

**INDIVIDUAL CHARACTERISTICS ASSOCIATED WITH REMOTE
MINDFULNESS APP USAGE**

A Thesis

by

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INTRODUCTION

This thesis aims to analyze the relationships between Big Five personality traits and usage of the mindfulness app Headspace in college students. College students who are in a high-stress environment could benefit from engaging in mindfulness practice as an easily accessible stress reliever and improve their mental health. There is a lack of research pertaining to mindfulness app usage rates among the college student population specifically. Existing studies focus on varying age ranges which do include adolescents and young adults. However, research on students in a college setting will help us to understand how mindfulness apps can be used to target this demographic in order to reduce stress, anxiety, and depression. It is important to understand how adherence and usage levels may differ as a sustained interaction with Headspace produces more positive mental health outcomes.

Headspace is known to be effective, based on scientific evidence, and is readily available to the population in question (O'Daffer et al., 2022). This study will utilize Headspace by asking students to use the app for a period of two weeks. Usage will not be required but rather encouraged as to effectively measure how the app may be used outside of this study. Reports of usage will be compared to International Personality Item Pool (IPIP) scores for the Big Five and questions targeting likelihood to continue use. The results will benefit the understanding of Headspace's efficacy among the population and in the future may lead to the development of personality specific mindfulness practice. Because mindfulness training can benefit college students in a variety of ways, the results will allow these students to understand how likely they may be to naturally benefit from the practice or how much external effort will be needed for adherence to be possible.

LITERATURE REVIEW

1.1 Background

During the COVID -19 pandemic, the United States saw a rise in mental health issues (Usher et al., 2020). Social isolation, like that inflicted by quarantine, has been linked to higher rates of anxiety and depression (Loades et al., 2020). A meta-regression found a significant positive relationship between the daily COVID-19 infection rate and the presence of major depressive disorder and anxiety disorders (Santomauro et al., 2021). Additionally, both anxiety and depression prevalence increased as human mobility decreased. Although mental health issues have always been an important concern among the young adults of the United States, the pandemic exacerbated some of these negative mental health outcomes.

Because of quarantine, many therapists transitioned into providing virtual care. In an attempt to reduce barriers to entry like wait time, money, and social stigma, there has been a recent influx of mental health mobile applications (Sorkin et al., 2021). Studies have evaluated psychological intervention applications and highlight the importance of these apps being based on evidence-supported therapies (Leigh & Flatt, 2015).

1.1.1 *Mindfulness*

Mindfulness techniques have become increasingly popular as a therapy option. The practice, which started as a Buddhist meditation technique, is defined as “paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally” (Kabat-Zinn, 2009). This technique is meant to promote a feeling of acceptance which should benefit overall well-being. Mindfulness has more recently been incorporated into clinical practices and therapies for stress and mental

health issues like anxiety and depression. Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) are the most common forms of mindfulness interventions (Hofmann & Gómez, 2017). Mindfulness-Based Stress Reduction utilizes classes and formal practices like meditation that promote integrating mindfulness into individuals' lives (especially in reactions to stressful situations) (Fjorback et al., 2011). Mindfulness-Based Cognitive Therapy utilizes similar methods as MBSR but focuses on combating negative thoughts and aims to prevent relapse for those who already suffer from depression (Fjorback et al., 2011). A study compiling modules from both MBSR and MBCT provided evidence that online mindfulness practice can lower perceived stress levels (Krusche et al., 2012). Building off research that digital mindfulness interventions are effective; a variety of mindfulness intervention applications have come to the surface. These apps have been found to significantly improve levels of anxiety, depression, perceived stress, and overall well-being (Gál et al., 2021; Howells et al., 2014). Most studies included reviews of the application Headspace. In a review of mindfulness apps, Headspace scored highest on the Mobile Application Rating Scale (Mani et al., 2015). This scale focuses on quality of the app in relation to engagement, functionality, aesthetics, information, and satisfaction, not specifically on efficacy. A systematic review comparing the efficacy of Headspace and Calm (the two most popular mindfulness apps in 2022) found that 40% of studies using Headspace reported an improvement in wellbeing and anxiety, and 75% of Headspace studies improved depressive symptoms (O'Daffer et al., 2022).

1.1.2 Personality

Mindfulness can be discussed in both a state and trait context. State mindfulness refers to a current experience of being mindful whereas trait mindfulness relies on a predisposition of a person to be mindful (Kiken et al., 2015). Trait mindfulness is stable over time whereas state mindfulness

is dependent on external factors. However, studies find that an increase of mindfulness practice (state mindfulness) can over time strengthen trait mindfulness (Kiken et al., 2015). Many studies focus on how personality traits like the Big Five correlate with trait mindfulness. The Big Five personality traits, stemming from the five-factor model of personality, form a comprehensive and widely accepted model of personality (McCrae & John, 1992). The Big Five personality traits are Openness to Experience, Conscientiousness, Extraversion, Agreeableness, and Neuroticism. Individuals who score high on extraversion tend to be social, dominant, and ambitious. Agreeable people are typically cooperative, trustworthy, and compliant. Neuroticism is the opposite of emotional stability, meaning high neuroticism scores correlate with anxiety, insecurity, and hostility. Those who are highly conscientious are known to be dependable and strive for achievement. Finally, openness to experience measures intellect, creativity, unconventionality, and open-mindedness (Barrick et al., 2001). It is important to understand the relationship between personality traits and how likely people are to benefit from or participate in mindfulness practice. Meta-analyses have discovered significant interactions between the Big Five and trait mindfulness. Mindfulness is positively correlated with conscientiousness ($r = .32$) and negatively correlated with neuroticism ($r = -.45$). Relationships with the other Big Five traits agreeableness ($r = .22$), openness ($r = .15$), and extraversion ($r = .12$) are smaller but present (Giluk, 2009). The studies included in the analysis by Giluk measure the trait construct of mindfulness and not mindfulness-based intervention efficacy.

This thesis aims to expand on these results and discuss the relationship between personality and likelihood to partake in mindfulness practice (state mindfulness) to the point of improving trait mindfulness. There are many scales that have been validated to measure the mindfulness construct. The Five Facet Mindfulness Questionnaire (FFMQ) breaks mindfulness into five different

categories: Observing, Describing, Acting with Awareness, Nonjudging, and Nonreactivity. In an analysis comparing mindfulness scales to personality scales that capture the Big Five, different personality traits were found to correlate with different aspects of mindfulness as broken apart by the FFMQ (Altizer et al., 2021). For those trying to benefit from mindfulness intervention, or who want to improve trait mindfulness by partaking in state mindfulness practice, it is important to know the relationship between their personality and what aspects of mindfulness practice are compatible with their predispositions.

1.1.3 Adherence

Personality can also impact adherence to practice. In a study on out-of-class mindfulness (mindfulness outside of a formal practice setting), baseline conscientiousness and openness predicted intervention adherence and conscientiousness also predicted post-intervention adherence (Canby et al., 2020). Adherence to practice impacts the effectiveness of positive mindfulness outcomes. Participants who were asked to participate in MBSR and MBCT practice for 45 minutes six days a week were found to only complete 64% of the recommended practice (Parsons et al., 2017). The researchers found a dose-response relationship: Participants who practiced longer had better treatment outcomes.

1.1.4 Mindfulness in College Students

The existing research regarding mindfulness intervention among college students shows promise for its efficacy in improving mental health. In a study of first-year students transitioning into college, mindfulness training was found to decrease levels of anxiety and depression (Dvořáková et al., 2017). Mindfulness intervention has also been found to improve college student's well-being by reducing the frequency of binge drinking episodes (Mermelstein & Garske,

2015), improving working memory capacity by reducing mind wandering (Mrazek et al., 2013), and reducing stress (Oman et al., 2008).

1.1.5 Hypotheses

Based on the literature, three hypotheses can be developed.

Hypothesis 1: Trait mindfulness will increase with increased daily usage of the app Headspace.

Hypothesis 2: Those who score highly on conscientiousness will be more likely to use the app, as well as rate the app highly.

Hypothesis 3: Anxiety, depression, and stress scores will decrease as app usage increases.

METHODS

1.2 Participants

The final sample consisted of 57 students. Eight pretest entries were excluded from the final sample due to failure to complete the post-test survey. Seven participants signed up to participate and either canceled or no showed for part 1 of the study, making them ineligible to complete part 2. Male participants made up 52.6% of the sample, female participants were 45.6% of the sample, and the other 1.7% indicated they identify with another gender or preferred not to answer. The mean age of the sample was 19.4 ($SD = 1.66$). The majority of participants identified as Asian (58%), followed by White or Caucasian (33%), African American (11%), and Hispanic (1%).

1.3 Procedure

After signing up for the study, the participants were emailed the pre-survey link and their individualized participant number. The participant numbers were used to make the surveys

anonymous while still being able to track participant progress and compare pre and post survey scores. During the pre-test survey they completed ten questionnaires, gave demographic information, and indicated their baseline mindfulness practice. After completing the first survey, the participants were instructed on how to download the mindfulness application Headspace and the data-collection application Expiwell for the daily surveys. They were asked to use Headspace at their own discretion over the course of the next two weeks. This timing and duration were included in hopes that app usage would reflect usage outside of the study. The daily surveys were deployed to capture usage of the application as well as state measures of stress, anxiety, mindfulness, and depression. At the end of the two-week trial period, the participants took the post-test survey. This survey had the same questionnaires as the pre-test with the addition of the Mobile Application Rating Scale and the removal of the baseline mindfulness information. The pre and post surveys took approximately 45-60 minutes, and the daily surveys took 2-3 minutes to complete. The participants were awarded 3 research credits for their participation.

The entirety of the study was conducted online. Participants were emailed- all survey links and instructions- They were given an individualized participant number to enter at the beginning of each survey. All surveys were administered via Qualtrics, and the mobile app Expiwell was utilized to send the daily surveys out every day at 6 pm. The daily surveys were available to be completed from 6 pm to midnight.

1.4 Measures

1.4.1 Personality

The Mini IPIP (Donnellan et al., 2006) is a validated 20-item shortened scale of the International Personality Item Pool. This scale was used to assess personality in the form of the Big

Five personality traits: Openness to Experience (also referred to as Intellect/ Imagination, sample item: “I have a vivid imagination”), Conscientiousness (sample item: “I like order.”), Extraversion (sample item: “I talk to a lot of different people at parties.”), Agreeableness (sample item: “I feel others’ emotions.”), and Neuroticism (sample item: “I get upset easily”). Participants ranked how accurate each phrase was at describing them on a scale from very inaccurate to very accurate.

1.4.2 Mindfulness

The Five Facets Mindfulness Questionnaire (FFMQ; Baer et al., 2008) is a 39-item questionnaire that measures trait mindfulness in regards to five categories: Observing (sample item: “I pay attention to sensations, such as the wind in my hair or sun on my face”), Describing (sample item: “I can easily put my beliefs, opinions, and expectations into words”), Acting with awareness (sample item: the reverse score of “I am easily distracted”), Nonjudging of inner experience (sample item: the reverse score of “I tell myself I shouldn’t be feeling the way I’m feeling”), and Nonreactivity to inner experience (sample item: “I watch my feelings without getting lost in them”). These statements are answered based on how true the participant feels the statement is to them on the scale “never or rarely true” to “very often or always true.” All items for the acting with awareness and non-judging of the inner experience facets are reverse scored before calculating the total or average score. Some items relating to the describing facet are also reverse scored.

1.4.3 Outcome Variables

The short version of the Depression Anxiety Stress Scale (DASS) the DASS-21 (Henry & Crawford, 2005) assesses Depression (sample item: “I couldn’t seem to experience any positive feeling at all”), Anxiety (sample item: “I felt I was close to panic”), and Stress (sample item: “I found it difficult to relax”) over the past week. The 21 items are scored on a scale of how often the

statement applied over the past week (“Did not apply to me at all” to “Applied to me very much or most of the time”).

1.4.4 Application Rating

The Mobile Application Rating Scale (MARS; Terhorst et al., 2020) is used to assess the Engagement (sample item: “Is the app fun/entertaining to use? Does it use any strategies to increase engagement through entertainment [e.g. through gamification]?”), Functionality (sample item: “How easy is it to learn how to use the app; how clear are the menu labels/icons and instructions?”), Aesthetics (sample item: “How high is the quality/resolution of graphics used for buttons/icons/menus/content?”), and App Subjective Quality (sample item: “Would you recommend this app to people who might benefit from it?”) of mental health applications.

1.4.5 Daily Surveys

The daily surveys target reliable data about usage of the Headspace app. Each day participants are asked “In the time since the last survey, did you use the Headspace app?” If so, they are asked follow up questions about how long, how often, what functions they used (meditate, move, sleep, music, other), and time of use. No matter their usage, participants are all asked how mindful, stressed, anxious, and depressed they feel in the current moment.

1.4.6 Demographics

At the end of both the pre and posttests, participants responded to demographic questions about gender, age, and race/ethnicity. At the end of the pre survey, participants were asked to indicate how often they meditate outside of religious services, how long they have been meditating,

and typical meditation time per week. They were also asked if they have used a mindfulness application before and to indicate which app(s) and how often they have used it.

1.4.7 Other Scales

The Self Compassion Scale (SCS; Raes et al., 2010) in its short form is a 12 item questionnaire that measures six different qualities of self-compassion: Self-kindness (sample item: “When I’m going through a very hard time, I give myself the caring and tenderness I need.”), Self-judgment (sample item: “I’m intolerant and impatient towards those aspects of my personality I don’t like.”), Common Humanity (sample item: “When I feel inadequate in some way, I try to remind myself that feelings of inadequacy are shared by most people.”), Isolation (sample item: “When I fail at something that’s important to me, I tend to feel alone in my failure.”), Mindfulness (sample item: “When something upsets me I try to keep my emotions in balance.”), and Over-Identification (sample item: “When I fail at something important to me I become consumed by feelings of inadequacy”). These items are rated on a scale of how often the participant behaves in the stated manner (1- Almost never to 5- Almost always).

The Broad Rumination Scale (BRS; Trani, 2021) is a 34-item scale that measures eight important aspects of rumination. Rumination is a repetitive cognitive process of focusing on negative (Sansone & Sansone, 2012), the factors that impact rumination are Brooding (sample item: “When considering my past, I think I have had more negative events than positive events”), Compulsivity (sample item: “When I start to worry, it is very hard for me to stop”), Distractibility (sample item: “My thoughts have the tendency to distract me from a task at hand”), Optimism (sample item: “I like myself”), Personal Expressiveness (sample item: “My creative hobbies are a way for me to communicate how I am feeling”), Reflectiveness (sample item: “When I feel down, it is important for me to understand why”), Social Expressiveness (sample item: “It helps me to talk

about my problems with other people”), and Worrying (sample item: “Uncertainty about the future bothers me”). Statements are answered on a 6 point Strongly Disagree to Strongly Agree scale.

Three subsections of the Resilience Scale (RS; Lundman et al., 2007) were utilized in this study. Meaningfulness (sample item: “I feel proud that I have accomplished things in my life”), Equanimity (sample item: “I do not dwell on things I can’t do anything about”), and Self Reliance (sample item: “I have self-discipline”). The included measures totaled in a 19-item questionnaire. Items were answered on a 6 point “Disagree Strongly” to “Agree Strongly” scale.

The Sense of Self Scale (SOSS; Flury & Ickes, 2007) aims to measure the strength of a person’s sense of self. Those with a strong sense of self have a strong answer for the question “who are you?” and a well-defined personality. Whereas those with a weak sense of self may change their identity often based on others, they may even feel they have no individual identity. The SOSS is a 12-item scale with items such as “It’s hard for me to figure out my own personality, interests, and opinions” and “I have a clear and definite sense of who I am and what I’m all about”. These items are rated on a 4-point scale from 1- Very Uncharacteristic of you to 4- Very Characteristic).

The Experiences Questionnaire (EQ; Fresco et al., 2007) is designed to measure decentering. Items that were aimed towards measuring rumination were excluded. Decentering is “the ability to observe one’s thoughts and feelings as temporary, objective events in the mind, as opposed to reflections of the self that are necessarily true” (234). The 13-item questionnaire included statements like “I can separate myself from my thoughts and feelings” and “I can take time to myself when things go wrong”. Statements are answered on a 5-point scale from 1-Never to 5- All the time.

The Dispositional Positive Emotion Scales (DPES; Shiota et al., 2006) includes seven subsections of positive emotion. This study includes the sections: Joy (sample item: “I often feel

bursts of joy”), Love (sample item: “I develop strong feelings of closeness to people easily”), Compassion (sample item: “It’s important to take care of people who are vulnerable”), and Awe (sample item: “I see beauty all around me”). Participants indicate their level of agreement with the statement on a 7-point scale.

The Aspects of Spirituality Scale (ASP; Büssing et al., 2010) was created to measure parts of spirituality outside of conventional religious practices. The subject of this scale included is Search for Insight/ Wisdom (sample item: “I try to develop wisdom”). The scale consists of 7 statements that are ranked on a 5-point scale from “Does not apply at all” to “Applies very much.”

These scales were included to take a deeper look at aspects that may be affected by mindfulness practices. The data from these scales will not be analyzed in this thesis and are primarily exploratory.

1.4.8 Data Analysis

Correlations were obtained between usage data, the Big Five personality traits, aspects of mindfulness (as determined by the FFMQ), measures of depression, anxiety, stress, and demographic information. T-tests were run between corresponding pre and post scores like mindfulness levels, stress, anxiety, and depression scores, to determine if there was any significant change in these scores over the trial period. New variables were created to represent the change in these variables from pre to post (FFMQ aspects, stress, anxiety, and depression). Correlations were then run between a pre-post change scores and frequency of usage. Additionally, correlations were run between the Big Five personality traits and scores on the MARS. A significance value of .05 was used to indicate a significant difference.

RESULTS

1.5 Usage and Mindfulness Background

Most participants indicated that they never meditated outside of religious services (58%). Those participants that meditated before their participation in this study meditated on average 1.34 hours a week for an average of 61 months ($SD = 95$ months). Note that this data is skewed, due to three participants who indicated having been meditating for the majority of their lives. 44% of participants had used a meditation or mindfulness app prior to the study and 19% had used Headspace specifically.

Participants used Headspace an average of 9.6 times over the trial period of two weeks ($SD = 8.6$ times, range = 0 - 47 times) and the average total time each participant spent using the app was 1 hour and 26 minutes ($SD = 94.66$ minutes, $Range = 0 - 450$ minutes). One participant entered a highly unlikely value for number of times the app was used on one of their daily surveys (i.e., 323). This outlier was replaced with the mean value of that participant's other entries.

1.6 Hypothesis 1

There was a significant difference between total FFMQ scores at the pre and the post ($t = -2.64, p = .011, df = 56$), indicating that trait mindfulness increased over the trial period. There were also significant changes in the FFMQ aspects observing ($t = -2.32, p = .024, df = 56$) and nonreactivity ($t = -2.48, p = .011, df = 56$). A positive correlation was found between the number of times the app was used and change in FFMQ nonreactivity scores (Pearson $r = .33, p = .013$), but no other correlations between app usage and mindfulness were significant. There is thus only limited evidence to support hypothesis 1 that Headspace usage correlates with an increase in trait mindfulness. Other FFMQ aspect change scores and their relationships with app usage can be seen in Table 1.

Table 1. Aspects of the FFMQ (Observing, Describing, Acting with Awareness, Non-judging, Non-reactivity) and their relationships with total time spent using Headspace over the two-week trial. The variables for change in FFMQ aspects were computed by subtracting the participants' pre score for the variable from their respective post score.

| | Change in Observing Score | | Change in Describing Score | | Change in Acting with Awareness Score | | Change in Non-judging Score | | Change in Non-reactivity Score | | Change in Total FFMQ score | |
|-------------------------------|---------------------------|---------------|----------------------------|---------------|---------------------------------------|---------------|-----------------------------|---------------|--------------------------------|---------------|----------------------------|---------------|
| | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed |
| Total Time Spent on Headspace | 0.11 | 0.414 | 0.067 | 0.618 | 0.196 | 0.144 | -0.034 | 0.801 | 0.226 | 0.091 | 0.193 | 0.151 |
| Number of times app was used | 0.038 | 0.78 | 0.136 | 0.312 | 0.161 | 0.23 | 0.007 | 0.959 | 0.327 | 0.013* | 0.228 | 0.088 |

* $p < .05$. $N=57$

1.7 Hypothesis 2

Opposite the hypothesis, there was no relationship between conscientiousness and app usage (Pearson $r = .04$, $p = .745$). No other significant relationships were found between usage data and personality traits. Relationships between usage and all Big Five traits can be seen in the Table 2.

Table 2. The Big Five Personality Traits (Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism) and their relationships with Headspace app usage (total time spent on app and number of total app uses over the two-week period).

| | Openness to experience | | Conscientiousness | | Extraversion | | Agreeableness | | Neuroticism | |
|-------------------------------|------------------------|---------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|
| | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed |
| Total Time Spent on Headspace | 0.035 | 0.782 | 0.041 | 0.745 | -0.161 | 0.199 | -0.042 | 0.74 | -0.078 | 0.538 |
| Number of times app was used | -0.009 | 0.943 | -0.001 | 0.994 | -0.09 | 0.473 | -0.042 | 0.74 | -0.078 | 0.538 |

* $p < .05$. $N=57$

A regression analysis was run with total time as the dependent variable, controlling for mindfulness aspects, personality, and initial levels of stress, anxiety, and depression. Gender was found to be a significant predictor of app usage ($t = -2.59$, $p = .013$, $df = 56$), indicating that women were more likely to use Headspace than men.

1.8 Hypothesis 3

There was a significant reduction in DASS-21 depression scores from the pretest to the posttest ($t = 2.24$, $p = .029$, $df = 56$). Anxiety ($p = .804$) and stress ($p = .484$) scores did not

change significantly over the trial period. App usage was not significantly correlated with change in DASS-21 scores from pre to post, providing no evidence to support hypothesis 3. The Pearson correlation scores and significance values breaking down each aspect of the DASS-21 can be seen in Table 3.

Table 3. Aspects of the DASS-21 (Depression, Anxiety, and Stress) and their relationships with total time spent using Headspace over the two-week trial. The variables for change in stress, depression, and anxiety were computed by subtracting the participants' pre score for the variable from their respective post score.

| | Change in Stress | | Change in Depression | | Change in Anxiety | |
|---|---------------------|---------------|----------------------|---------------|---------------------|---------------|
| | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed |
| Total Time Spent Using Headspace | -0.053 | 0.693 | -0.042 | 0.755 | 0.021 | 0.878 |

* $p < .05$. $N=57$

1.9 FFMQ and Big Five Relationships

The Big Five personality traits and their correlations with change in each FFMQ mindfulness aspect can be seen in Table 4. There was a significant positive relationship between Extraversion and change in non-judging score (Pearson $r = .54$, $p = .000$) and between Agreeableness and change in non-judging (Pearson $r = .46$, $p = .000$). Additionally, both Extraversion and Agreeableness had positive relationships with change in total FFMQ score (this study's measure of trait mindfulness; Extraversion: Pearson $r = .29$, $p = .027$; Agreeableness: Pearson $r = .29$, $p = .027$)

Table 4. The Big Five Personality Traits (Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism) and their relationships with the change of scores on the five aspects of mindfulness discussed in the FFMQ (Observing, Describing, Acting with Awareness, Non-judging,

Non-reactivity). The variables for change in FFMQ aspects were computed by subtracting the participants' pre score for the variable from their respective post score.

| | Openness to experience | | Conscientiousness | | Extraversion | | Agreeableness | | Neuroticism | |
|------------------------------|------------------------|---------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|
| | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed |
| Observing Change | 0.007 | 0.959 | 0.044 | 0.746 | 0.114 | 0.399 | 0.145 | 0.281 | 0.037 | 0.786 |
| Describing Change | -0.133 | 0.325 | -0.104 | 0.44 | 0.046 | 0.735 | -0.026 | 0.847 | 0.129 | 0.338 |
| Acting with Awareness Change | 0.043 | 0.752 | 0.146 | 0.278 | -0.069 | 0.609 | 0.163 | 0.225 | 0.022 | 0.873 |
| Non-judging Change | 0.23 | 0.085 | 0.095 | 0.481 | 0.535 | .000* | 0.464 | .000* | 0.11 | 0.415 |
| Non-reactivity Change | 0.141 | 0.297 | -0.094 | 0.485 | 0.228 | 0.088 | 0.128 | 0.343 | 0.014 | 0.915 |
| Total FFMQ change | 0.11 | 0.417 | 0.025 | 0.852 | 0.293 | .027* | 0.292 | .027* | 0.094 | 0.487 |

* $p < .05$. $N=57$

1.10 App Rating Relationships

App ratings for engagement (Pearson $r = .43$, $p = .001$), functionality (Pearson $r = .30$, $p = .024$), and aesthetics (Pearson $r = .27$, $p = .041$) were positively correlated to app usage as can be seen in Table 5.

Table 5. Aspects of the Mobile Application Rating Scale (Engagement, Functionality, Aesthetics, and Subjective Quality) and their relationships with usage of the Headspace app over the trial period (seen through total time spent on app and number of times the app was used).

| | MARS engagement | | MARS functionality | | MARS aesthetic | | MARS subjective quality | |
|-------------------------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|-------------------------|---------------|
| | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed |
| Total Time Spent on Headspace | 0.426 | .001* | 0.298 | .024* | 0.271 | .041* | -0.005 | 0.971 |
| Number of times app was used | 0.322 | .014* | 0.333 | .011* | 0.346 | .008* | 0.156 | 0.214 |

* $p < .05$. $N=57$

There was a significant positive relationship between ratings of app functionality and the personality trait of Agreeableness (Pearson $r = .31$, $p = .020$). Mean app rating by category and personality can be seen in Table 6 below.

Table 6. The relationships between the Big Five Personality Traits (Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism) and Mobile Application Rating Score Means (Engagement, Functionality, Aesthetic, Subjective Quality).

| | Openness to experience | | Conscientiousness | | Extraversion | | Agreeableness | | Neuroticism | |
|--------------------------------------|------------------------|---------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|---------------------|---------------|
| | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed | Pearson Correlation | Sig. 2 tailed |
| Engagement Mean Score | 0.205 | 0.126 | 0.059 | 0.664 | -0.01 | 0.941 | 0.156 | 0.246 | -0.005 | 0.969 |
| Functionality Mean Score | 0.239 | 0.073 | -0.033 | 0.805 | 0.06 | 0.658 | 0.308 | .020* | -0.043 | 0.752 |
| Aesthetic Mean Score | 0.252 | 0.059 | -0.035 | 0.796 | 0.063 | 0.641 | 0.222 | 0.096 | 0.054 | 0.693 |
| Subjective Quality Mean Score | -0.106 | 0.399 | -0.117 | 0.354 | -0.045 | 0.721 | 0.102 | 0.421 | 0.096 | 0.448 |

* $p < .05$. $N=57$

DISCUSSION

1.11 Change in Mindfulness

Over the course of the study, participants increased in trait mindfulness. This increase in mindfulness levels, as measured by the FFMQ, likely cannot be attributed to Headspace usage, as there was not a significant correlation between total FFMQ score change and app usage. Usage was positively and significantly correlated with FFMQ non-reactivity scores. This suggests that Headspace can help people learn to experience their feelings and thoughts without having to react to them. It is also possible that simply having the application downloaded on one's smart phone could have contributed to this increase in mindfulness, that is, by making the participants aware of mindfulness, they could become more mindful. The transtheoretical model of behavior change provides some support for this possible explanation. Making a commitment to a new behavior is known to promote long-term behavior change (Lokhorst et al., 2011). If this explanation is true, a correlation between actual app usage and changes in mindfulness are not to be expected. Note that a previous study on mental health application usage, however, found that downloading the app was not enough to produce significant mental health benefits (Torous et al., 2018). Mindfulness, which is a trait as well as a state, may be affected differently by mobile application downloads.

1.12 Personality and Usage

This study aimed to discover and describe relationships between the Big Five personality traits and Headspace usage. Instead of the hypothesized positive relationship between conscientiousness and usage, no significant correlations were found between any of the Big Five and total time spent on Headspace.

I did not predict gender effects, but the regression analysis highlighted the impact of gender on total app usage. Women, who were more likely to use Headspace than men, also increased in mindfulness more than men. Men did not see a significant increase in mindfulness scores from pre to post, while women's scores increased significantly. One factor contributing to women's likelihood to participate might be perceived locus of control (LOC). Although both genders perceive locus of control as external, women tend to perceive LOC significantly more external than men. Factor analysis specifies that men are more likely to believe that they can control uncontrollable events than women (Sherman et al., 1997). Accepting what you cannot control but acknowledging your thoughts and feelings on the subject resembles the non-reactivity aspect of mindfulness measured by the FFMQ. Women, being more likely to attribute events to uncontrollable factors, may then be more likely to adopt an "it is what it is" mentality, making it easier for them to be non-reactive of their inner experience. Further research should be conducted on LOC and other internal factors that may influence one's ability to practice and benefit from mindfulness.

1.13 Mindfulness, Stress, Anxiety, and Depression

Depression was the only outcome variable that showed a significant decrease over the course of this study. This decrease in depression symptoms, however, cannot be attributed to the

Headspace application, as app usage was not significantly correlated with change in depression scores. Depression may have been reduced due to influence from a third-party variable that comes along with mindfulness practice. For example, one possible explanation was that the increase in nonreactivity (learning how to not react to unpleasant thoughts) could potentially have influenced depression levels. After running further analyses, it was found that change in depression scores was not significantly correlated with non-reactivity.

Anxiety change was negatively correlated with the change in acting with awareness scores (Pearson $r = -.28$, $p = .042$). As participants learned how to become aware of their surroundings in any present moment, their anxiety decreased. This relationship may also go the other way, that is, the less anxiety a person experiences, the more able they are to act in the present and fully become Aaware of each moment.

There was a trend ($p < .10$) for change in stress to be correlated with change in nonjudging and change in total FFMQ score. Similarly to the above explanation, we can not distinguish directionality.

1.14 Personality and Mindfulness Aspects

There were few significant relationships found between the Big Five and aspects of the FFMQ. Individuals who are extraverted or agreeable were more likely to increase in trait mindfulness (measured by total FFMQ score). Looking into the individual FFMQ aspects, extraverted or agreeable individuals also had a significant increase in non-judging of the inner experience. Individuals who score highest on openness to experience, neuroticism, or conscientiousness may need to spend more time engaging with mindfulness apps in order to increase their mindfulness levels.

1.15 App Rating Scores

App ratings, specifically engagement, functionality, and aesthetics tend towards the positive as app usage increases. The direction of this relationship is unclear – it could be that people who use the app more frequently develop more positive feelings towards it, or it could be that people who find the app more engaging, functional, and aesthetic are more likely to engage with it. Additionally, those who used the app very rarely may rate the app low because they did not interact with the app enough to evaluate it. Subjective quality of the app did not have a significant relationship with app usage. It is possible that two weeks is insufficient time to form opinions of an application and predict future usage.

In relation to app ratings and personality, there was no significant relationship between Conscientiousness and app ratings. Agreeable individuals rated the app higher in functionality (performance, ease of use, navigation, flow logic, and gestural design). Agreeableness is known to positively affect app users' perceived benefits and trust (Tang et al., 2022). Perceived benefit and trust may have some impact on the high ratings of functionality among this group.

1.16 Limitations

One limitation of this study is the sample. The college student population was accurately assessed with the age breakdown of the survey. However, the sample is not fully representative of the Georgia Tech student demographics. The majority of participants were registered in a psychology course and received class research credit for their efforts. This volunteer sample may introduce extraneous variables that could have affected the results. For example, those who select into a mindfulness study may have a stronger interest in mindfulness or have experience with mindfulness already. Therefore, usage data and mindfulness pre-scores may differ significantly

from the typical Georgia Tech student. A similar study focused on capturing the typical Georgia Tech college student would have to offer an incentive to promote participation and offer the study to a random sample of the student body. Issues of selection bias may still be present in this sample on a lesser scale.

Additionally, the two-week Headspace trial cannot accurately reflect usage patterns. The participants were asked to use the app at their own discretion to simulate use in the real world, but the daily study reminders may have influenced participants to use the app more than they typically would.

1.17 Future Research

In addition to the proposed additional research discussed throughout the discussion, it would be beneficial to conduct this study on a larger scale, including more participants and allowing more time between pre and posttests. Broadening the timeline of the study could produce more accurate usage data that can then be compared to personality and other factors. Further research should be conducted on third party variables that may affect Headspace usage, like locus of control or perceived benefit. Understanding what makes people more likely to participate in mindfulness practice regularly can help individuals understand if this form of practice is the best fit for their needs.

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