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The effect of movement-focused and breath-focused yoga practice on stress parameters and sustained attention: A randomized controlled pilot study

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ABSTRACT

Yoga-based practices (YBP) typically involve a combination of movement sequences, conscious regulation of the breath, and techniques to engage attention. However, little is known about whether effects of YBP result from the synergistic combination of these components, or whether a subset may yield similar effects. In this study we compared the effect of a movement-focused practice and a breath-focused practice on stress parameters (perceived stress and salivary cortisol) and sustained attention (response inhibition) in yoga naïve university students. While participants of both programs showed a reduction in perceived stress and salivary cortisol, only the breath-focused group showed improvements in sustained attention. In addition, improvement in sustained attention was correlated with reduction in perceived stress but not with reduction in salivary cortisol. We discuss these findings in the context of a theoretical framework outlining bottom-up neurophysiological and top-down neurocognitive mechanisms hypothesized to be engaged by YBP.

1. Introduction

1.1. Growing interest in research on yoga-based practices (YBP)

Over the past decades yoga-based practices (YBP) have been sparking continually growing interest within the scientific community, with a rapidly increasing number of studies investigating their effects on physiological, neural, and behavioral measures (Gard, Noggle, Park, Vago, & Wilson, 2014). In fact, in healthy populations YBP have been shown to elicit measurable changes in cardiovascular indices (Papp, Lindfors, Storck, & Wandell, 2013), stress hormones (Rocha et al., 2012), inflammatory markers (Streeter et al., 2007), brain structure (Villemure, Ceko, Cotton, & Bushnell, 2015), brain function (Gard et al., 2015), body awareness (David, Fiori, & Aglioti, 2014), perceived stress (Gard et al., 2012), visual attention (Telles, Nagarathna, & Nagendra, 1995), memory

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(Gothe, Pontifex, Hillman, & McAuley, 2013), and executive functioning (Gard, Taquet et al., 2014). It is less well known, however, which components of YBP are driving these observed effects. YBP typically involve a combination of specific postures or movement sequences, conscious regulation of the breath, and various techniques to promote attention (Schmalzl, Powers, & Henje Blom, 2015), but so far few, if any, studies have directly attempted to deconstruct the role of these different component parts. It therefore remains unclear to which extent physiological, neural, and behavioral changes are driven by the movement, breath or attention components, and whether the effect of these components is additive or synergistic in nature (Payne & Crane-Godreau, 2013).

1.2. The effect of YBP on perceived stress and cortisol in healthy populations

Accumulating experimental and clinical research demonstrates that YBP are effective for stress reduction, and self-report measures of stress and related constructs are frequently used outcome measures to document these effects (Riley & Park, 2015). For example, self-reported perceived stress was assessed alongside other psychological outcome measures in participants of a four months long residential yoga program involving physical postures, breathing practices and meditation. (Gard et al., 2012). Attendees had lower scores on a 10-item version of the Perceived Stress Scale (PSS) (Cohen, Kamarack, & Mermelstein, 1983) compared to a control group of individuals not participating in the program. The results were statistically demonstrated to be mediated by increased levels of mindfulness and self-compassion, and interpreted according to existing theories of how mindfulness affects well-being (Shahar, Britton, Sbarra, Figueredo, & Bootzin, 2011). Similarly, a study with military populations participating in a 6-months Hatha Yoga program (Rocha et al., 2012), exhibited reduced self-reported levels of stress accompanying the reduced physiological stress parameters (i.e. salivary cortisol).

One of the primary stress response mediators in humans is the hypothalamo–pituitary–adrenal (HPA) axis. In short, environmental or psychological events perceived as stressful initiate an HPA axis response provoking a cascade of physiological events that ultimately result in the release of the steroid hormone cortisol from the adrenal gland (Nicolson, 2008). Cortisol is routinely used as a biomarker of stress, and the diurnal pattern of hormone secretion can provide clues about HPA axis regulation (Hellhammer, Wüst, & Kudielka, 2009). In humans, cortisol levels commonly peak shortly after awakening and then progressively decrease throughout the day (Levine, Zagoory-Sharon, Feldman, Lewis, & Weller, 2007). A systematic review of randomized control trials on the effect of YBP on physiological stress parameters provides preliminary evidence to suggest that yoga may efficiently promote HPA axis regulation (Pascoe & Bauer, 2015; Pascoe, Thompson, & Ski, 2017). The results of individual studies specifically targeting healthy individuals, however, are varied. One of the above-mentioned studies (Rocha et al., 2012) compared the effects of 6-months of yoga or physical exercise on salivary cortisol levels in a group of military populations. Participants assigned to the yoga group had significantly lower levels of cortisol at the end of the program, but since the analyses were based on a single sample both pre and post intervention, they need to be interpreted with caution. Another study investigated the effects of an 8-week Hatha Yoga and compassion meditation program on salivary cortisol and self-reported levels of anxiety and depression in familial caregivers of patients with Alzheimer's disease (Danucalov et al., 2013). Compared to a passive control group, the yoga group exhibited a significantly reduced cortisol awakening response (CAR) (a typically observed increase in cortisol during the first 30–40 min after awakening), as well as lower levels of stress, anxiety and depression. Unfortunately, neither of these studies described the yoga protocol in enough detail to inform specific hypotheses about the mechanism that may have driven the physiological changes. As for negative findings, one study conducted pre-post assessments of salivary cortisol and various self-report measures in healthy adults participating in ten classes of either Iyengar Yoga, mindfulness involving body-scan meditation, or "brain wave vibration training" (a type of meditative exercises (Bowden, Gaudry, An, & Gruzelier, 2012). Two saliva samples were taken for each participant within a four-hour window both pre and post intervention. While all three programs yielded improved self-report measures of stress and mindfulness, no effects on salivary cortisol were observed. Another study compared the effects of six months of restorative yoga and stretching classes on salivary cortisol and psychosocial outcome measures (Corey et al., 2014). At the end of the program, CAR as well as bedtime cortisol were more reduced in the stretching group compared to the yoga group. Interestingly, post-hoc analyses revealed that changes in cortisol were correlated with ratings of increased perceived social support, possibly driven by weekly group discussions that were part of the stretching but not the yoga protocol. The authors proposed that incorporating aspects of social support may be a crucial factor in promoting HPA regulation.

Psychological and endocrine stress responses are often assumed to represent indicators of the same construct, and hence generally expected to co-vary (Hellhammer et al., 2009). This hypothesis is corroborated on a neuroanatomical level by close links between the HPA axis and brain structures involved in mediating subjective psychological stress responses, in particular the ventral right prefrontal cortex (RPFC) (Wang et al., 2005). The analysis of psycho-endocrine covariance in studies using a variety of stressors, self-report measures, and populations has, however, yielded largely inconsistent and often negative results (Oswald, Mathena, & Wand, 2004). Substantial variation within theoretical conceptions of what constitutes stress as well as foci underlying commonly used questionnaires, are both likely to contribute to the lack of consistent findings of correlation between neuroendocrine factors and psychological stress responses.

1.3. The effects of YBP on attention healthy in populations

Only a few studies have directly investigated the impact of YBP on attention and executive functioning in healthy populations, but they nonetheless suggest that yoga may be helpful for improving aspects of attentional functioning.

One group evaluated changes in visual attention associated with a ten-day yoga program involving physical postures, breathing exercises, meditation, visual focusing exercises as well as the study of yoga philosophy. By the end of the days, participants had a