

## Analysis of Factors that Predict Positive Emotion and Well-Being Using Continuous Tracking

## Sandler1

1*Virginia Tech*

## December 8, 2021

**Abstract**

 he main objective of this work is to use quantified emotions and continuous evaluation to determine significant factors in predicting an individual’s overall well-being. In 2011, Martin Seligman introduced the concept of “PERMA” of factors that account for measuring an individual’s well-being. The PERMA theory separates overall well-being into five pillars of Positive Emotion, Engagement, Relationships, Meaning, and Accomplishment. Seligman’s work has led to the development of many questionnaires and scales incorporating this theory and has since become an industry standard for positive psychology. However, the origins of “PERMA” remain mostly unclear and little work has explored supporting these concepts with continuous tracking measures. The work in this present study was carried out by utilizing positive emotion and well-being tracking over a span of six-months, where positive emotion was evaluated in fifteen-minute intervals and well-being was evaluated daily. Additionally, a questionnaire was developed and prompted to the participant, and the tracked measures are evaluated as predictors for positive emotion and well-being. Many findings for well-being align closely with the theories in PERMA, with strong associations with accomplishment and relationships. Predictive factors that align with the participant’s well-being not included in PERMA include the influence of anticipation and specific physical and dietary components. Factors that influence positive emotion and daily exhaustion are analyzed and discussed as well. Distribution analysis of positive emotion emphasizes the impact of momentary, extremely happy moments for well-being. Future work should provide direction for studies to evaluate these findings and a new iteration of tracking measures.

T

# Introduction

In 1962, Abraham Maslow introduced the concept of “hierarchy of needs” where individuals need to satisfy each of these needs in order to achieve well-being (Maslow, 1962). It is through this hierarchy in which one satisfies each of their needs, with the end goal being self-transcendentalism (Maslow, 1962).

Upon Martin Seligman’s induction of the president of the American Psychological Association in 1998, he has emphasized the introduction of the field of positive psychology (Seligman, 1998). Psychology is not just the study of disease, weakness, and damage; it also is the study of strength and virtue. Treatment is not just fixing what is wrong; it also is building what is right. Psychology is not just about illness or health; it also is about work, education, insight, love, growth, and play (Seligman, 2002, p. 4).

One of the early theories regarding well-being is the authentic happiness theory (Seligman, 2002); this separated well-being into three distinctive pathways: pleasure, engagement, and meaning. Pleasure focused on positive emotion. Engagement regarded utilizing the strengths of one’s character to induce a state of flow (Csikszentmihalyi 1990). Meaning regarded having a sense of purpose (Seligman, 2002).

In 2011, Seligman introduced a shift from the authentic happiness theory to the well-being theory with the acronym “PERMA”. The PERMA theory separates overall well-being into five pillars of Positive Emotion, Engagement, Positive Relationships, Meaning, and Accomplishment. Reasons for the shift from the authentic happiness theory was due to issues with the connotation around the word “happiness”. Happiness is often associated with cheerfulness. With the well-being theory, happiness is measured with positive emotion. Additionally, the components of the authentic happiness theory lack positive relationships and accomplishment. It is well established that couples with children have on average lower happiness and life satisfaction than childless couples, but when the view of well-being is broadened to include meaning and relationships, therefore individuals choose to have children and why they choose to care for aging parents, this element is captured within PERMA but not the authentic happiness theory (Seligman, 2011). The goal of positive psychology and authentic happiness theory is, to increase the amount of happiness in one’s own life and on the planet. The goal of positive psychology and well-being theory, in contrast, is plural and importantly different: it is to increase the amount of flourishing in your own life and on the planet (Seligman, 2011).

Research has shown significant positive associations between each of the PERMA components and physical health, vitality, job satisfaction, life satisfaction, and commitment within organizations (Kern, Waters, Alder, & White, 2014). PERMA is also a better predictor of psychological distress than previous reports of distress (Forgeard et al., 2011). This means that proactively working on the components of PERMA not only increases aspects of wellbeing, but also decreases psychological distress.

**Positive Emotion**

Emotions are attitudes or responses to a situation or an object, like judgments (Zemach, 2001). Positive emotion extends beyond happiness and includes feelings of gratitude, serenity, interest, amusement, awe, elevation, altruism, eagerness and euphoria (Seligman, 2011). Positive emotion is momentary and can vary distinctly throughout the day, depending on a person’s location and the activities they are engaged in (Stone et al., 1996).

Positive emotions can increase one’s resilience and ability to cope with negative emotions (Tugade & Fredrickson, 2004). In addition, being mindful and taking the time to savor positive emotions can provide an extra buffer against symptoms of depression while boosting psychological well-being and life satisfaction (Kiken, Lundberg, & Fredrickson, 2017).

There have also been significant correlations between physical health and positive emotion. Students who were randomly assigned to writing about intense, positive experiences for three days, 20 minutes a day, made significantly fewer visits to the student health center for symptoms of illness, compared to students who wrote about a neutral topic (Burton & King, 2004). Another health benefit of positive emotions is that they may result in a stronger heart; Kok and colleagues (2013) found a connection between a healthy heart rate and the experience of positive social emotions. Similarly, a meta-analysis of several studies found that well-being was significantly related to good cardiovascular functioning, general health, and longevity overall (Howell, Kern, & Lyubomirsky, 2007).

**Engagement**

Engagement relates to the concept of “flow”; when an individual focuses on tasks and activities they enjoy and care about, they are engaged completely with the present moment (Seligman, 2011). Flow experiences involve being attentively absorbed and skillfully engaged in an activity that one finds valuable (Csikszentmihalyi, 1990). This refers to attachment, involvement, concentration, and the level of inclination towards activities such as recreation, hobbies, or work (Higgins, 2006; Schaufeli et al., 2006).

Research into flow has it separated into distinct categories: (1) the nature of the activity is challenging but doable with defined goals and immediate feedback available to the participant; (2) the effect of the activity allows the participant to feel in control; (3) the nature of involvement in the activity leads to immersion of self; and (4) the effect of the activity makes the participant forget themselves and time slows down. Research on engagement has indicated that after six months, those who utilize strength in new ways are happier and less depressed (Seligman, Steen, Park, & Peterson, 2005).

**Positive Relationships**

Relationships include the strength of ties between an individual and those around them, which can be friends, family, colleagues, and others. Positive relationships are when ties with others are strong, and relationships in the PERMA model refer to feeling supported, loved, and valued by others. (Seligman, 2011).

Social connections and positive relationships are critical to the health of individuals as well as their well-being (Ryff and Singer, 2001; Cohen, 2004). After attributing for demographic and health status factors, individuals with adequate naturally occurring social relationships have greater life longevity when compared to individuals with poor or insufficient social relationships (Holt-Lunstad et al., 2010); the effects of poor or insufficient social relationships are comparable to other mortality risk factors, including smoking, obesity, and physical inactivity (Holt-Lunstad et al., 2010).

**Meaning**

Meaning is the utilization of one’s strengths for what that individual perceives to be important, and oftentimes applying those strengths in connection greater than the self (Seligman, 2011). A sense of meaning is guided by personal values, and people who report having purpose in life live longer and have greater life satisfaction and fewer health problems (Kashdan, Mishra, Breen, & Froh, 2009).

**Accomplishment**

Accomplishment is done through being able to look back on one’s life with a sense of achievement (Seligman, 2011). This can be achieved through reaching goals, mastering an endeavor, and having self-motivation to finish out what one sets to do (Seligman, 2011). Achieving intrinsic goals (such as growth and connection) leads to larger gains in wellbeing than external goals such as money or fame (Seligman, 2013).

**Physical Health**

Research has indicated numerous other factors that are important for well-being. Numerous findings in literature link physical activity to decrease symptoms of depression, anxiety, and improvement of mental focus and clarity (Sharma et al., 2006). Significant research has also tied one’s nutrition and their mental health, where individuals who eat balanced diets with nutrients and vegetables have greater well-being (Stranges, Samaraweera, Taggart, Kandala, & Stewart-Brown, 2014). Sleep has also been a significant factor in evaluating one’s wellbeing, where good sleep hygiene fosters mental and emotional resilience, and sleep deprivation leads to negative thinking and emotional vulnerability (Freeman et al. 2017).

**PERMA Profiler**

Current scales to measure PERMA include the PERMA Profiler, which is an extensive questionnaire from the University of Pennsylvania developed to assess Seligman’s (2011) components of well-being (Butler & Kern, 2016). The PERMA profiler was constructed through the generation of a bank of 700 items with specific sub-domains for each PERMA component. Three experts in positive psychology then rated each of the compiled items, based on face valid relevance to the domains and sub-domains. After discussion, some revisions were made to wording, and the structure of some of the remaining items was adjusted to create consistency across items. The final item bank included 109 questions theoretically relevant to one of the PERMA components (33 emotion, 23 engagement, 21 relationships, 15 meaning, 17 accomplishment). Then, the items were reduced to a brief measure that loaded on the expected factor and demonstrated adequate reliability. Since the development of the PERMA profiler, similar scales were created in a similar manner, oftentimes with a focus on a particular industry.

Seligman’s theory of PERMA aligns with research in the field, but there has been little to no known research to date quantifiably testing the validity of this theory. Additionally, there has been a lack of research in understanding how these factors interrelate, and which factors hold more weight in evaluating an individual’s overall well-being. The PERMA profiler nor any PERMA-relevant questionnaire to date, has tested specifically if the components it is asking quantitatively affect well-being. The present study is unique regarding testing which aspects of Seligman’s theory are reliable and which factors are indicative of well-being and positive emotion.

Additionally, the PERMA profiler initially included both general and specific time scales (i.e., “in general” versus “in the past week”). For analysis, it was chosen to focus on more stable aspects of wellbeing rather than transient mood (Butler & Kern, 2016). Specific periods (e.g., yesterday, currently) capture momentary states and are more susceptible to change, whereas a general response captures more stable reflections of one’s wellbeing (Butler & Kern, 2016). Additionally, the authentic happiness theory focuses on life satisfaction as being the gold standard, yet when individuals are prompted with measuring life satisfaction 70% of the time it relates to how they feel at that exact moment and not their life overall (Seligman, 2011). Because of the tendency for individuals to reflect on how they are currently more so than overall, it would be more effective to capture current states with a shorter time frame in order to understand what factors affect well-being for that time.

Another limitation of the PERMA profiler could be argued is the difficulty of questions to answer accurately, and how that relates to an individual’s overall well-being. Questions such as, “In general, to what extent do you feel contented” could be significantly more difficult to answer honestly and accurately than a question answering specific components about that individual’s day.

**Objective**

The main objective of this work is to evaluate which factors are significant when measuring an individual’s overall well-being and positive emotion. A series of questions related to PERMA were developed and prompted to the participant, and the daily positive emotion of the participant was tracked on a ten-point scale in fifteen-minute intervals throughout the day. The aim of this work is to provide insight into these measures as a mean to create a more refined well-being questionnaire to be re-evaluated in the future. This will aid in understanding what direction to focus when working in the design of similar experiments that analyze overall well-being.

This work is unique regarding the continuous tracking of perceived happiness from the individual, where there is a rating assigned to each fifteen minutes awake. Furthermore, the participant in this study has greater credibility regarding accurate ratings for perceived wellbeing, because of their extensive tracking for 3.25 years prior to the introduction of the well-being questionnaire; alternate studies are often presented with participants relatively new to the process of quantifying their happiness.

The purpose of this study is to evaluate which of these factors are prevalent, and aid in understanding and provide direction for future studies for how PERMA can be quantified and evaluated.

# Methodology

**Data Collected**

Data collection initiated in January 2018 for perceived happiness on a scale from zero to ten, and this data will be referred to as the positive emotion ratings. Data measuring happiness initiated was collected over 1382 days, or 3.78 years, and through one male participant. It was initiated on January 1st, 2018 (Participant’s Age: 17.79 years) has been ongoing. Data for the present study evaluates positive emotion from April 1st, 2021 (Participant’s Age: 21.04 years) to October 14th, 2021 (Participant’s Age: 21.57 years). Due to the length of time the individual spent tracking his happiness, a personal scale for the individual has been developed overtime where the individual has keen attention to the acute differences in measuring their positive emotion. Data was collected for each fifteen-minute-interval the participant was awake, and data recording would occur no longer than twenty-four hours following the recorded time, with approximately 80% of the data being recorded between 7:45 AM to 9:00 AM the following day. According to this scale, 4.8 is “Very Unhappy”, 5.35 is “Slightly Unhappy”, 5.45 is “Neutral”, 5.55 is “Slightly Happy”, and 6.1 is “Very Happy”. One important note is that the scale is specific for the individual, meaning that although the numbers in the scale appear numerically indifferent, the specific scale to the individual measures it differently.

The participant collected data on his happiness for each fifteen-minute-interval awake on a given day. This allows for the collection of sleep data by subtracting the count of all of the points on a given day from 96 (the total number of fifteen-minute intervals within a day) and then multiplying by 4 to get the amount of sleep measured in hours.

A new scale was developed to keep track of anxiety in April 2018 (day 103) in addition to positive emotion; this serves to get a clearer picture into the participant’s overall wellbeing for each interval. The Anxiety Scale has a minimum of 0 but no defined maximum. An anxiety score of 1 is measured as “very slight pain”, a score of 2 is “mild pain”, a score of 5 is “moderate pain” and a score of 10 is “severe pain”. Anxiety data was considered from was considered from April 1st, 2021 (Participant’s Age: 21.04 years) to October 14th, 2021 (Participant’s Age: 21.57 years).

Details measuring the participant’s perception of their health, and perception of the weather were collected starting on January 1st, 2019 (day 366) and has attained additions from the time the data for the study was considered on April 1st, 2021 (day 1186). Health was collected through the individual providing reflective insight into how healthy they have eaten in several categories. As of the initial data consideration for the study, objective factors measured include amount of sugar (in grams), salt intake (in milligrams), water intake (fluid ounces), calorie intake (kilocalories), and coffee intake (cups). Subjective factors for health were measured each on a ten-point scale including “frugies” (intake of fruits and vegetables), complex carbohydrate intake, dairy intake, and red-meat intake. For the subjective ten-point scales, a rating of ten would be a positive outlook on that day's eating habits while closer to zero would be a negative perception. Negative numbers in this scale are also possible. Opinion on the weather was recorded as well, and provided on a scale from zero through ten, where ten would be a favorable view of that day’s weather while zero would be unfavorable.

Questions relating to well-being were recorded and tracked daily initiating April 1st, 2021 (Participant’s Age: 21.04 years) to October 14th, 2021 (Participant’s Age: 21.57 years). The questionnaire is provided in the appendix. The questions were developed from the participant and their predictions of the factors that affect their happiness on a given day, or simply items they were interested in monitoring. Starting in June 2021, an additional question was prompted as, “does today exemplify what you seek long term?”. Answers to these questions were answered daily, with a maximum recording period of twenty-four hours following the day recorded. The answer to this question will be used as the measure for well-being, and thus will be referred to as “well-being rating”.

**Analysis Methodology**

All the collected data was first organized into an excel workbook. Collected data was categorized into four groups: emotional measures, physical measures, distributions, and atmospheric conditions. Emotional measures incorporate aspects of the survey that are more subjective, where one answers based off how they feel. Physical measures—such as sleep and food intake—are less reflective and more of an objective measure. Distribution measures are derived quantitatively from the differences in the ratings of positive emotion. Atmospheric conditions incorporate humidity, dewpoint, and temperature as it relates to the three locations of the individual over the course of data collection.

All the data was loaded into RStudio and organized as a data frame. After the data was loaded and called using the “readxl” library in R, null values were removed, and remaining values were made into numeric values. Any values not wished to be kept in the data for analysis would also be removed. A linear regression model would then be applied using either positive emotion, wellbeing, sleepiness rating, or exhaustion rating as response variables. Following this, based off the Multiple R-squared and Adjusted R-squared, the p-values of the predictors would be used to reduce the number of predictor variables to simplify or increase the strength of the linear regression model.

Strength of linear regression models can be measured in a variety of ways, and here it is measured as a form of their R-squared values. The predictor column is the element that was tracked, and the coefficients is the number used from the predictor to get the response variable. A fictional example is provided below, where grams of sugar and oven temperature are used as predictor variables for the response of time it takes to bake a cake.

|  |  |  |
| --- | --- | --- |
| **Predictor** | **Coefficients** | **Scale / Unit** |
| Sugar | 0.925 | Grams |
| Oven Temperature | -0.023 | ºF |
| Intercept | 2.1 |  |

***Table 1A:*** *Example Linear Regression Model*

In this example, you would use the equation:

Expected Time to Bake Cake (min) = 0.925\*(Sugar) + -0.023(Temperature) + 2.1

Hypothetically, if 40 grams of sugar are used and the oven temperature is 350ºF (176.7ºC), then 0.925\*(40) + -0.023(350) + 2.1 = 31.05 min

# Conclusions

**Results & Discussion**

The purpose of this study is to evaluate and analyze the factors that contribute to well-being in one individual to aid in the design and direction for future work, as well as future iterations of tracking. All comments regarding the results are preliminary and may not hold true with more data, time, or testing. All predictive factors and summaries of all models discussed are provided in the appendix.

***Factors That Predict Well-being***

Analysis initiated with emotional measures. The model in **Table 2A** has seven predictor variables, using well-being as a response variable. Multiple R-squared for the analysis is 0.7927 and the Adjusted R-squared is 0.7764.

|  |  |  |
| --- | --- | --- |
| **Predictor** | **Coefficient** | **Scale / Unit** |
| 076-Of the things you did today, what percent of it was spent doing things you love doing? | 3.212 | Percentage |
| 078-Are you proud of what you accomplished today? | 0.275 | Ten-Point |
| 079-Excitement: Upcoming Week | 0.525 | Ten-Point |
| 085-Contact with someone virtually | 0.449 | Hours |
| 094-Surrounded by one person F2F who you don't enjoy or less: | 0.681 | Hours |
| 097-Surrounded by people (2) F2F who you really enjoy or more: | 0.745 | Hours |
| 116-Your location today, have you been there in the past week? | 0.745 | Binary |
| Intercept | -0.798 |  |
|  |  |  |

***Table 2A:*** *Well-Being Linear Regression Model with Emotional Measures as Predictor*

“Of the things you did today, what percent of it was spent doing things you love doing?” is a measure of time spent in the day in which the individual worked on tasks in which they enjoy. “Are you proud of what you accomplished today?” is a short-term reflective measure of productivity and achievement, with a rating of ten being “very accomplished”. “Excitement: Upcoming Week” evaluates positive anticipation, with “incredibly excited” translating to a rating of a ten. “Contact with someone virtually” measures time spent communicating on a digital platform, either through video or audio chat, such as a phone call. “F2F” is an acronym for face to face, whereby these factors measure time spent engaged in direct in-person communication. “Your location today, have you been there in the past week?” is a binary predictor, where 0 represents no, and 1 represents yes.

As for the factors that predict well-being, the significant factors from this model mirror the theory of PERMA in certain ways. Accomplishment is a pillar of PERMA that is significant in predicting well-being according to this model, as evidenced by “Are you proud of what you accomplished today?” Additionally, “Contact with someone virtually”, “Surrounded by one person F2F who you don't enjoy or less” and “Surrounded by people (2) F2F who you really enjoy or more:” are representative of the relationships pillar, where the amount of time the participant spent around two people of whom they “really enjoy” or more is a significant factor in predicting overall well-being for a day. However, “Contact with someone virtually”, denotes a negative relationship between virtual communication in a day and the impact of it on overall well-being.

As for results from this model not covered by the theory of PERMA, “Surrounded by one person F2F who you don't enjoy or less” indicates that time spent around one individual that the participant did not enjoy, had a significant correlation in predicting greater overall well-being for that day. The linear regression model in **Table 2A** also introduces the importance of anticipation, and how positive anticipation has a correlation to overall well-being in the present moment. Furthermore, “Your location today, have you been there in the past week?” denotes a significant positive difference in well-being on days in which the participant has been in a familiar environment, compared to traveling to a new location.

For days where positive emotion is relatively equal, but well-being rating differs, **Table 2B** emphasize a simplified version of the specific factors that made it differ. Daily positive emotion values below the 25th or above the 75th percentile of all the positive emotion values were removed at the start of this analysis. The model in **Table 2B** has four predictor variables, using well-being as a response variable. Multiple R-squared for the analysis is 0.6253 and the Adjusted R-squared is 0.6063.

|  |  |  |
| --- | --- | --- |
| **Predictor** | **Coefficients** | **Scale / Unit** |
| 074-How busy were you today overall? | 0.229 | Ten-Point |
| 077-In general, are you content with the work you are doing every day? How much does it feel like your "calling"? | 0.275 | Ten-Point |
| 079-Excitement: Upcoming Week | 0.445 | Ten-Point |
| 092-Surrounded by one person F2F who you really enjoy or more: | 0.359 | Hours |
| Intercept | 0.114 |  |

***Table 2B:*** *Well-Being Linear Regression Model with Equalized Positive Emotion (Simplified)*

A rating of ten for the predictor, “074-How busy were you today overall?” is “no free time at all”, and a ten rating for “077-In general, are you content with the work you are doing every day? How much does it feel like your "calling"?” is “incredibly content”.

Like the model represented in **Table 2A**, anticipation for the upcoming week and the influence of being surrounded by individuals whom one “really” enjoys is significant in predicting overall well-being. However, when excluding differences in positive emotion from affecting well-being, the “meaning” facet of PERMA has strong significant correlations. Additionally, amount of time one spends dedicated to something—how busy was defined to the participant—is a factor that is significant in predicting overall well-being provided equalized positive emotion.

In terms of the impact of sleep, exercise, or diet, on well-being, there are no major association between these variables independently as indicated by the Adjusted R-squared values in the models. For example, when only looking at only nutritional intake as it relates to well-being, there are no significant correlations. However, when sleep, exercise, or diet is combined and then paired with the data attained in the emotional measures, a Multiple R-squared of 0.8703 and Adjusted R-squared of 0.8462 is attained with 13 factors, shown in **Table 2C**.

|  |  |  |
| --- | --- | --- |
| **Predictor** | **Coefficients** | **Scale / Unit** |
| 006-T-Water | 0.214 | fl oz |
| 013-T-Calories | -0.169 | kcals |
| 028-Y3-Dairy | 0.054 | Ten-Point |
| 038-Y2-Salt | 0.007 | mg |
| 076-Of the things you did today, what percent of it was spent doing things you love doing? | 0.0004 | Percentage |
| 078-Are you proud of what you accomplished today? | 0.108 | Ten-Point |
| 079-Excitement: Upcoming Week | 0.0002 | Ten-Point |
| 094-Surrounded by one person F2F who you don't enjoy or less: | 3.058 | Hours |
| 097-Surrounded by people (2) F2F who you really enjoy or more: | 0.314 | Hours |
| 116-Your location today, have you been there in the past week? | 0.518 | Binary |
| 121-Exhausted | 0.859 | Ten-Point |
| 123-Cold | 0.738 | Ten-Point |
| 125-Coffee Time | 0.387 | Time |
| Intercept | -4.334 |  |

***Table 2C:*** *Well-being Linear Regression Model with Emotional & Physical Measures as Predictors where T is today, Y is yesterday, and number following signifies days before today.*

Dietary factors included in this model include water intake (measured in fluid ounces) and caloric intake (measured in kilocalories), and both are on the day (T) in which the participant’s well-being is being assessed. Dairy intake is a subjective measure on a ten-point scale where a rating of ten is “no dairy consumed”, and a rating of five is described to the participant as a “decent amount”. Additionally, this measure is averaged with the values on the previous three days (Y3) prior to day the well-being is being evaluated. For instance, the average of the dairy intake of Day 1, Day 2, and Day 3 would be used as a predictor variable for the response of the well-being rating on Day 4. “Salt” is an objective measure of the average sodium intake in milligrams for two days (Y2) prior to day the well-being is being evaluated.

Physical factors included in his model include a rating of how “exhausted” the individual felt during the day. One important note is the distinction between “exhausted” and “sleepy” where “sleepy” is more of an intense overwhelming “wave” of tired, as “exhausted” is more like how one feels when their body feels as if it needs sleep. Exhaustion ratings are measured on a ten-point scale, where a ten indicates that at no point in the day did the individual feel “exhausted”. The predictor “cold” is a measure of if the participant felt cold in their environment, not a measure of the actual temperature of the environment, where a rating of ten indicates that at no point in the day did the individual feel “cold”. Finally, the time in which the first coffee beverage of the day was tracked and recorded, where “7:15 AM” would be recorded as 7.25 and “3:30 PM” would be recorded as 15.5.

The combination of these factors continues to highlight the aspects discussed earlier as to the important components of well-being, but also now consider physical and dietary components. As for physical factors, the level of exhaustion experienced within a day is associated with a strong negative impact on overall well-being for that given day. Additionally, warmth is an important factor to the participant, where days the participant was cold had a negative impact on that day’s overall well-being. Dietary decisions have a role in the impact on the individual as well, as increased water intake and caloric intake on a given day are directly associated with well-being. Furthermore, average daily intake and sodium intake in the prior days affect the individual as well, where higher sodium and lower dairy intake led to greater well-being.

***Factors That Predict Positive Emotion***

In terms of the emotional and physical measures as predictor variables, the well-being models outperform the positive emotion, as models where positive emotion is the response variable have lower R-squared values.

Models with emotional measures exclusively as predictor variables highlight key differences between what can potentially drive well-being and what can potentially drive positive emotion. These differences can be seen in the model for positive emotion using emotional measures, shown in **Table 3A.** The Multiple R-squared for the analysis is 0.6617 and the Adjusted R-squared is 0.6087.

|  |  |  |
| --- | --- | --- |
| **Predictor** | **Coefficients** | **Scale / Unit** |
| 074-How busy were you today overall: | 0.007 | Ten-Point |
| 075-If I were to pick a random time in the day, what's like likelihood you'd remember what you did? | -0.127 | Percentage |
| 076-Of the things you did today, what percent of it was spent doing things you love doing? | 0.113 | Percentage |
| 079-Excitement: Upcoming Week | 0.014 | Ten-Point |
| 082-Anxiety: Upcoming Week | -0.012 | Ten-Point |
| 083-Anxiety: Upcoming Months | 0.015 | Ten-Point |
| 085-Contact with someone virtually | 0.036 | Hours |
| 086-Contact with someone virtually who you somewhat enjoy or more | 0.043 | Hours |
| 089-Contact with someone virtually who you don't enjoy or less | 0.084 | Hours |
| 096-Surrounded by people (2) F2F who you somewhat enjoy or more: | 0.037 | Hours |
| 097-Surrounded by people (2) F2F who you really enjoy or more: | 0.143 | Hours |
| 098-Surrounded by people (2) F2F who you absolutely love or more: | -0.133 | Hours |
| 102-Surrounded by people (3 or more) F2F who you really enjoy or more: | 0.038 | Hours |
| Intercept | 5.315 |  |

***Table 3A:*** *Positive Emotion Linear Regression Model with Emotional Measures as Predictors*

Unlike the strongest predictors for well-being, more predictors for positive emotion account for more factors in terms of relationships and communication. Virtual communication, no matter who it is with, has a correlation with positive emotion; this relationship is complex given that the opposite result is seen with virtual communication and the impact on well-being.

Positive anticipation (excitement) for the upcoming week is a factor that predicts both positive emotion and well-being, but negative anticipation (anxiety) only seems to affect positive emotion on a given day. Anxiety for upcoming months has significance in terms of improving overall well-being on a given day, while anxiety for the upcoming week has the opposite effect.

The ability to recall one’s actions on a given day has an inverse relationship with happiness, as indicated in **Table 3A**. A possible explanation of this could be the pillar of engagement in PERMA, where it is described that achieving this state prompts an individual to “forget themselves and time slows down” (Seligman, Steen, Park, & Peterson, 2005).

A linear regression model with the combination of emotional measures and physical measures achieves an R-Squared value of 1 with 30 predictors. These thirty predictors are outlined in **Table 3B**.

|  |
| --- |
| T-Frugies |
| Sleep Variability |
| Avg Amt Sleep 2 Nights |
| Coffee Diff Yest |
| Y3-Meat |
| Y3-Sleep Hr |
| Y3-Rough Wake Up Time |
| Y2-Bed Time |
| Y2-Sleep Hr |
| Y2-Rough Wake Up Time |
| Y1-Carbs |
| Y1-Water |
| Y1-Exercise |
| If I were to pick a random time in the day, what's like likelihood you'd remember what you did? |
| Of the things you did today, what percent of it was spent doing things you love doing? |
| Excitement: Upcoming Week |
| Excitement: Upcoming Months |
| Anxiety: Upcoming Months |
| Contact with someone virtually |
| Contact with someone virtually who you somewhat enjoy or more |
| Contact with someone virtually who you don't enjoy or less |
| Surrounded by people (2) F2F who you somewhat enjoy or more: |
| Surrounded by people (2) F2F who you really enjoy or more: |
| Surrounded by people (2) F2F who you absolutely love or more: |
| Surrounded by people (3 or more) F2F who you really enjoy or more: |
| Did you sing and dance to music today? |
| Sick |
| Exhausted |
| Cold |

***Table 3B:*** *Emotional & Physical Measures Predictors for Positive Emotion Linear Regression Model where T is today, Y is yesterday, and number following signifies days before today.*

“Frugies” is a measure of fruit and vegetable intake, measured on a ten-point scale. “Coffee Diff Yest” is the difference in cups of coffee between one day and the day before it. “Sleep Variability” measures the standard deviation in number of hours of sleep received in the previous five nights.

Of these thirty factors, further analysis indicated which of these are the largest driving factors of positive emotion through each of their respective p-values. In addition to the emotional measures discussed from **Table 3A**, other important predictors of positive emotion include dietary factors such as meat intake from the previous three days, water intake from the day before, as well as how ill the individual felt during the day. Meat intake was measured subjectively on a ten-point scale. A rating of ten is a day without meat, nine is a day with one serving of fish, eight is a day with one serving of white meat, five is a day with one serving of red meat. Water intake was measured in fluid oz. “Sick” rating is a subjective measure of how ill the individual felt, with a rating of ten equating to feeling great.

***Components of Physical Well-Being***

Because of the significant impact of exhaustion on the well-being of the individual, additional analysis was conducted, allocating the measured predictors using exhaustion rating and sleepiness rating as a response variable. As mentioned, an important note is the distinction between “exhausted” and “sleepy” where “sleepy” is more of an intense overwhelming “wave” of tired, as “exhausted” is more similar to how one feels when their body feels as if it needs sleep. Exhaustion and sleepiness ratings are measured on a ten-point scale, where a ten indicates that at no point in the day did the individual feel “exhausted” nor “sleepy”.

The following components analyzed specific to sleep are shown in **Table 4**, where variability is a measure of standard deviation.

|  |
| --- |
| Hours of Sleep, Last Night |
| Average Hours of Sleep, Past Two Nights |
| Average Hours of Sleep, Past Three Nights |
| Sleep Hours Variability, Five Days |
| Wake Up Time |
| Wake Up Time Variability, Five Days |
| Bed Time |
| Bed Time Variability, Five Days |

***Table 4:*** *Predictor Variables Relating to Sleep*

In addition to sleep factors, dietary factors were considered as well, spanning to the three days prior to the day’s exhaustion being evaluated.

Creating a model using exhaustion as a response variable, there is no association with the predictor variables. Although these variables cannot predict exhaustion on a given day, with the output p-values, this model does inform which of the variables have the most impact in affecting exhaustion. These variables include a negative relationship with average coffee intake for the previous three days, where more coffee is correlated with exhaustion. Additionally, exercising and drinking coffee later in the day is correlated with less exhaustion.

Creating a similar model with sleepiness as a response variable, there is no association with the predictor variables. Factors that do have the greatest influence on sleepiness, however, is intake of meat and refined carbohydrates. Meat intake is the most impactful predictor, and higher meat intake over a span of three days is associated with greater sleepiness on that following day. Average refined carbohydrate intake for two days prior to the day evaluated is another factor that impacts sleepiness. Higher refined carbohydrate intake, such as with foods pasta and bread, is associated with less sleepiness.

***Distribution of Positive Emotion***

Because of the potential for a day of equal positive emotion to be distributed in a variety of ways, analysis was performed on the relationship between these distributions and overall well-being.

First, the percent at each positive emotion rating within the day was evaluated as it relates to the well-being rating for that given day. **Table 5** describes further how these figures were collected, where on April 1st, 33% of the positive emotion ratings were a 5.5.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **1-Apr** | **2-Apr** | **3-Apr** | **4-Apr** |
| **5.1 or Below** | 1% | 0% | 0% | 0% |
| **5.2** | 1% | 2% | 0% | 2% |
| **5.3** | 0% | 18% | 8% | 10% |
| **5.4** | 31% | 40% | 25% | 55% |
| **5.5** | 33% | 33% | 49% | 18% |
| **5.6** | 19% | 5% | 11% | 8% |
| **5.7** | 6% | 0% | 5% | 3% |
| **5.8** | 4% | 2% | 2% | 3% |
| **5.9 or Above** | 3% | 0% | 2% | 2% |

***Table 5:*** *Percentage Derivations for Distributions*

A linear regression model was created using this data as the predictor variables and well-being as a response, with an Adjusted R-squared of 0.5272. This model emphasizes the influence of moments spent at a 5.9 or above on overall well-being.

Another model was developed to evaluate the impact of positive emotion percentiles within a day itself as it relates to overall well-being. Unlike in **Table 5**, for each date there is the percentile value from 0.05 to 0.95 in intervals of 0.05. The Adjusted R-squared of 0.5354. Concurrent with the findings in the percentage derivations model, the positive emotion percentiles model has very similar indications. The findings from this model indicate that 0.05 (p=0.9764) is the least effective predictor, and 0.5 (p=0.244) and 0.95 (p=0.0856) are the most effective predictors for overall well-being. The 95th percentile alone can predict 25% of overall wellbeing in a day, and 50th percentile can predict 45% of the time. 5th percentile can predict 15%.

These two models emphasize the importance of having very happy moments within a day to achieve optimal well-being, and how very unhappy moments, or moments opposite of positive emotion are not as substantial to the participant’s day overall.

***Impact of Weather Events***

A model associating the temperature, dew point, and humidity with well-being and positive emotion was derived as well. Data from NASA Project Daymet was evaluated as well for the three primary locations in which the participant resided. Stellenbosch, Western Cape, South Africa was a location for April, May, June, and July. Long Beach, New York, USA was a location for July and August. Blacksburg, Virginia, USA was a location for July, August, September, and October. Days in which the participant traveled between these locations, was outside of a 25-mile radius from these locations or did not spend most of the time at the location (<70% of the day) were removed.

For both well-being and positive emotion, neither temperature, dew point, nor humidity have a substantial correlation. This applies to both individual models with these factors, and combination models, for the maximum Adjusted R-squared values on any of these models was equal to 0.055.

**Future Work**

This study aimed to evaluate which factors can be predictive of well-being and positive emotion through continuous tracking and quantifiably evaluate the effectiveness of the PERMA theory. The PERMA profiler is effective at relating to individuals on a broader scale but can be difficult for an individual to distinctively track day to day, and this study tested predictive factors to analyze the components of well-being and positive emotion. Future work should use these findings as a basis to design similar studies aimed at developing more definable and predictive questions that accurately can assess an individual’s overall well-being. Expansion of these methods to a larger population of participants and standardization of data collection could allow these findings to have direct applications. Furthermore, by understanding the factors that contribute to well-being and positive emotion, an algorithm can be developed for individuals or organizations to monitor well-being and positive emotion and make positive impactful changes.

# References

|  |
| --- |
| 1.    Butler, J., & Kern, M. L. (2016).The PERMA-Profiler: A brief multidimensional measure of flourishing. International Journal of Wellbeing, 6(3), 1-48. doi:10.5502/ijw.v6i3.526  |
| 2.    Csikszentmihalyi M. (1990). Flow: The psychology of optimal experience. New York, NY: Harper & Row. |
| 3.    Diener, E., Seligman, M. (2004). Beyond money: Toward an economy of well-being. *Psychological Science in the Public Interest*. 5(1), pp.1-31. https://doi.org/10.1111/j.0963-7214.2004.00501001.x  |
| 4.    Forgeard, M. J., Haigh, E. A., Beck, A. T., Davidson, R. J., Henn, F. A., Maier, S. F., Mayberg, H. S., & Seligman, M. E. (2011). Beyond Depression: Towards a Process-Based Approach to Research, Diagnosis, and Treatment. Clinical psychology : a publication of the Division of Clinical Psychology of the American Psychological Association, 18(4), 275–299. https://doi.org/10.1111/j.1468-2850.2011.01259.x |
| 5.    Freeman, D., Sheaves, B., Goodwin, G. M., Yu, L. M., Nickless, A., Harrison, P. J., Emsley, R., Luik, A. I., Foster, R. G., Wadekar, V., Hinds, C., Gumley, A., Jones, R., Lightman, S., Jones, S., Bentall, R., Kinderman, P., Rowse, G., Brugha, T., Blagrove, M., … Espie, C. A. (2017). The effects of improving sleep on mental health (OASIS): a randomised controlled trial with mediation analysis. *The lancet. Psychiatry*, *4*(10), 749–758. https://doi.org/10.1016/S2215-0366(17)30328-0 |
| 6.    Higgins, E. T. (2006). Value from hedonic experience and engagement. Psychological Review, 113(3), 439–460. https://doi.org/10.1037/0033-295X.113.3.439 |
| 7.    Holt-Lunstad J., Smith T. B., Layton J. B. (2010). Social relationships and mortality risk: a meta-analytic review. PLoS Med. 7:e1000316. 10.1371/journal.pmed.1000316, |
| 8.    Howell, R., Kern, M., Lyubomirsky S., (2007) Health benefits: Meta-analytically determining the impact of well-being on objective health outcomes, Health Psychology Review, 1:1, 83-136, DOI: 10.1080/17437190701492486 |
| 9.    Kashdan, T. B., Mishra, A., Breen, W. E., & Froh, J. J. (2009). Gender differences in gratitude: examining appraisals, narratives, the willingness to express emotions, and changes in psychological needs. Journal of personality, 77(3), 691–730. https://doi.org/10.1111/j.1467-6494.2009.00562.x |
| 10. Kern, M. L., Waters, L., Adler, A., & White, M. (2014). Assessing employee wellbeing in schools using a multifaceted approach: Associations with physical health, life satisfaction, and professional thriving. Psychology, 5(6), 500–513. https://doi.org/10.4236/psych.2014.56060 |
| 11. Kiken, L. G., Lundberg, K. B., & Fredrickson, B. L. (2017). Being present and enjoying it: Dispositional mindfulness and savoring the moment are distinct, interactive predictors of positive emotions and psychological health. Mindfulness, 8(5), 1280–1290. https://doi.org/10.1007/s12671-017-0704-3 |
| 12. King, L. A., &amp; Burton, C. M. (2003). The hazards of goal pursuit. In E. C. Chang &amp; L. J. Sanna (Eds.), Virtue, vice, and personality: The complexity of behavior (pp. 53–69). American Psychological Association. https://doi.org/10.1037/10614-004 |
| 13.  Maslow, A. (1962). Toward a psychology of being. https://doi.org/10.1037/10793-000  |
| 14. Ryff C. D., Singer B. (2001). Emotion, social relationships, and health. USA: Oxford University Press.  |
| 15. Schaufeli, W., Bakker, A., Salanova, M. (2006). The Measurement of Work Engagement With a Short Questionnaire: A Cross-National Study. Educational and Psychological Measurement, 66(4), 701-716. https://doi.org/10.1177/0013164405282471 |
| 16. Seligman, M. (1998). APA president address 1998*.* https://positivepsychologynews.com/ppnd\_wp/wp-content/uploads/2018/04/APA-President-Address-1998.pdf.  |
| 17. Seligman, M. (2002). Authentic happiness: Using the new positive psychology to realize your potential for lasting fulfillment. New York: Free Press. https://doi.org/10.1017/s0360966900000426  |
| 18. Seligman, M. E. P., Steen, T. A., Park, N., &amp; Peterson, C. (2005). Positive Psychology Progress: Empirical Validation of Interventions. American Psychologist, 60(5), 410–421. https://doi.org/10.1037/0003-066X.60.5.410 |
| 19. Seligman M. E. (2011). Flourish: A visionary new understanding of happiness and well-being. New York, NY: Simon and Schuster. |
| 20. Sharma, A., Madaan, V., & Petty, F. D. (2006). Exercise for mental health. *Primary care companion to the Journal of clinical psychiatry*, *8*(2), 106. https://doi.org/10.4088/pcc.v08n0208a |
| 21. Stone A. A., Smyth J. M., Pickering T., Schwartz J. (1996). Daily mood variability: form of diurnal patterns and determinants of diurnal patterns. J. Appl. Soc. Psychol. 26, 1286–1305. 10.1111/j.1559-1816.1996.tb01781.x |
| 22. Stranges, S., Samaraweera, P. C., Taggart, F., Kandala, N. B., & Stewart-Brown, S. (2014). Major health-related behaviours and mental well-being in the general population: the Health Survey for England. *BMJ open*, *4*(9), e005878. https://doi.org/10.1136/bmjopen-2014-005878 |
|  |
| 23. Tugade, M. M., &amp; Fredrickson, B. L. (2004). Resilient Individuals Use Positive Emotions to Bounce Back From Negative Emotional Experiences. Journal of Personality and Social Psychology, 86(2), 320–333. https://doi.org/10.1037/0022-3514.86.2.320 |
|  |
| 24. Zemach, E. M. (2001). What Is Emotion? American Philosophical Quarterly, 38(2), 197–207. http://www.jstor.org/stable/20010033 |

