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Original article

Immediate effect of yogic visual concentration on cognitive performance

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ABSTRACT

The ancient Indian yoga text, *Hatha Yoga Pradipika*, describes six cleansing techniques. The objective of cleansing techniques is to purify and prepare the body for the practice of yoga postures, breath regulation, and meditation. Yogic visual concentration technique (*trataka*) is one of these techniques. A previous study showed an increase in critical flicker fusion (CFF) following yogic visual concentration (*trataka*).

The present study planned to assess the immediate effect of *trataka* on cognitive performance using the Stroop color–word test.

Performance on the Stroop color–word test was assessed in 30 healthy male volunteers with ages ranging from 18 years to 31 years old (22.57 ± 3.65 years). The participants were tested before and after yogic visual concentration (*trataka*) and during a control session on two separate days.

There was a significant improvement in performance on the Stroop color–word test after *trataka* compared to the control session [repeated measures analysis of variance (RM ANOVA) with Bonferroni adjustment; $p < 0.001$].

Performance on the Stroop color–word test was better after *trataka* compared to the control session suggesting that the *trataka* technique increased the selective attention, cognitive flexibility, and response inhibition.

1. Introduction

Yogic visual concentration (*trataka)* is one of the six cleansing techniques mentioned in the ancient Indian yogic text, *Hata Yoga Pradipika*. The literal meaning of the Sanskrit word *trataka* is "to gaze steadily". Looking intently with an unwavering gaze at a small point until tears are shed is known as *trataka* (*Hata Yoga Pradipika*, Ch:2, V: 31).[1] *Hata Yoga Pradipika* mentions that the practice of *trataka* eradicates all eye diseases, fatigue, and lethargy (*Hata Yoga Pradipika*, Ch:2, V: 32).[1] Although *trataka* is known as a cleansing technique, the final stage of *trataka* induces a meditative mental state.[2] When meditation is practiced over a period of time it improves perception, attention, and cognition.[3] A large number of research studies have shown improvement in attentional task performance following meditation.

The Stroop color–word test is a useful and reliable assessment tool used in psychology.[4,5] It was first described by John Ridley Stroop in 1935. It measures selective attention, cognitive flexibility, and reaction time.[4] A study used Stroop color–word test to examine the differences in various domains of attention between long-term concentrative meditators versus matched controls.[6] Performance on the Stroop test was significantly higher following long-term Vihangam meditation practice suggesting an increase in selective attention, cognitive flexibility, and processing speed.

Recently, a study was conducted to evaluate the immediate effect of *trataka* on critical flicker fusion (CFF).[7] CFF is defined as the frequency at which a flickering stimulus is perceived to be continuous. Thirty healthy volunteers were assessed in two sessions, i.e., a *trataka* and a control session. There was a significant increase in CFF following *trataka*, suggesting changes at the cortical level in the processes that mediates fusion.

However, no studies evaluating the immediate effect of *trataka* on cognitive performance, suggesting that there are changes, exist. Hence, the present study was designed to assess the immediate effect of *trataka* on cognitive performance using the Stroop color–word test.

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2. Materials and methods

2.1. Participants

Thirty male volunteers with ages ranging from 18 years to 31 years old (22.57 ± 3.65 years) were recruited for the study. They were all students of a yoga university in Southern India. Their health status was evaluated by a routine clinical examination and case history. They had normal health and were not taking any medication. The predetermined conditions to exclude participants from the trial were chronic illness, visual deformities, and color blindness. The project was approved by the institution's ethics committee (Swami Vivekananda Yoga Anusandhana Samsthana (a deemed University) Bangalore). The study protocol was explained to the participants and their signed consent was obtained.

2.2. Assessment

The Adult's version of the Stroop color–word test was used to assess the cognitive function of the participants.[8] The test consists of three pages. The first page tests how fast the participant can read the words, the second page tests how fast the participants can name the colors on the page, and on the third page the participants were asked to name the color of the ink the individual words were printed in, ignoring the word itself for each item. The task was administered individually. If the participants made a mistake, they were asked to stop and proceed after correcting the mistake. The participants were given 45 seconds for each page. Detailed instructions were given to the participants before starting the test. A stop-watch was used to record the time taken to complete the task.

2.3. Design

A self-controlled study design was used. Each participant was assessed during two sessions (a *trataka* and a control session) on two separate days. Half of the participants practiced *trataka* on the 1st day and the control session was carried out on 2nd day. The remaining participants reversed the order of the sessions. Participants were alternately allocated to either schedule to prevent the order of the sessions influencing the outcome. The duration of both sessions was 25 minutes. Participants were assessed before and immediately after each session.

2.4. Intervention

2.4.1. Trataka

The participants were given 15 days of training in *trataka*. The theoretical aspects of *trataka* were explained by a qualified yoga teacher on the 1st day. Prerecorded audio instructions for *trataka* were played during the session. *Trataka* practice consists of two distinct stages. The first stage consists of eye exercises, which is a preparatory practice for *trataka*. The eye exercises include eyeball movements in horizontal, vertical, and diagonal directions and circular movements. These were performed with the eyes open, in a well-lit room. This was followed by the practice of palming to relax the eyes. Palming consists of putting slightly cupped palms over the eyes, so that the eyes perceive complete darkness. The first stage lasted for 10 minutes. The second stage was *trataka*, and it was practiced in a dark room. The participants were asked to fix their gaze on the flame of a candle for approximately 2–3 minutes, suppressing the urge to blink as far as possible. Then they were asked to visualize the candle flame in between the eyebrows. This process was repeated for two to three rounds. Finally, the participants were asked to defocus, and the practice ended with silence and prayer. The second stage lasted for 15 minutes. The duration of the whole practice was 25 minutes.

2.4.2. Control session

During the control session, the participants practiced eye exercises for 10 minutes, and then for the next 15 minutes, they sat quietly with their eyes closed without doing any concentration or meditation exercises.

2.5. Data extraction

The Stroop color–word test yields three basic scores, namely: (1) raw word scores; (2) raw color scores; and (3) raw color–word scores. The raw word score is the number of items completed on the word page, the raw color score is the number of items completed on the color page, and the raw color–word score is the number of items completed on the color–word page. The pure interference score is calculated by subtracting the raw color score from the raw color–word score.

2.6. Data analysis

Statistical analysis was carried out using SPSS (IBM Corporation, USA) (Version 19.0). Since the same individuals were assessed in repeat sessions on separate days (i.e., *trataka* and *control*), repeated measures analysis of variance (RM ANOVA) was used. Two-way RM ANOVA was performed using two 'within participants' factors, i.e., Factor 1: sessions; *trataka* and *control* and Factor 2: states; "pre", and "post". This was followed by a *post-hoc* analyses using Bonferroni adjustment to compare pre with post values.

3. Results

The group mean and standard deviation for the scores obtained in the Stroop color–word test are presented in Table 1.

3.1. RM ANOVA

Two-way RM ANOVA showed a significant difference between sessions for: (1) word score $F(1, 29) = 21.57$, $p < 0.001$; and (2) color score $F(1, 29) = 9.65$, $p < 0.01$. There was a significant difference between states for: (1) word score $F(1, 29) = 163.42$, $p < 0.001$; (2) color score $F(1, 29) = 195.30$, $p < 0.001$; and (3) color–word score $F(1, 29) = 435.24$, $p < 0.001$. Also, there was a significant interaction between the session and state for (1 word score $F(1, 29) = 55.69$, $p < 0.001$; (2) color score $F(1, 29) = 29.61$, $p < 0.001$; and (3) color–word score $F(1, 29) = 54.90$, $p < 0.001$.

3.2. Post hoc analyses with Bonferroni adjustment

Post hoc analyses with Bonferroni adjustment was performed and all comparisons were made using the respective "pre" states. There was a significant difference between the "post" session of *trataka* and of the control ($p < 0.001$). There was a significant increase in the word score ($p < 0.001$), color score ($p < 0.001$), and color–word score ($p < 0.001$) after *trataka* compared to before *trataka*. And also, there was a significant increase in the word score ($p < 0.01$), color score ($p < 0.001$), and color–word score ($p < 0.001$) after the control session compared to before. There was no significant difference in the interference score.

4. Discussion

In this study, Stroop color–word test was assessed before and after the practice of *trataka* and control sessions in 30 male volunteers. The