significant correlations were found between pre-frontal cortex activity, measured by the Bivalent Shape Task score, and gratitude activity (r = - .33, p = .14; see Figure 4). Finally, no statistically significant correlation was found between sleep quality and gratitude activity (r = -.10, p = .68; see Figure 5). Based on a comparison of the correlation coefficients, the pre-frontal cortex activity showed the strongest correlation with an r of -.33.

4. Discussion

4.1 Summary of Results

Based on previous research, I hypothesized that increases in three variables would be due to increased gratitude activity: the oxytocin level (Hypothesis #1), the sleep quality (Hypothesis #2), and the prefrontal cortex activity (Hypothesis #3). Data from my correlational study did not support the predicted relationships of gratitude activity with oxytocin level, sleep quality, and prefrontal cortex activity (Hypotheses #1, 2 &3).

4.2 Relation of Results to Past Research

The lack of a significant relationship between gratitude activity and oxytocin level in the present correlational study is different from what would be expected based on previous research conducted by Algoe and Way (2014). Algoe and Way (2014) sampled saliva from their participants after gratitude activities and analyzed it for its CD38 content. This substance plays a role in oxytocin signalling and social processes (Algoe & Way, 2014). In contrast, in my correlation study I measured the average blood pressure (diastolic and systolic pressure) of the participant, based on the association between oxytocin level and blood pressure (Petersson et al., 1997), and also measured the number of times the participant felt caring and sympathy towards other people, based on that the ability of oxytocin levels to affect social bonding (Algoe and Way, 2014). These methodology differences could be the reason why the results of the previous study and my correlation study differ.

The lack of a significant relationship between gratitude activity and sleep quality in the present correlational study is different from what has previously been reported by Wood et al. (2009). In the study of Wood et al. (2009), the participants were asked to rate their sleep quality using Pittsburgh Sleep Quality Index. In the correlational study I have conducted, the Fitbit tracker was used to measure the sleep quality of the participant. The Fitbit tracker measures the overall sleep score based on a combination of the duration of time being asleep/awake across the whole night, how much time is spent in deep and REM sleep, the sleeping heart rate, and behavioral restlessness. This

difference in the methodology of how sleep quality was measured could have resulted in the different result obtain in the present correlational study.

The lack of a significant relationship between gratitude activity and prefrontal cortex activity differs from what has been reported in previous research. In the studies of Fox et al. (2015) and Kini et al. (2016), the brain's prefrontal cortex activity was measured using an fMRI scanner, which could have given them a more accurate way of measuring prefrontal cortex activity. In contrast, in the present research, the researcher has used the PEBL Bivalent Shape Task as the dependent measure of speed and accuracy, as Mueller & Esposito (2014) associated this to the anterior cingulate cortex activity. These different methodologies in how prefrontal cortex activity was measured could have resulted in their different results.

4.3 Implications of Results

Previous studies on gratitude have shown positive results on its effect on the well-being of people. Although the results of this research did not show significant results, this study will serve as guidelines on which substitute methodologies will not be adequate to correlate the effect of gratitude to the well-being of the students. Furthermore, the results in this study will serve as guidelines for those who want to study further the use of the Bivalent shape task as a measure of the pre-frontal cortex activity concerning gratitude activity since the result in this study showed the highest correlation.

In our society, wherein the stress level is continuously increasing because of many challenging situations like the Covid-19 pandemic, finding a way to manage the stress level would be beneficial to people's overall well-being. The result of previous studies showed that gratitude work had helped lower the stress precursor. In addition, the result of this research showed a good relationship between gratitude activity and pre-frontal cortex activity. Increased activity in the pre-frontal cortex is a region of the brain associated with empathy, social reward, and interpersonal bonding (Fox et al., 2015 and Kini et al., 2016) that would help lower the stress level of the students and improve their well-being.

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Table 1

Correlation coefficient (r) values, with number of daily trials (n) per correlation in brackets.

Variables correlated	*r*(n)
Gratitude activity & oxytocin level (Diastolic pressure)	*-0.14*(*22*)
Gratitude activity & oxytocin level (Systolic pressure)	*0.01*(*22*)
Gratitude activity & oxytocin level (Feeling of caring and sympathy)	*0.20*(*22*)
Gratitude activity & sleep quality	*-0.10*(*22*)
Gratitude activity & prefrontal cortex activity	*-0.33*(*22*)

* $p < .05$.

Figure 1

Scatterplot of gratitude activity and oxytocin level measured by diastolic blood pressure.

Figure 2

Scatterplot of gratitude activity and oxytocin level measured by systolic blood pressure.

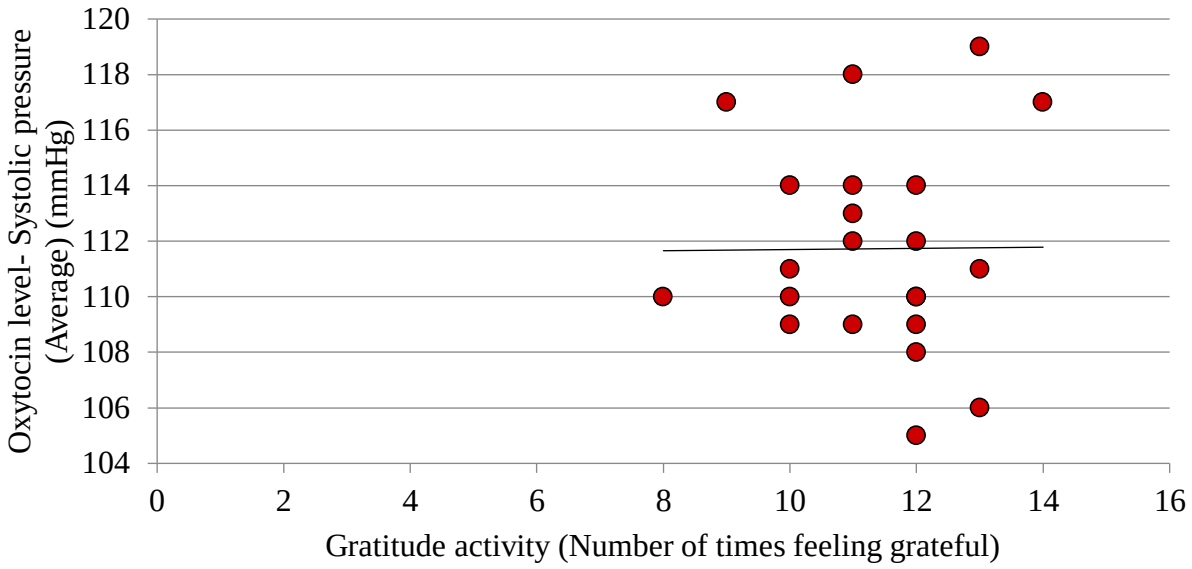


Figure 3

Scatterplot of gratitude activity and oxytocin level measured by the frequency of feelings of caring and sympathy.

Figure 4

Scatterplot of gratitude activity and prefrontal cortex activity measured by the incongruent score on the Mixed trials of the Bivalent Shape Task.

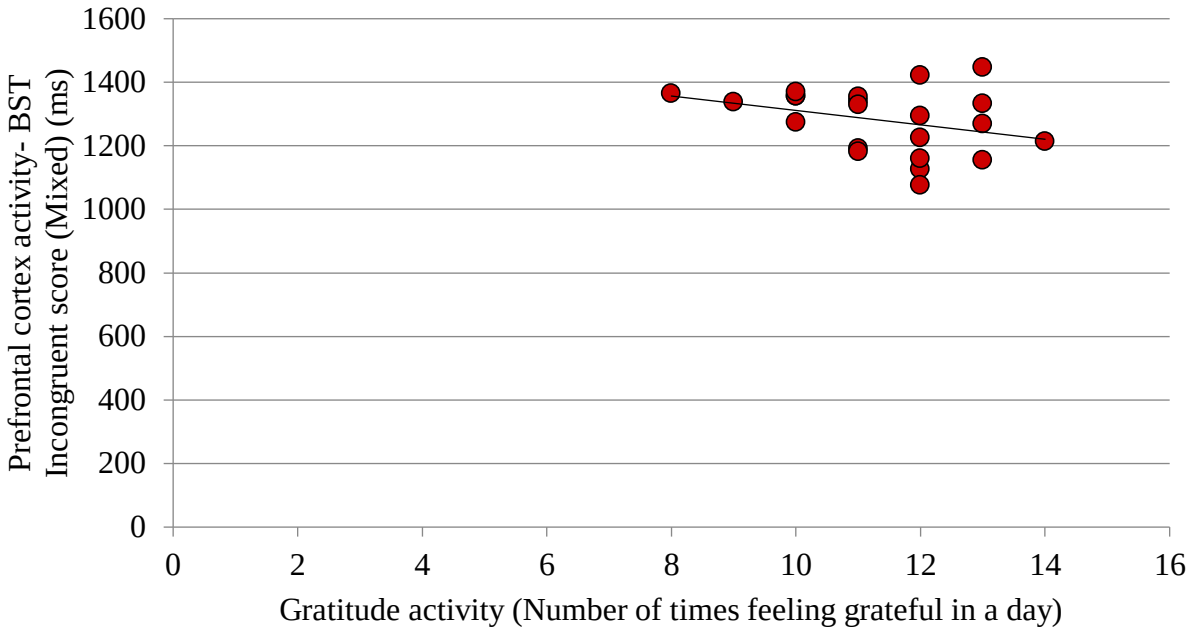
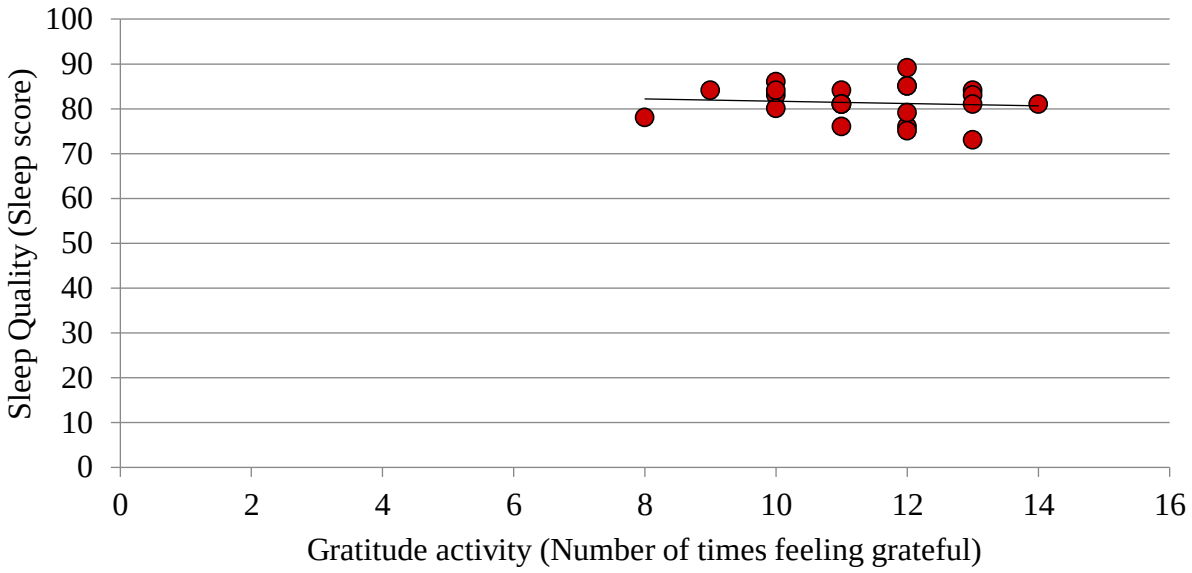


Figure 5

Scatterplot of gratitude activity and sleep quality.



Appendix

The figure shows the possible shapes and colors in the PEBL Bivalent Shape Task (Mueller, 2014).