Ms. Ref. No.: BIOPSY-D-16-00081

Title: Yoga Practice Improves Cognition by Attenuating Stress Levels Biological Psychology

Background: Prolonged activation of the hypothalamus-pituitary-adrenal system is thought to have deleterious effects on brain function. Neuroendocrine studies suggest that brain exposure to higher cortisol concentrations contribute to cognitive deficits as we age. Mind-body techniques such as yoga have shown to improve stress levels by restoring the body's sympathetic-parasympathetic balance. The objective of this study was to determine whether yoga practice moderated the stress response resulting in improved cognitive performance.Methods: Sedentary community dwelling older adults (N=118, Mage=62.02) were randomized to an 8-week yoga intervention or a stretching control group. At baseline and following 8 weeks, all participants completed measures of cognition, self-reported stress and anxiety and provided saliva samples before and after cognitive testing to assess cortisol.Results: Yoga participants showed improved cognitive scores and an attenuated cortisol response compared to their stretching counterparts who showed increased cortisol levels and poor cognitive performance at follow up. The change in cortisol levels as well as self-reported stress and anxiety levels predicted performance on the running span task, n-back working memory and task switching paradigm (<beta>'s=.27 to .38, p's ≤.05 for yoga and <beta>'s=-.37 to -.47, p's ≤.01 for stretching control).Conclusion: Eight weeks of regular yoga practice resulted in improved working memory performance that was mediated by an attenuated response to stress as measured by self-report stress and objective salivary cortisol measurements. This trial offers evidence for non-traditional physical activity interventions such as yoga that may be helpful in restoring HPA balance in older adults, thereby preventing cognitive decline.

Comment: I commend the authors for focusing on the potential and promising effects of yoga on stress and cognition. Yoga is indeed non-invasive, easy to apply and can be easily implemented in clinical and non-clinical settings. Given the sparse literature in this research field additional information about the biological mechanisms underlying the benefits of yoga is urgently needed. Considering the significance of this study, I would highly recommend that the authors provide a more robust rationale for their study, including a better structured outline of the study procedure, and consider or discussing additional/alternative analyses (for instance mediational analyses) in their discussion section. It’s only by conducting this kind of analyses that one could conclude that “working memory was mediated by an attenuated response to stress as measured by self-report stress and objective salivary cortisol measurements”.

Introduction

1. Please provide additional references related to fMRI and EEG findings following yoga interventions, with and without behavioral measures. This would provide evidence of the presence of neural mechanisms underlying the benefits of yoga.
2. If possible, please provide some references linking physiological measures (e.g. heart rate, skin conductance, respiratory activity) and yoga. Stress and mood are strongly related to the autonomic system.
3. Since we talk about stress in this paper some references to yoga interventions in individuals with mood disorders and anxiety could be helpful too to build an argument in support to studying the effects of yoga. The link between mood and yoga could be a potential future direction to be included in the discussion section.
4. There are several types of yoga and meditation techniques are closely related to yoga practice. Did the authors plan to differentiate the benefits of yoga from those of meditation? If so what was the rationale for choosing one type of yoga over another in this study.
5. The authors should discuss the role of age, gender and hormones in the release of endorphins and response to yoga or stretching in general. This would make the introduction/rationale of the study more compelling and robust.
6. Is there any longitudinal data related to the long-terms calming effects of yoga/exercise?
7. Methods: I noticed that there were more females than males in both groups. Was this intentional and/or does it reflect the reality of a gender disparity in yoga classes for instance?
8. Could the authors provide additional information on exclusion/inclusion criteria, specifically in terms of the psychiatric history of the participants? If this was not exclusion criteria could the authors mention how many individuals suffered from mood disorders or anxiety.
9. I would highly recommend that the authors provide a diagram showing the temporal sequence of administration for cognitive tasks and salivary measurements. This could be placed within the “Procedure” section.
10. Could the authors please mention whether the description or general presentation given to participants at the beginning of classes was standardized? Did the instructors mention that yoga/stretching have benefits or encourage people to relax? Did the instructor read/memorize a script to read at the beginning/during each session? How were times/days of sessions selected?
11. Statistics: please mention if distributions, outliers and missing data was checked for all the variables. Since the authors mention that they used an ANCOVA could they please clarify which covariates they included. Could the authors explain why they did not consider including demographic data to the regression models (e.g. IQ)? Also did they consider conducting ordinal regressions using the entire sample and including a group variable coded as 1=yoga, 2=stretching. Did the authors consider conducting mediation analyses to check direct and indirect effects of anxiety and cortisol on cognition? If not, did they consider doing this and could they mention in the discussion which alternative analyses they could have conducted. Could the authors mention what their statistical threshold was, and if multiple comparison correction methods were used?
12. Were cognitive tasks age-appropriate or was there a ceiling effect? I noticed that accuracy was elevated (above 80%). I would address this point in the discussion.
13. Did participants change their exercise and nutritional lifestyle during the yoga/stretching course? Did authors check for health or weight changes? I would discuss this in the discussion too.
14. When presenting the regression results I would recommend that the authors provide R2 (in the table) and mention how independent variables were entered into the analysis (enter, stepwise, forward).

Minor details

1. I am not sure if the use of the word “sedentary’ refers here to individuals reporting low levels of physical activity or is it based on official Physical Activity Guidelines.
2. In the abstract please replace “Mage” with “M age”