

How Meditation Positively Affects the Brain

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ABSTRACT

In this paper, meditation was examined to determine the influence it has on avoiding bad habits and embracing more of the positive in life. Previous research indicates that stress reduction, a lengthened attention span, and disengaged addictions are all beneficial side effects of meditating. In my first (correlational) study, the strength of these relationships was tested by examining naturalistic daily changes in their variables longitudinally over a two-week period. Stress reduction was measured by calculating the amount of self-reported stress experienced each day, attention span was measured through the PEBLs “Attention Network Test”, addictions were measured by tallying the number of times nicotine was used, and the amount of time spent meditating was measured. My results showed significant negative correlations of time spent meditating with stress and nicotine consumption, but not with attention span. Based on the strength of correlation found between time spent meditating and nicotine consumption in the correlational study, a second (experimental) study was conducted to test for specifically a causal relationship between these two variables. Over a two-week period, the participant was assigned on alternate days to either a half hour long meditation condition or a zero-meditation condition and on each day nicotine use was measured. The results of the experimental study successfully established an ability of meditation to reduce nicotine consumption.

1. Introduction

1.1 Research Problem

Meditation is said to allow an individual to have better control over and even restructure their brain (McGonigal, 2010). As humans, we often let our untrained minds dictate us throughout the day. Sometimes this can be especially detrimental to our mental wellbeing if those thoughts are negatively stress inducing. Concentrating difficulties are prevalent with the rise of such easily accessible information at our

fingertips that focusing on a task for long periods of time can be problematic. Meditation may help to lengthen attention span. An untrained mind may also impair self-control and result in compulsive behaviours. Meditation seeks to undo addictions through the power of self-discipline. This paper hopes to identify the benefits of meditation on the brain, so that the common issues humanity has been increasingly battling can be resolved.

1.2 Literature Review

Former research shows that meditation can be a powerful tool for alleviating physiological stress levels. Creswell et al. (2014) conducted a study in brief mindfulness meditation training was arranged consecutively (75 minutes over 3) days for the experimental group out of the total 66 participants. The meditations were guided, and participants were asked to focus on breath awareness labelling their inhales and exhales. Psychological stress levels were reported through self-reported questionnaires both before and after training. Biological stress was measured through blood pressure and cortisol levels in saliva on the third day after giving a speech and partaking in an arithmetic task. The results indicated that self-reported stress decreased ($p = .038$) for those who were assigned meditation training, and that cortisol reactivity responses increased ($p = .04$) to the stress tests especially for those not previously experienced with mindfulness. However, blood pressure was not found to have significant effects. Based on these results, mindfulness in small measures can reduce stress levels both on a psychological and a biological level.

Another previously examined beneficial factor of meditation is its ability to lengthen attention span by allowing an individual to have better control over their wandering thoughts. Bauer et al. (2019) wanted to determine the changes that occur between the default mode network (DMN) and the central executive network (CEN) before, during, and after meditation in experienced practisers. The 33 participants were divided into experienced and non-experienced groups and given fMRI scans to determine connectivity 5 minutes pre, 20 minutes engaged in eyes open resting state, and 5 minutes post, with an additional 20 minutes eyes open engaged in meditation for only the experienced group. Significant activity

reduction was observed in various nodes within the DMN, specifically the meditators with more than 3 years of practice. These findings suggest that the brain is able to gain a better focus of attention span, especially over time, with meditation.

A final finding is that meditation has shown to treat addiction. Tang, Tang, and Posner (2016) explored the self-control of 59 participants, both smokers and non-smokers, after mindful meditation to test if it would reduce cravings. Each group was assigned 5 hours of training over two weeks with the first assigned to integrative body-mind meditation and the second assigned to relaxation training. Each participant was subject to a self-reported smoking/craving survey and CO monitoring, as well as an fMRI, fractional fALFF, and a MPRAGE sequence to map brain activity before and after the training. The smokers in the meditation assigned group had significantly lower CO levels ($P < 0.01$), lower self-reported craving scores ($P < 0.01$), and increased activity in many parts of the brain (the medial prefrontal cortex and anterior cingulate cortex which regulate decision making and impulse control, the ventrolateral prefrontal cortex which is associated with response inhibition and goal-appropriate response selection) ($P < 0.05$). The smokers in the relaxation group did not have significant results to indicate smoking reduction ($P > 0.05$), or increased activity in craving reduction brain regions ($P > 0.05$). It is possible that mindful meditation can improve impulse control, and thus be a tool for diminishing addiction.

1.3 Hypotheses

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

- Hypothesis #1: If the time spent practicing meditation increases then the attention span increases
- Hypothesis #2: If the time spent practicing meditation increases then stress decreases
- Hypothesis #3: If the time spent practicing meditation increases then the addiction to nicotine decreases.

2. Methods

2.1 Participant

The author of this paper served as the single participant in its studies. The participant is 21-year-old female. The participant is an undergraduate student at Camosun College who completed the current studies as an assignment for Psyc 215 (“Biological Psychology”) and was interested in the positive biological impact of meditation on the brain. The participant is a regular nicotine user.

2.2 Materials and Procedure

2.2.1 Correlational Study Methods

A correlational study was performed to test concurrently all hypotheses by examining naturalistic daily changes in the variables longitudinally. The participant kept a study journal with them at all times over this study’s two-week period in order to record self-observations of the following 4 variables: (1) attention, (2) stress, (3) addiction, and (4) time spent meditating.

To measure the level of attention, the Attention Network Test found under the filename “ANT” by PEBL was used. The test is used to quantify activity within the dorsolateral prefrontal cortex and posterior parietal cortex by asking the participant to watch a screen and click the correct shift

button when the cue is shown on screen. Arrows and visual stimulus are used to influence the participants attention. Each day of the study the participant used the test in the early afternoon around work schedule and class times.

To measure stress, the participant recorded in their study journal on a scale from 0-100 how much stress they felt three times per day; after waking, around mid-day, and before sleeping. The possible values on this stress scale ranged from not stressed at all (a score of 0) to extremely stressed (a score of 100). The average stress of each day will be calculated by adding each stress score and dividing the total by 300, and then multiplying that score by 100.

To measure addiction to nicotine the participant simply recorded in their study journal the number of times they used nicotine each day.

To best measure the time spent meditating the participant recorded in their journal the number of minutes they spent meditating each day.

To assess the strength and statistical significance of associations between variable between variables predicted by the hypotheses, the researcher performed Pearson product moment correlations of their predictor variables (increased time spent meditating) with their outcome variables (increased attention span, lower stress, and reduced addiction to nicotine). For testing hypothesis #1, the results from the attention network span test were correlated with the participants time spent meditating score of the same day. For testing hypothesis #2, the daily measure of stress was correlated with the participants time spent meditating score of the same day. For testing hypothesis #3, the number of times the participant used nicotine each day was correlated with the participants time spent meditating score of the same day. 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).

2.2.2 Experimental Study Methods

Based on the strength of the correlation between meditation and nicotine consumption found in the correlational study, an experimental study was then conducted to test for a causal relationship between these two variables from Hypothesis #3: If the time spent practicing meditation increases then the addiction to nicotine decreases.

The independent variable, time spent meditating, was manipulated over a two-week period by randomly assigning the participant each day to either a half hour long experimental condition or a zero-mediation practice condition. On moderate mediation experimental days, the participant followed a half hour long meditation practice in the morning (quiet space, laying with eyes closed and focusing on breath). On control days the participant didn't practice at all. The experimental time chosen was based on the highest amount of time naturally practiced within the correlation study.

To avoid order effects, a counterbalance procedure was followed, and the participant alternated between experimental and control days. Placebo effects and experimenter expectancy effects were difficult to avoid as the one participant was also the lone researcher. However, an additional craving journal recording measure was added. This scale measured cravings from 1(not craving) to 10 (extreme cravings) each day over the two week period.

To assess the statistical significance of differences seen in nicotine consumption on moderate mediation experimental days vs. zero meditation control days, t -tests were

performed. An average difference between conditions was considered statistically significant if, using a two-tailed distribution (i.e., allowing this difference to be positive or negative), the probability of its random occurrence (p) was $< .05$ (i.e., less than 5% of the time expected by chance alone).

3. Results

3.1 Correlational Study Results

As shown in Table 1, both stress and nicotine consumption were significantly correlated with time spent meditating. Stress showed a significant negative correlation ($r \leq -.65$, $p \geq 0.0114$ see Figure 1) with a mean of 29.14, as did nicotine consumption ($r \leq -.69$, $p \geq 0.004$ see Figure 2) with a mean of 26.85 nicotine uses per day. However, attention span did not show statistical significance with meditation ($r \leq .51$, $p \geq 0.06$ see Figure 3). Based on a comparison of the correlation coefficients using raw data, time spent meditating showed the strongest correlation with nicotine consumption.

3.2 Experimental Study Results

As presented in Table 2, a significant difference was found in nicotine consumption between the moderate meditation condition (30 minutes of practice) and control meditation condition (no practice) ($p = 0.0056$; see Figure 4).

4. Discussion

4.1 Summary of Results

Based on previous research, we hypothesized that increases in the meditation would be followed by positive effects: increased attention span (Hypothesis #1),

lower stress levels (Hypothesis #2), and lowered dependence on nicotine (Hypothesis #3). Data from the correlational study supported the predicted relationship of time spent meditating with stress and dependence on nicotine (Hypotheses #2&3) but not with attention span (Hypothesis #1). Data from the experimental study confirmed that the relationship between time spent meditating and dependence on nicotine (Hypothesis #3) was a causal relationship.

4.2 Relation of Results to Past Research

This correlational study failed to confirm the relationship between time spent meditating and attention span reported by previous research. Bauer et al. (2019) found that participants who meditated had a significant reduction of activity within nodes of the DMN through performing various brain scans. These regions of the brain are typically associated with attention span, and decreasing activity allows for better control over the DMN. However, their findings also suggested more control in those with three years of experience or more. This is important to note as the single participant while being well aware of meditating over the past half decade did not practice regularly. Additionally, the participant of the present study did not recognize a noticeable difference in attention span on days they had or had not meditated. The methods of the current study and that of Bauer et al. (2019) differed reasonably. While this study used a fairly simple attention testing technique, theirs had utilized several reliable brain scanning devices. Their observation that the more experienced participants were with meditation showed significantly higher changes in brain activity likely impacted the success of their results, in comparison to this study which had one relatively unexperienced participant. Further studies

with larger sample sizes and diversely experienced participants should be conducted to examine the effects of meditating on attention span.

The moderate correlation found between meditation and stress in this study is consistent with past research. Creswell et al. (2014) was able to find a decrease in cortisol levels as well as lowered self-reported psychological stress levels in their 66 participants. While the Creswell et al. (2014) study was able to discover lower stress on both a psychological and biological level, this study was able to support the psychological evidence as it also used self-reported measures. The similarity of results between this previous study and this suggest that there is a strong relationship that exists between increased time spent meditating and lowered stress levels.

The ability of this study to establish its strongest relationship between nicotine consumption and meditating is also supported by previous investigations. The study by Tang, Tang, and Posner (2016) was able to provide self-reported evidence and increased brain activity within several brain regions associated with decision-making and impulse control in smokers who undertook meditation training, which essentially improved their impulse control. Likewise, this study found a significant correlation between time spent meditating and less nicotine use. While their study was able to provide exact CO levels in the bloodstream as well as brain map sequencing, self-reported measures were utilized by both. Although there are substantial differences in methods, the results of this study are nonetheless in support of the relation between meditating and addiction to nicotine.

4.3 Implications of Results

The findings of the experiment infer that meditating may assist impulse control that is necessary for quitting an addiction to nicotine. However, considering the extremely small sample size, and absence of multiple models of data collection techniques, the results may have been affected by invalid methodology. The correlation between meditation and stress suggests that with further experimental research, causation may be found as it was with meditation on nicotine impulse. Attention span did not provide an adequate correlation with meditation, therefore more research must be successfully completed to further support this hypothesis.

The current study aimed to explore just a few considered positive benefits of meditation on brain mechanisms. Based on the experimental results, it can be assumed that meditating may indeed be a utilizable tool for those hoping to quit their smoking habits. Further studies may provide additional support of this specific hypothesis. However, meditation evidently showcases its positive influence on brain structures and should be recommended as a method for those looking to promote their mental health.

References

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Table 1

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

Variables correlated	Participant #1
Attention span & time spent meditating	.51(14)
Stress & time spent meditating	-.65(14)*
Addiction to nicotine & time spent meditating	-0.69(14)*

* $p < .05$.

Table 2

Descriptive statistics on nicotine consumption between the moderate meditation condition and control meditation condition.

Condition	Statistic	Nicotine consumption
Moderate meditation (30 minutes)	Mean	22.57*
	SD	2.07
	<i>n</i>	7
Control meditation (0 minutes)	Mean	26
	SD	1.732
	<i>n</i>	7

* $p < .05$.

Figure 1

Scatterplot of daily time spent meditating and stress

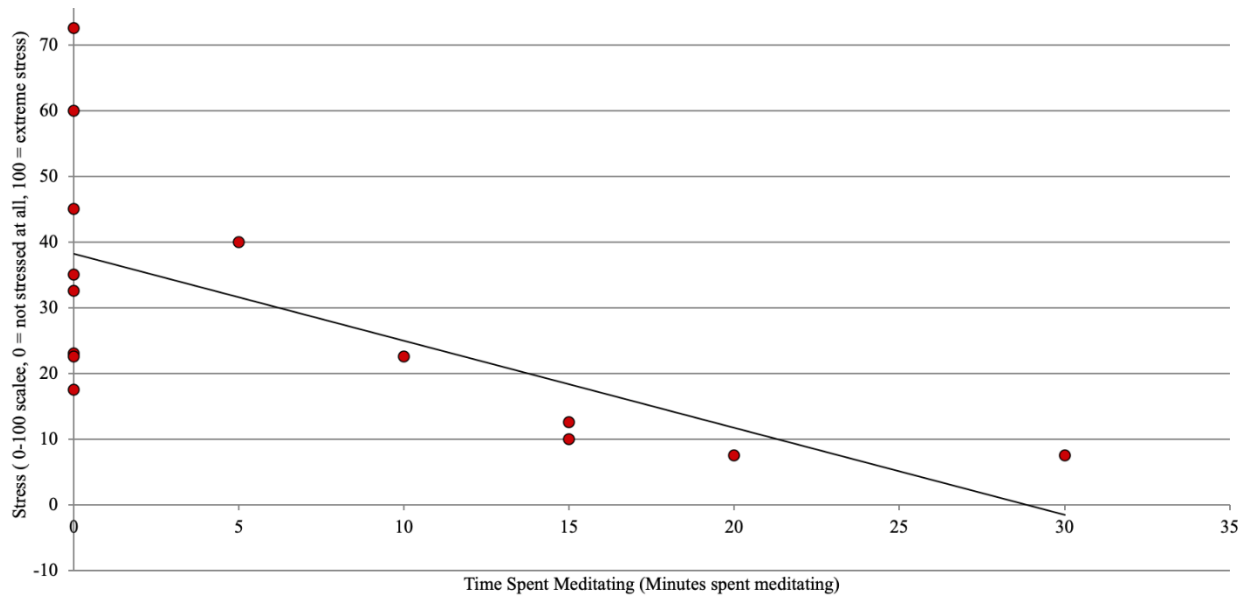


Figure 2

Scatterplot of daily time spent meditating and nicotine consumption

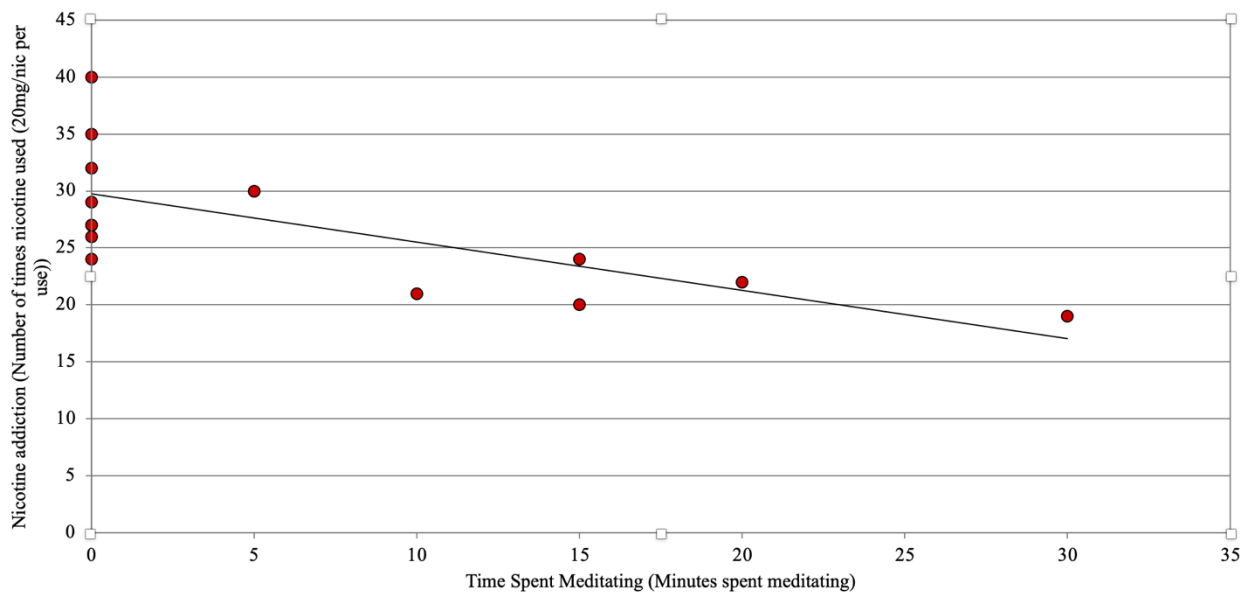


Figure 3

Scatterplot of daily time spent meditating and attention span

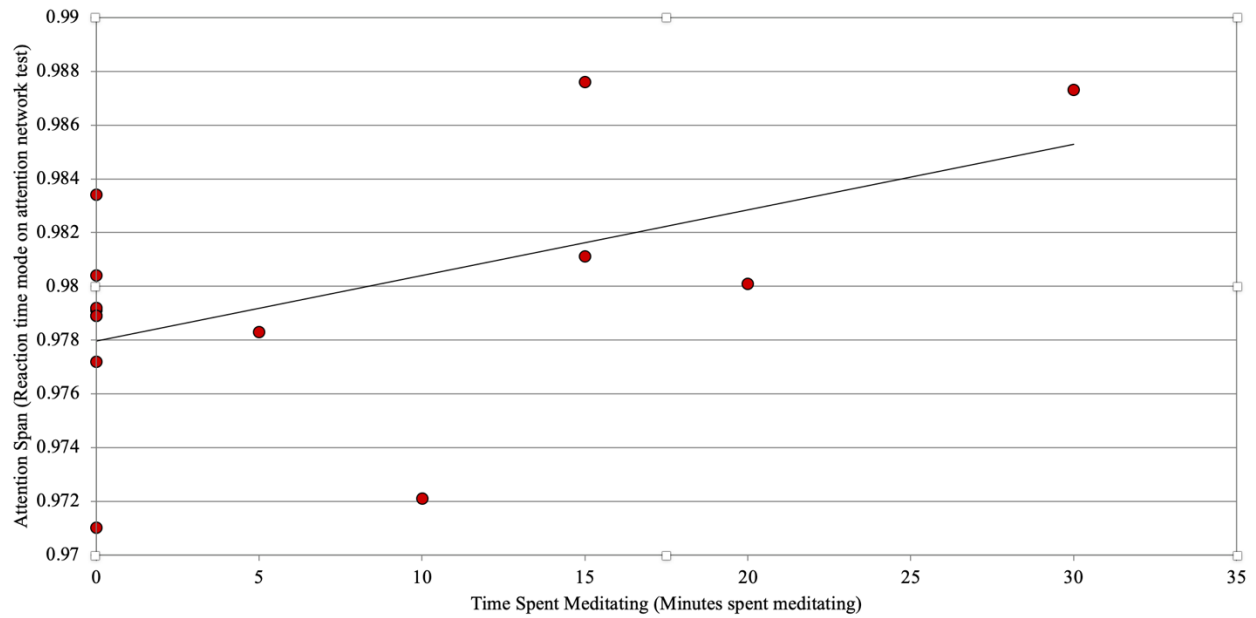


Figure 4

Bar graph of time spent meditating and nicotine consumption, with error bars showing $\pm 95\%$ confidence levels, and with an overlapping scatterplot of data.

