The Psycho-linguistic Effects of Yoga: A Lexical Analysis of Shifts in Positivity, Agency, and Creativity

Abstract

Introduction: Yoga is understood in the scientific community as a powerful de-stressor. Reduced stress has been linked to improved mood, increased agency, and enhanced creativity. Objective: This study investigates these potential psychological effects of yoga by comparing two lexical data sets, composed of nearly 3000 words collected before and after yoga classes. Methods: Each word is scored along three dimensions: positivity, agency, and creativity. Positivity is calculated using SentiWords Sentiment Dictionary 1.0; agency is determined by grammatical categorization; and creativity is viewed as a function of the set distribution. Results: Analysis reveals a shift toward more positive and less agentful self-reporting after practice. No significant difference is found in creativity. Conclusion: This study provides insight into how yoga alters thought processes and affects the mental health of practitioners.

Keywords: Agency, creativity, mental health, positivity, yoga

Introduction

For thousands of years, yoga has been used to improve mental health. Studies have found that yoga reduces blood pressure, heart rate, cortisol levels, peripheral cytokine expression, and activation in stress-related regions of the brain.[1,2] Yoga is known to help with a variety of psychological disorders exacerbated by stress, including depression, fatigue, anxiety, posttraumatic stress disorder, insomnia, and chronic pain.[3] Evidence suggests that yoga inhibits stress responses by downregulating both the sympathetic nervous system and the hypothalamic–pituitary–adrenal axis.[4] Experts theorize that yoga may be a powerful tool for reducing the body’s “allostatic load,” meaning the physiological fatigue that accumulates from repeated or chronic stress.[5] The Flexible Fridays (FF) program at the University of California, Los Angeles (UCLA), offers students free vinyasa-based yoga for stress relief. Every class, participants wrote down three words reflecting how they felt both before and after each class. This study compares the words collected before and after yoga in order to assess the deeper psycholinguistic impacts of the practice created by stress reduction, specifically shifts in mood, sense of self, and creativity.

Yoga potentially increases positivity by diminishing negative thought processes produced by stress. Chronic stress is known to lower serotonin and dopamine levels, which contribute to the development of depression and anxiety.[6,7] Studies show that yoga contributes to the development of more positive feelings that counter this trend.[8] One study of chronically stressed women noted both a decrease in stress and increase in positive affect after 2 months of biweekly yoga.[9] In a comparison between yoga and walking interventions, participants in the former reported mood improvements, accompanied by decreased anxiety and thalamic gamma-aminobutyric acid levels.[10] Other researches have found similar results, supporting the theory that yoga improves overall effect more than other forms of exercise.[11‑13] This body of research relies largely on psychological mood tests (such as Positive and Negative Affect Schedule, Exercise-Induced Feeling Inventory (EIFI), or the Affects Balance Scale), which assess participant agreement with predetermined emotive adjectives, such as “attentive,” “ashamed,” “determined,” or “distressed.”[14] Such
evidence suggests that yoga increases positivity by reducing stress.

Although only preliminary research exists, yoga may also increase one’s sense of agency – the feeling of control over actions and their consequences.[15] Researchers have demonstrated that stress enhances amygdala activity and reduces hippocampal function, leading to heightened emotional reactivity, worsened memory, and general cognitive impairment.[16,17] This psychological instability produced by stress presumably reduces agency by creating a sense of victimhood; in contrast, yoga would boost agency.[18] A recent study discovered a significantly higher sense of agency in a small group of hatha yoga practitioners as compared to nonpractitioners.[19] Researchers used “The Alien Hand Experiment” to measure an awareness of agency independent from any sense of ownership.[20,21] Other scholars have demonstrated a similarly augmented self-awareness among yoga practitioners.[22] Yoga may increase agency by giving practitioners a sense of control over themselves and their environment, thus counteracting the stress response.

In this study, creativity is quantitatively understood as originality. Although there is little research on yoga’s effects on creativity, yoga may increase creativity by reducing stress-related thought patterns. Stress is known to reduce neural adaptivity and creates an unhealthy ratio of white-to-gray matter in the prefrontal cortex.[23] One early study from 1969 proposed that stress inhibits divergent thinking, yet has no effect on convergent thinking, suggesting that creative intellectual abilities may be undermined by stress.[24] Divergent thinking involves nonlinear problem-solving to generate multiple spontaneous solutions, while convergent thought generates a single, linear solution with speed and accuracy. Compared to other theories of creativity, Guilford’s convergent-divergent thinking paradigm remains both popular and testable. Evaluations rely mainly on free association tasks (quick responses, unusual uses, remote associations, etc.), which judge creativity based on uncommonness.[25] Other researchers have found that stress increases intrusive (involuntary) and repetitive thoughts, based on self-report.[26] Thus, yoga may increase creativity by reducing intrusive, repetitive thought and by fueling divergent thinking.

This study explores the impacts of yoga by analyzing how practitioners feel before and after yoga. Stress seriously alters thought processes by unbalancing hormones and disrupting normal brain activity. Yoga may reverse these destructive psychological changes and produce a range of benefits to mental health. This study investigates three potential effects: on mood, sense of self, and creativity. We hypothesize that linguistic measures of positivity, agency, and creativity will increase after yoga based on relevant stress reduction literature.

**Methods**

While previous research has mainly relied on questionnaires, this study proposes new methods in order to analyze a unique data set: 2816 words collected before and after yoga classes at UCLA by the way of free association. Participants were given surveys with the following prompt: “Free associate three words that describe your current condition.” They were verbally instructed to write down three words describing how they felt at the beginning and end of the yoga practice [Appendix]. Approximately 500 anonymous UCLA students contributed about six words each. The students were generally between 18 and 22 years old, predominately female with little to intermediate yoga experience. The classes were taught in a range of environments: outdoors and inside, on campus, and in the dormitories, with and without yoga mats. The surveys were collected by teachers employed by UCLA Recreation, who taught all-level, vinyasa-based, 1-h classes over the course of 2 years (from January 2016 to March 2018). These words are analyzed as linguistic proxies for psychological change. Quantifiers were consolidated based on concept (e.g., happier becomes happy). Multiword responses were preserved by averaging the scores of each individual term.

Positivity, agency, and creativity are unavoidably subjective concepts and difficult to operationalize. Our methods were constrained by the technical tools available for analyzing lexical characteristics. Positivity is based on SentiWords1.0’s Sentiment Dictionary, which derives the polarity of lexica out of context, rather than relying on preset psychological mood surveys.[27] Agency is based on grammatical category, as opposed to behavioral measures, because a recent study has found evidence that verbs are linguistic markers of agency.[28] Thus, verbs are scored as the most agentful part of speech, followed by active participles, passive participles, adverbs, adjective, and nouns based on the numerical assignments [Table 1]. Finally, creativity is measured by words’ relative frequency within each dataset (before and after yoga practice). The resulting values were adjusted on a logarithmic scale to increase the distribution based on “power law” characteristics, a common approach to quantifying social phenomenon.[29]

This dataset and its related methodology are novel in the field of yoga research. To our knowledge, no studies have

| Part of speech                  | Score |
|--------------------------------|-------|
| Verb                           | 1     |
| Active participle (verbal adjective) | 0.75  |
| Passive participle (verbal adjective) | 0.25  |
| Adverb                         | 0     |
| Adjective                      | −0.5  |
| Noun                           | −1    |
used free association data to analyze the effects of yoga. One natural caveat in this study is that although word choice may reflect mental states, the process of pondering and then writing words may also alter one’s perceived experience.[30] The effects of yoga also may not be fully accessible through self-reflection. Despite these concerns, this type of self-report method is common in modern psychology, which regularly uses introspective responses from questionnaires and diaries to assess mental states. In fact, free association is arguably better than other evaluative strategies since it avoids the danger of leading questions and offers a relatively direct and immediate route to conceptual networks. We also argue that studying the perceived effects of the practice offers valuable insight into how people transform their mental frameworks and understand their own wellness.

Results

A total of 2816 words were taken from FF surveys and analyzed in this study. The before dataset contains 1406 words, including 283 unique words. The most common terms are “stressed” and “tired.” The after dataset contains 1410 words with 263 unique terms, the most common of which are “calm,” “happy,” and “relaxed” [Figure 1].

Two-sample unpaired t-tests of unequal variance reveal that there is a statistically significant difference between participants’ lexical choices before and after yoga class in terms of positivity and agency, but not creativity [Table 2]. These results suggest that yoga induces a shift toward more positive and less agentful sentiments, while creativity is unaffected.

Discussion

The yoga interventions offered by FF were expected to improve mood, increase agency, and enhance creativity based on previous research. The proposed mechanism for inducing these psychological effects was stress reduction. An analysis of word choice revealed a significant and positive shift in sentiment after practice, supporting the hypothesis that yoga improves mood by decreasing negative thought processes. This finding remains the most robust based on our dataset and is supported by the current yoga literature. This free association task offers particularly detailed insights into the language of self-improvement used by yoga practitioners. Responses clumped around a few specific terms in both the before and after datasets, suggesting a fairly uniform transformation in emotional states from “stressed” and “tired” to “calm,” “happy,” and

| Table 2: Statistical analysis of the before and after datasets |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----|-----|
|                                | Before: Average | Before: SD      | After: Average  | After: SD       | t   | P   |
| Positivity                     | −0.052          | 0.423           | 0.389           | 0.334           | 30.765 | <0.0001 |
| Agency                         | −0.173          | 0.431           | −0.207          | 0.415           | 2.165 | 0.0305 |
| Creativity                     | 0.148           | 0.675           | 0.137           | 0.664           | 0.4232 | 0.6722 |

SD=Standard deviation
“relaxed.” This shift is likely supported by placebo and concrete processes, created by yoga’s reputation for stress relief and its biological effects.

A significant change was also observed toward less agentful word choices. This finding is contrary to expectation, as early behavioral research suggests that yoga may increase agency by reducing stress. This result could reflect an error in operationalization, or it could demonstrate a novel psychological impact of yoga that can be captured by unconscious grammatical choices. In our opinion, this decrease in agency may reflect an increase in a productive form of passivity, known as contentment (santosha). Santosha is a key spiritual concept in yogic philosophy, which refers to the ability to accept oneself and the world as it is. Instead of generating more agentful psychology based on perceptions of control, yoga may instead produce a transformation in framing: from victimhood to acceptance. This nuanced shift may result in more passive grammatical constructions, which actually reflect a deeper change in mental state. Further investigation is required into the intricacies of agency and passivity to understand the effect of yoga on mental health.

Finally, no significant difference was found in creativity between the before and after groups. Yoga may still affect creativity, but its impact may only be visible over longer periods of time. The format of this free association exercise may also undermine the visibility of creative responses, given that each participant only wrote down six words total. The brevity and immediacy of data collection may have reduced the sensitivity of this experiment to creativity measures. We recommend that future studies perform more detailed analyses of yoga’s effects on creativity—specifically with longer responses over longer periods (perhaps in paragraph form).

The two significant variables, positivity and agency, likely interact with each other. Yoga may improve mood by diminishing stress, which in turn decreases the need for agency. Alternatively, yoga may decrease agency by reducing stress, which results in more positive thinking. Although the directionality of this interaction is unclear, such psychological dimensions need not be mutually exclusive; they likely do not function independently and have effects across measures. Future studies should investigate the interactions between these variables.

This study elucidates how people understand their practice and what yoga may do for them. Prevalent scientific literature on yoga mainly focuses on immediate physiological measures: blood pressure, hormone levels, muscular tension, brain waves, and so forth. Previous research suggests that yoga provides mental health relief by reducing stress, which historically accounts support. This study explores the potential secondary impacts created by this de-stressing mechanism: on mood, sense of self, and creativity. Results found an increase in positivity, a decrease in agency, and no change in creativity based on word choice before and after yoga. These findings support previous research on mood improvement, yet challenge early theories regarding yoga’s impact on agency.

Ultimately, this research innovates a new procedure for data collection and measurement of yoga’s impacts through linguistic proxies. Although future studies should develop strategies for examining these psychological phenomena without relying upon self-report data, free association tasks are a way to access positivity and agency, while avoiding the well-documented pitfalls of traditional psychological surveys. This study’s goal is to improve our understanding of yoga as a mental health treatment, to spread information about the potential benefits of yoga, and to support the continued growth of the yoga community.

Acknowledgments

The author would like to thank all those who made this research possible, including the participants of FF for contributing their survey responses, UCLA Recreation for providing the yoga teachers, the Healthy Campus Initiative for funding the FF yoga classes, the Undergraduate Research Fellowship Program for supporting my research initiative, David MacFadyen, for editing every draft, and Wesley Boyd for consulting on the visualization of the data.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Pascoe MC, Bauer IE. A systematic review of randomised control trials on the effects of yoga on stress measures and mood. J Psychiatr Res 2015;68:270-82.
2. Vadiraja HS, Raghavendra RM, Nagarathna R, Nagendra HR, Rekha M, Vanitha N, et al. Effects of a yoga program on cortisol rhythm and mood states in early breast cancer patients undergoing adjuvant radiotherapy: A randomized controlled trial. Integr Cancer Ther 2009;8:37-46.
3. Woodyard C. Exploring the therapeutic effects of yoga and its ability to increase quality of life. Int J Yoga 2011;4:49-54.
4. Büssing A, Michalsen A, Khalsa SB, Telles S, Sherman KJ. Effects of yoga on mental and physical health: A short summary of reviews. Evid Based Complement Alternat Med 2012;2012:165410.
5. Streeter CC, Gerbarg PL, Saper RB, Ciraulo DA, Brown RP. Effects of yoga on the autonomic nervous system, gamma-aminobutyric-acid, and allostasis in epilepsy, depression, and post-traumatic stress disorder. Med Hypotheses 2012;78:571-9.
6. Isovich E, Mijnster MJ, Flügge G, Fuchs E. Chronic psychosocial stress reduces the density of dopamine transporters. Eur J Neurosci 2000;12:1071-8.
7. Tafet GE, Idogaya-Vargas VP, Abulafia DP, Calandria JM,
Roffman SS, Chiovetta A, et al. Correlation between cortisol level and serotonin uptake in patients with chronic stress and depression. Cogn Affect Behav Neurosci 2001;1:388-93.
8. Schneiderman N, Ironson G, Siegel SD. Stress and health: Psychological, behavioral, and biological determinants. Annu Rev Clin Psychol 2005;1:607-28.
9. Harkess KN, Delfabro P, Mortimer J, Hansaffoer Z, Cohen-Woods S. Brief report on the psychophysiological effects of a yoga intervention for chronic stress. Hogrefe J Psychophysiol 2016;31:33-48. Available from: http://www.econtent.hogrefe.com/doi/abs/10.1027/0269-8803/a000169.
10. Streeter CC, Whitfield TH, Owen L, Rein T, Karri SK, Yakhkind A, et al. Effects of yoga versus walking on mood, anxiety, and brain GABA levels: A randomized controlled MRS study. J Altern Complement Med 2010;16:1145-52.
11. Shapiro D, Cook IA, Davydov DM, Ottaviani C, Leuchter AF, Abrams M, et al. Yoga as a complementary treatment of depression: Effects of traits and moods on treatment outcome. Evid Based Complement Alternat Med 2007;4:493-502.
12. Berger B, Owen D. Stress reduction and mood enhancement in four exercise modes: Swimming, body conditioning, hatha yoga, and fencing. Rese Q Exere Sport 1988;59:148-59.
13. Oken BS, Zajdel D, Kishiyama S, Flegal K, Dehen C, Haas M, et al. Randomized, controlled, six-month trial of yoga in healthy seniors: Effects on cognition and quality of life. Altern Ther Health Med 2006;12:40-7.
14. Watson D, Clark LA, Tellegen A. Development and validation of brief measures of positive and negative affect: The PANAS scales. J Pers Soc Psychol 1988;54:1063-70.
15. Moore JW. What is the sense of agency and why does it matter? Front Psychol 2016;7:1272.
16. Ghosh S, Laxmi TR, Chattarji S. Functional connectivity from the amygdala to the hippocampus grows stronger after stress. J Neurosci 2013;33:7234-44.
17. Kirschbaum C, Wolf OT, May M, Wippich W, Helliger DH. Stress- and treatment-induced elevations of cortisol levels associated with impaired declarative memory in healthy adults. Life Sci 1996;58:1475-83.
18. Stoliker BE. Victimization, Stress, and Psychological Well-being: An Analysis of the 2009 Canadian Victimization Survey. Electronic Thesis and Dissertation Repository 3660; 2010. Available from: https://www.ir.lib.uwo.ca/etd/3660. [Last accessed on 2018 May 02].
19. Gwiazdziński P, Fedy O, Krawczyk M, Szymański M. Practicing hatha-yoga, sense of coherence and sense of agency. Neurophenomenological approach. Psychiatr Danub 2017;29:530-5.
20. Schaefer M, Heinze HJ, Galazky I. Alien hand syndrome: Neural correlates of movements without conscious will. PLoS One 2010;5:e15010.
21. Gallagher II. Philosophical conceptions of the self: Implications for cognitive science. Trends Cogn Sci 2000;4:14-21.
22. Danielly Y, Silverthorne C. Psychological benefits of yoga for female inmates. Int J Yoga Therap 2017;1:9-14.
23. Bremner JD. Traumatic stress: Effects on the brain. Dialogues Clin Neurosci 2006;8:445-61.
24. Krop HD, Alegre CE, Williams CD. Effect of induced stress on convergent and divergent thinking. Psychol Rep 1969;24:895-8.
25. Zhu X, Xu Z, Khot T. How creative is your writing? A linguistic creativity measure from computer science and cognitive psychology perspectives. CALC '09 Proceedings of the Workshop on Computation Approaches to Linguistic Creativity. Madison, WI: University of Wisconsin-Madison; 2009. p. 87-93.
26. Horowitz MJ, Becker SS, Moskowitz M, Rashid K. Intrusive thinking in psychiatric patients after stress. Psychol Rep 1972;31:235-8.
27. Gatti L, Guerini M, Turchi M. SentiWords: Deriving a high precision and high coverage lexicon for sentiment analysis. Cornell University Library; 2015.
28. Formanowicz M, Roessel J, Suitner C, Maass A. Verbs as linguistic markers of agency: The social side of grammar. Eur J Soc Psychol 2017;47:566-79.
29. Kumanoto S, Kamihigashi T. Power Laws in Stochastic Processes for Social Phenomenon: An Introductory Review. Front Phys 2018;6. Available from: https://www.frontiersin.org/articles/10.3389/fphy.2018.00020/full. [Last accessed on 2018 Apr 28].
30. Kassam KS, Mendes WB. The effects of measuring emotion: Physiological reactions to emotional situations depend on whether someone is asking. PLoS One 2013;8:e64959.
31. Rego A, Sousa F, Marques C, Pina e Cunha M. Optimism predicting employees’ creativity: The mediating role of positive affect and the positivity ratio. Eur J Work Organ Psychol 2011;2:244-70.

Appendix
Flexible Friday Survey
BEFORE CLASS:
Free associate three words that describe your current condition:
1. ____________________
2. ____________________
3. ____________________

AFTER CLASS:
Free associate three words that describe your current condition:
1. ____________________
2. ____________________
3. ____________________