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The Effects of a Yoga Intervention on Cognitive Function in Older Adults

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THE EFFECTS OF A YOGA INTERVENTION ON COGNITIVE FUNCTION IN

OLDER ADULTS

by

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ABSTRACT

The Effects of a Yoga Intervention on Cognitive Function in Older Adults

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Cognitive decline and reduced cognitive function presents a serious risk to the older adult population. As the population of individuals over the age of 65 continues to increase, this presents a need for effective solutions to help people sustain healthy, independent lifestyles. Currently, physical activity is recommended for physical health in older adults and has shown evidence in maintaining cognitive function. In particular, the mind-body practice of yoga is a promising form of physical exercise that shows positive cognitive benefits. While the effects of yoga appear to be promising, the current literature is lacking scientific rigor. This study investigated the effects of a six-week yoga practice on older adults in a standardized response inhibition task called the stop-signal task compared with a sedentary control group that performed six-weeks of computer-based cognitive training exercises. This task provides a precise measure of response inhibition, a key component of cognitive performance. We hypothesized that older adults would show increased cognitive performance as observed through a measure of response inhibition (i.e. stop signal reaction time, or SSRT). Following the 6-week interventions, a two-way mixed model ANOVA revealed no meaningful differences between either group for go reaction time ($F = 0.0292$, $p = 0.868$) or SSRT ($F = 0.0901$, $p = 0.77$). There was, however, was a trend toward improvement with the SSRT following both interventions ($F = 3.467$, $p = 0.092$). The overall trend toward improvement in SSRT for both groups could possibly support both yoga and computer-based cognitive training (such as Lumosity) as viable methods for improving this aspect of cognitive function. However, due to a number of methodological issues, such as recruitment challenges that resulted in a small sample size, further research is required.

PUBLIC ABSTRACT

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Cognitive decline and reduced cognitive function presents a serious risk to the older adult population. As the population of individuals over the age of 65 continues to increase, this presents a need for effective solutions to help people sustain healthy, independent lifestyles. Currently, physical activity is recommended for physical health in older adults and has shown evidence in maintaining cognitive function. In particular, the mind-body practice of yoga is a promising form of low-impact, and accessible exercise that shows positive cognitive benefits. While the effects of yoga appear to be promising, the current literature lacks sufficient scientific rigor. This study investigated the effects of a six-week yoga practice on older adults in a standardized response inhibition task called the stop-signal task compared with a sedentary control group that performed six-weeks of computer-based cognitive training exercises. We hypothesized that older adults would show increased cognitive performance as observed through stop signal reaction time, or SSRT. Following the 6-week interventions, there were no meaningful differences between either group for go reaction time or SSRT time. There was, however, was a trend toward improvement with the SSRT following both interventions. The overall trend toward improvement in SSRT for both groups could possibly support both yoga and computer-based cognitive training (such as Lumosity) as viable methods for improving this aspect of cognitive function, however, due the small sample size, further research is required.

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INTRODUCTION

As the population of older adults over the age of 65 is expected to almost double between 2012 and 2050, age-related health concerns will become more impactful on society (Ortman, Velkoff, & Hogan, 2014). Sustained & healthy cognitive function is a key factor in maintaining vitality and an independent lifestyle as one ages. A decline in cognitive function has been found to correlate with less independence and reduced quality of life (Guralnik & Ferrucci, 2003) and can lead to increased risk of disability and functional limitations (Centers for Disease Control National Center for Health Statistics, 2004). With the increasing burden of cognitive decline as the population grows older, it is even more important to determine effective, yet practical ways to deal with this growing challenge.

Cognitive function encompasses our ability to be independent, to process and learn information, and to control behavior. Cognitive abilities, such as attention, memory, reasoning, and processing speed, have been shown to decline with increased age (Park & Reuter-Lorenz, 2009; Salthouse, 2009; Prull, Gabrieli, & Bunge, 2000). At a higher level, executive functions include multiple components, such as planning, problem-solving, and decision-making, and these abilities allow individuals to learn, understand, and adapt to the world. A key component of executive control is the ability to suppress highly automatic, yet task irrelevant action (Fuster, 2008). This ability, referred to as response inhibition, diminishes with age as shown with both tests of speeded choice-reaction time tests and in standard cognitive assessments, such as the Stroop task (Cohen, 2011). In general, response inhibition allows for controlled, planned, goal-oriented behaviors in a changing environment and has numerous applications in the ability to perform daily living tasks (Kramer et al., 1999; Mirelman et al., 2012). More specifically, response inhibition allows us to respond and change a behavior due to unexpected actions, outcomes, and events in everyday life (Wessel & Aron, 2017). For example, when driving a familiar street, accelerating becomes automatic and well-known. When the car is cut off by another driver, however, one must respond quickly by pressing on the brakes to avoid an accident. The key to appropriate action in such an instance is the ability to quickly stop and/or revise ongoing activity, which is to say that response inhibition provides us the means for behavioral flexibility.

Due to the importance and application to everyday life, response inhibition has been extensively researched using a variety of methods. One of the increasingly popular and powerful methods for examining the capacity to stop unwanted behavior is called the Stop Signal Task (SST). This test offers a precise measure of response inhibition called the stop signal reaction time (SSRT), which indicates how quickly someone can inhibit a prepotent response after receiving an imperative stop cue. The elapsed time from the go cue until the stop cue is referred to as the Stop Signal Delay (SSD). Another important measurement in the SST is the go reaction time. This reflects the amount of time that a participant takes to respond to a stimulus. Because the SSRT cannot be observed directly, the stop signal process can be thought of as a race between the go response and the inhibition process (Logan & Cowan, 1984). If the go response is processed before the response is inhibited, the participant responds to the stimulus. If the inhibitory process finishes first, the response is inhibited. Based on this model, the probability of responding depends on the SSD, go reaction time, and SSRT (Figure 1). A faster SSRT represents a better cognitive performance in terms of response inhibition, whereas a slower SSRT represents reduced ability to inhibit a response (Verbruggen & Logan, 2009). Measuring stopping ability with SSRT has many behavioral correlates, including a consistent relationship with many social/cognitive disorders. Attention deficit/hyperactivity disorder (ADHD), impulsivity, obsessive compulsive disorder, and substance abuse have been linked to deficits in response inhibition and slower SSRT (Dimoska et al., 2003, Logan et al., 1997, Schachar, et al., 1995, Willcutt et al., 2005).

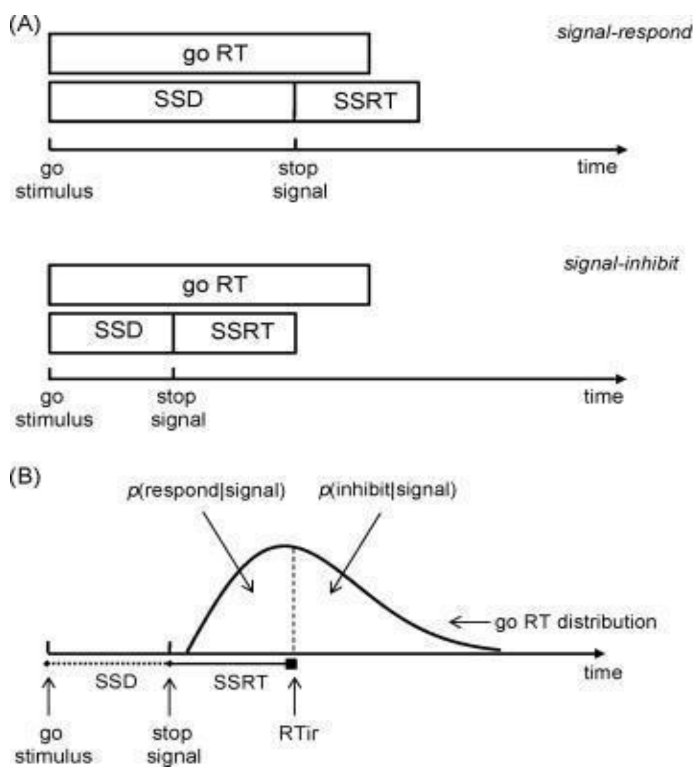

Figure 1: Visual depiction of the horse-race model & explanation of the assumptions of the probability of responding or inhibiting a behavior (Verbruggen & Logan, 2009).

As the relationship between aging and cognitive impairment becomes more evident, many studies have looked into ways of preventing or slowing cognitive decline. Research into the effects of physical exercise with aging has shown promise. Physical activity, at any level, has been found to positively benefit numerous levels of cognition and significantly protect against cognitive decline (Sofi et al., 2010). In the older adult population, many barriers prevent individuals from engaging in physical activity such as physical limitations and disability, health concerns, and accessibility.

Yoga is a promising form of physical exercise that has shown positive benefits both physically and cognitively. This mind-body practice has been rapidly growing in popularity around the United States, and it has become a trending area of research to study the effects of yoga on physical health and well-being. In addition to being a means of physical exercise, yoga has grown in popularity as a way to improve emotional state of mind, reduce stress and anxiety, and to improve overall health (Desai, Tailor, & Bhatt, 2015). A recent review evaluated studies comparing yoga with more traditional forms physical exercise, such as walking, running, or bicycling, and stretching. It was suggested that yoga may be as, or more effective than these forms of exercise at improving health outcomes such as heart rate variability (HRV), blood pressure, respiratory rate, and parasympathetic activity (Ross & Thomas, 2016). These results are thought to be accounted for due to the multidimensionality of yoga, including aspects of physical activity, breathing, concentration, and meditation.

With the compelling evidence that physical activity promotes improved cognitive function, research is starting to consider the impact of yoga on cognitive function. While research is still in the beginning stages, there is a lot of promise. Gothe and colleagues observed that an eight-week yoga intervention showed significant improvements in executive function measures of working memory capacity as well as mental set shifting, flexibility efficiency, visuospatial, and perceptual processing compared to a stretching-strengthening control group (Gothe, Kramer, & McAuley, 2014; Gothe et al., 2017). Improvements have also been found in memory tasks, mental balance, attention and concentration, immediate and delayed recall, visual retention, and visual recognition following an eight-week yoga intervention (Chattha, Nagarathna, Padmalatha, & Nagendra, 2008).

As yoga continues to show promising health outcomes for a healthy population, more research is starting to consider the elderly pop ulation. One important factor when considering physical exercise and older adults is finding an exercise intervention that is accessible for all skill levels. Combined with aforementioned benefits, yoga is a safe practice for older adults because it is low-impact, easy to learn, and can be modified for individuals of different ages and abilities (Jeter et al., 2014). Additionally, it requires little space and little or no equipment.

As the proportion of older adults increases, it is critical to find effective ways to slow cognitive decline and to promote brain health. Yoga is a promising intervention because it provides a focus on the mind-body connection, incorporating multiple facets such as exercise, mindfulness, and breathing, combining improvements for both physical and brain health.

Despite the promising effects of yoga, the current literature is still lacking in scientific rigor due to a lack of proper controls, insensitive outcome measures, and very low sample sizes (Field, 2016; Walsh & Shapiro, 2006; Rocha, et al., 2012). As an intervention that may improve cognitive function in older adults using a multifaceted, mind-body approach, yoga warrants further research and scientific analysis. In order to advance the current literature, this study aimed to use sound methodology to measure the effects of yoga on cognition in healthy older adults. By using the SST, a cognitive test that provides a precise measure of response inhibition (SSRT in milliseconds), we measured a specific aspect of executive function (response inhibition) with a high degree of sensitivity to reveal changes in cognitive performance at a behavioral level.

We hypothesized that older adults would show increased cognitive function following a 6-week yoga intervention compared with a sedentary control group. Increased cognitive function would be evident in terms of improved (i.e. faster) SSRT. These findings could offer important insights into adaptations in cognitive capacity following yoga practice.

METHODOLOGY

Participants

Thirteen community dwelling older adults, ages 60+ were recruited for the study. The final sample of the study included twelve individuals after one person dropped out. Participants were recruited through the Cache County Senior Community newsletter, the summer citizens program at Utah State University, local church and community groups, fliers and postings. Participants were excluded if they (a) had a history of neurologic or motor impairment due to illness or injury, (b) had practiced yoga or tai chi in the last year, (c) were unable to stand unassisted for 2 minutes, (d) had serious visual impairments, (e) had uncontrolled high blood pressure, and/or (f) severe hypotension. Prospective participants were screened prior to enrollment in the study using a questionnaire (Adult Health History Form) and an established measure of cognitive function (Montreal Cognitive Assessment, MoCA). For the MoCA, the administrator of the test read the screening instructions to the participant for each of the 11 subsections and the participant provided both written and verbal responses. The test was scored out of a possible 30 points, and participants with a score less than 20 were excluded. Participants had to be able and willing to attend six weeks of group-based yoga classes that required sitting, stretching and breathing exercises (*See Appendix for examples*). Eligible participants who had agreed to participate in the study completed the informed consent prior to testing.

The original sample size was estimated using G-Power software (Beck, 2013). A moderate effect size was used based on similar studies (Gothe, Kramer, & McAuley, 2014; Subramaniam, Davaki, & Salikumar., 2016). Using this moderate effect size of f = .30 a sample size of 24 was determined, however, due to recruitment difficulties, only 12 participants completed this study, which represents a limitation discussed later.

Experimental Design

Participants were randomly assigned into either the *control intervention* or the *yoga intervention* (6 per group) with an attempt to keep gender equal among groups. Pre and post intervention testing was done at the Utah State University Perception-Action laboratory. This study is one part of a bigger intervention study which also included balance ability, and strength testing. Balance ability was assessed on a separate day than cognitive function/strength, with strength testing (~30 minutes) done immediately before cognitive testing. The study timeline consisted of (1) Pre-testing, (2) Intervention (either 6 weeks of yoga practice or control) followed by (3) Post-testing.

Yoga Intervention:

Participants in the yoga group attended a six-week yoga intervention. Group classes lasted one hour and were held twice a week on the main campus of Utah State University. The classes were led by a certified yoga instructor (RYT-200hr). Each class started with 10 minutes of active breath work, followed by 40 minutes of physical poses, and a final 10 minutes of guided meditation/mindfulness. Participants were instructed to listen to their bodies and not go beyond their physical limitations. Chairs, blocks and straps were available as needed, and the instructors demonstrated how to modify poses for those individuals unable to perform a given posture/exercise.

Control group:

Participants in the control group performed six-weeks of computer-based cognitive training exercises. Trainings were conducted using a comprehensive brain fitness training program known as *Lumosity®* which employs a variety of computer games to challenge memory, attention and problem-solving ability. Games that specifically targeted response inhibition were purposely omitted from these training sessions. Participants trained twice per week for approximately one hour on a computer located within the YETC computer lab, supervised by a research assistant. The purpose of this control group was to account for weekly contact time with trainers and to engage individuals in some form of cognitive training without physical activity.

Cognitive Testing: Stop Signal Task (SST)

At the beginning of the cognitive session, each individual was trained on the SST until they were comfortable with the task. The SST used a customized MatLab program (The MathWorks, Natick, MA) and was completed while participants were seated at a desk facing a computer (Figure 2). The participants were presented with instructions on the monitor and trained with the task prior to testing. The SST requires the participant to respond to a repeated "go" stimulus by quickly pressing specific keys on a keyboard in response to left- or right-pointing arrows that appear on the screen. Specifically, participants must press ">" if the arrow points to the right, and "<" if the arrow points to the left. They are to do this as quickly as possible once the arrow appears. The maximum time allotted to press a key after the "go" stimulus is presented is 500 milliseconds. If a key is not pressed within 500 milliseconds, a new trial begins. After several "go" trials (i.e. no inhibitory stimulus is presented), the average reaction time is calculated. Eventually, an inhibitory stop signal is added at the same time, or shortly following the appearance of the arrow. The stop signal is presented as an auditory beep and participants are asked to withhold action and press no key if they hear the sound. It should be noted that the beep is not always present on all the trials. In other words, there are "go" trials (no inhibitory stimulus) mixed in with the "no-go" trials at random. To help automate the behavior of responding to the "go" stimulus, more of the trials are "go" compared to "no-go" at a ratio of 75:25. After the completion of all the trials, data output is given with values such as number of errors, the time delay between the presentation of the "go" stimulus and the "no-go" stimulus (stop signal delay), error type (pushing the wrong key) and graphical feedback of performance. Another important factor about the "no-go" trials is that the inhibitory stimulus (the beep) is delivered at variable time intervals following the presentation of the "go" stimulus. The time interval may be from 0 milliseconds (it appears at the same time as the arrow) to 400 milliseconds. The idea is that the inhibition is more difficult when the inhibitory stimulus is presented after a longer time interval than a shorter one. This helped gauge how well the participant was able to inhibit an incipient response. Participants were instructed that responding quickly and successfully stopping were equally important. The participant did 50 trials for practice (these included 20 with only the "go" stimulus presented and then 30 that are mixed "go" and "no-go" trials) and then 50 additional trials for the actual data collection.

The key outcome variable is the stop signal reaction time (SSRT), a measure for the speed of stopping.

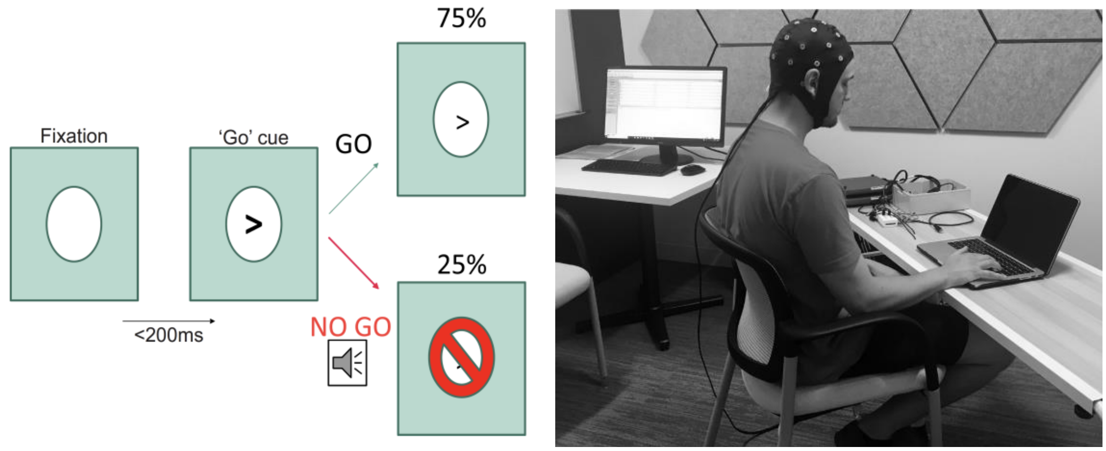

Figure 2: Left: This figure represents the time frame of "go" and "no-go" trials. Right: Depiction of basic EEG method used for the SST facing a computer

Statistical Analysis

A two-way mixed model ANOVA with training condition (yoga versus control) as the between-subjects factor and time (pre-test versus post-test) as the within-subjects factor was conducted on each variable: (a) SSRT, (b) Go reaction time. These two variables provided insight into (a) stopping ability (response inhibition) and (b) processing speed, respectively.

RESULTS

Thirteen community dwelling older adults, ages 60+ were recruited for the study. Twelve individuals were included in the final sample for this study after one participant dropped out (six per group). The average age for participants was 74.6 (+/-4.7) years old. During the preliminary testing, MOCA scores were collected for screening purposes. No participants were excluded for a low MOCA score (i.e. <20). The MOCA information provided useful data to see how the groups compared in terms of cognitive function prior to intervention. These results suggest that more participants in the control group started at a slightly higher baseline level. An independent samples t-test showed that there were no significant differences, however, the control group trended toward higher MOCA scores (Figure 3; $t = 1.52$, $df = 10.0$, $p = 0.158$, $SE = 1.31$).

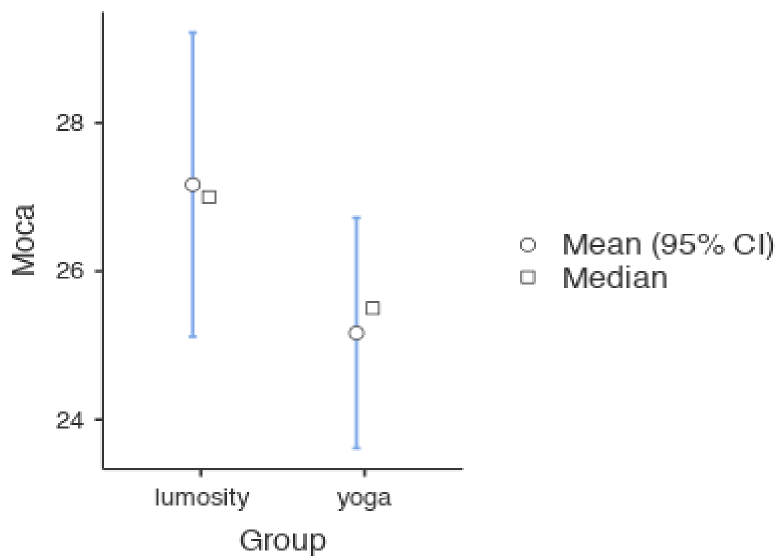

Figure 3: Plotted MOCA scores for Lumosity and yoga group.

For the standard stop signal task (SST), proper task performance is defined as falling within 40-60% successful inhibition. Falling within this range offers support for the SST tracking algorithm, which adjusts task difficulty to match individual performance with an aim of reaching 50% successful inhibition. During the pre-test, the group average was 42.12% successful inhibition (Table 1). For reasons outlined in the Discussion section, we used a more challenging version of the SST, making it more difficult for participants to meet the ideal performance range for successful stopping. During the pre-test, there were 3 participants who did not comply with 40-60% successful inhibition. One participant specifically did not successfully stop throughout the task on any trial (i.e. 0% success with stopping when cued). The average group reaction time for the pretest was 561.1 ms.

Following the 6-week interventions, the median go reaction time was 559.3 ms ($SE = 25.0$) and the average stop signal reaction time (SSRT) was 174.8 ms ($SE = 25.9$). During the post-test, the group average was at 47.01% successful inhibition (Table 2). A two-way mixed model ANOVA revealed no meaningful differences between either group for go reaction time ($F = 0.0292, p = 0.868$, $\eta^2 = 0.002$) or SSRT ($F = 0.0901, p = 0.77$, $\eta^2 = 0.006$). Both groups collapsed trended toward improved response inhibition with a better ability to successfully stop following the interventions (see Figure 4), however, this main effect of time was not significant ($F = 3.467, p = 0.092$).

Following the 6-week intervention, 2 participants did not comply with 40-60% successful inhibition (versus 3 in pre-testing), and the participant who was unable to successfully stop during the pretest was able to demonstrate an ability to inhibit during post-testing (although still below 40%).

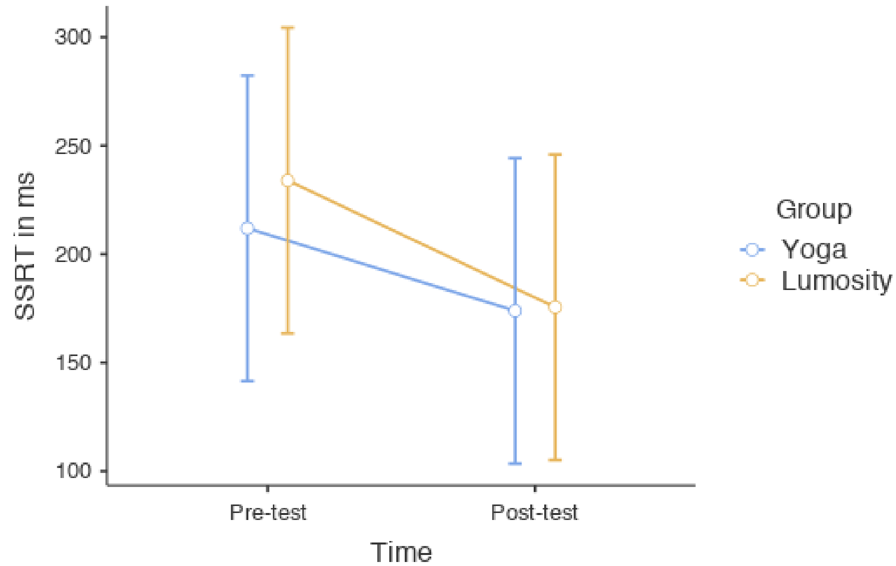

Figure 4: SSRT between groups for pre-test and post-test. Error bars: 95% CI

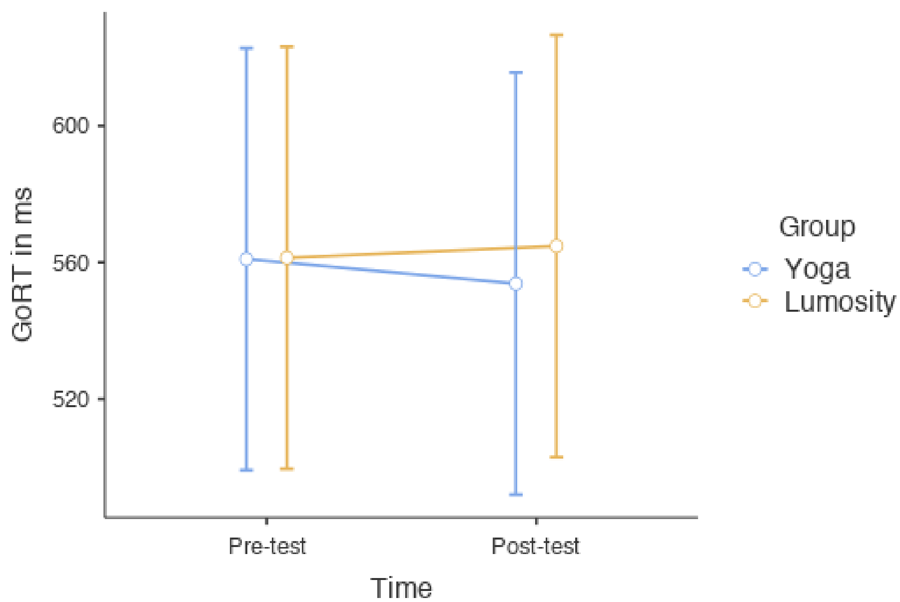

Figure 5: Go reaction time between groups for pre-test and post-test. Error bars:95% CI.

Table 1: Pretest scores for median go reaction time, stop signal delay, stop signal reaction time, and % inhibition. Note: For the standard SST proper task, successful performance is defined as falling within 40-60% successful inhibition. Those instances where success falls below that range, indicating poor task compliance, are marked with an asterisk. X% inhibition refers to the individual's average % inhibition.

Group	Median Go Reaction Time (at x% inhibition)	Stop Signal Delay	Stop Signal Reaction Time (at x% inhibition)	% Inhibition
Control	545.1	362.0	183.1	45.3
Control	585.8	335.5	250.4	50.0
Control	631.9	246.4	385.5	39.9*
Control	582.2	485.5	96.7	51.6
Control	523.5	387.8	135.7	48.4
Control	499.5	146.8	352.7	0*
Yoga	538.9	266.4	272.5	43.0
Yoga	521.2	408.1	113.1	49.2
Yoga	509.1	175.7	333.4	29.7*
Yoga	653.7	491.0	162.8	52.3
Yoga	569.0	338.2	230.8	43.8
Yoga	573.8	414.4	159.4	52.3
Average:	561.1	338.1	223.0	42.1

Table 2: Posttest scores for median go reaction time, stop signal delay, stop signal reaction time, and % inhibition.

Group	Median Go Reaction Time (at x% inhibition)	Stop Signal Delay	Stop Signal Reaction Time (at x% inhibition)	% Inhibition
Control	569.9	423.8	146.2	52.3
Control	542.4	315.9	226.5	49.2
Control	613.1	421.4	191.7	51.56
Control	720.0	631.6	88.4	59.4
Control	483.0	331.2	149.9	45.3
Control	460.3	209.3	251.0	32.1*
Yoga	513.7	338.6	175.2	48.5
Yoga	454.4	193.7	260.7	29.7*
Yoga	579.5	371.0	208.4	48.5
Yoga	483.0	331.2	149.9	45.3
Yoga	632.1	508.1	123.9	51.6
Yoga	660.1	534.7	125.4	50.8
Average:	559.3	384.5	174.7	47.0

DISCUSSION

This study examined the effects of a 6-week yoga intervention on cognitive functioning by measuring stop signal reaction time (SSRT), which measures response inhibition. While there were no significant differences, following the 6-week intervention, both the yoga and cognitive training groups collapsed showed a trend toward SSRT improvement between the pre-test and post-test. That is, both groups tended towards a quicker (lower) SSRT post-training. Neither training groups had any significant change in go reaction time, which possibly suggests training effects were specific to response inhibition versus central processing speed more generally.

This study used a precise, quantitative measure of a specific component of executive function – response inhibition - to provide insight into subtle cognitive changes that may arise from yoga practice. The overall trend toward improvement in SSRT for both groups could possibly support both yoga and computer-based cognitive training (such as Lumosity) as viable methods for improving this aspect of cognitive function. If true, such interventions could be used to help older adults reduce cognitive decline and/or maintain cognitive functioning, specifically response inhibition. Such speculation however must be viewed cautiously given the low sample size and high variability in the present study.

Methodological Considerations/Study Limitations

This study had several limitations. First, due to extreme challenges with recruitment, this study has a low power due to a small sample size. Additionally, despite attempts to randomize the yoga and control groups, MOCA scores provide insight about groups being slightly different, indicating more participants in the control group having higher baseline abilities. This suggests that our control group may have started off a higher level of cognitive function. Although not an original consideration for creating comparable groups at baseline, this would be potentially important in any follow-up work.

It is important to note that the aim for the control group was to keep factors such as social contact and training time the same as the yoga group, along with any 'placebo' effect of experiencing some form of intervention. However in our attempt to create a comparable control group we may have inadvertently imposed new challenges. The cognitive control intervention was specifically designed to train cognition, where participants would complete computerized mental training games. The intention of this group was to provide a sedentary form of intervention, while keeping other factors constant, as outlined above. Current literature regarding brain training software shows evidence for improvements in specific games that are played, however, little evidence is seen for generalizability to other tasks or improved cognitive performance (Simons et al., 2016; Hackley, 2011). Despite attempts to avoid exercises that specifically trained response inhibition, some of the training games may have been similar to the actual stop signal task. Additionally, maintaining social contact while playing these computer games in a structured training environment may have enhanced any benefits beyond those normally attained in traditionally isolated computer based cognitive training. While research has shown that stopping performance does not seem to improve with simply retaking the test (Waefer, Baggott, & de Wit, 2013), we are currently conducting a control study to look into the potential role of practice effects. The participants in the yoga intervention, which did not specifically train for cognitive functioning, showed the same trend of improvements with SSRT. If such a finding is upheld in a future higher power study this would lend support to the proposal that that physical activity and mindfulness promotes improved cognitive function. This would be particularly compelling if our upcoming control study fails to show improvement post-test.

Another important limitation in this test involved programming changes to the version of SST used. This version was more difficult for the participants than the original version of the SST and failed to properly accommodate the slower performers by limiting the lower range of the stop signal delay. In other words, this program which normally adjusts task difficulty to match performance levels for each individual, had an artificially high stop signal delay limit that prevented this task from becoming easy enough for those individuals with lower ability. These program revisions were originally made to allow for interaction between our cognitive testing program and the electroencephalographic equipment, with the aim of revealing changes in neural markers underlying response inhibition. Unfortunately, the impact on task difficulty was an unintended consequence of this program adjustment. In the end, technical difficulties forced us to abandon these supplementary measures of brain activity, and focus purely on behavioral performance on this cognitive task.

Lastly, due to the specific measure used in this study to assess response inhibition (SSRT), other executive functions aside from response inhibition may have also improved with either group, but may not have been revealed. For example, previous research has investigated the impact of yoga on improving working memory and attention (Brunner et al., 2017). The combination of dynamic movement tied to breath, as well as mindfulness, work on bringing attention to the present moment. The meditative aspect of yoga may also contribute to enhancements in cognitive functioning, which could be measured by other tests such as those that assess the ability to sustain attention, filter out distractions, and hold items in working memory. Such changes would likely go undetected using the SST.

Future Considerations

The present study, although underpowered, provided a useful platform to build upon in future research. The subtle tendency for both training groups to reveal improved response inhibition was an encouraging result and warrants further investigation. The participants in the yoga intervention, which did not specifically train for cognitive functioning, showed the same trend of improvements with SSRT. If such a finding is upheld in a future higher power study this would lend support to the proposal that that physical activity and mindfulness promotes improved cognitive function.

To build upon our present findings, future research should revert back to an easier version of the stop signal task to encourage successful stop inhibition between 40-60% to more accurately assess response inhibition across the full spectrum of performance levels. Additionally, adding a more comprehensive battery of cognitive tests would allow measurements of other cognitive functions in addition to response inhibition, such as working memory or the ability to sustain attention, and may improve our ability to detect specialized changes in discrete cognitive abilities. We are presently collecting data on a control group which receives no training in order to tease out any test-retest practice effects. We are also conducting a follow up study to collect the more quantitative benefits/outcomes of these interventions using a phone interview to provide a more comprehensive picture of how these interventions may have impacted these participants.

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APPENDIX A: Example Yoga Poses used in Study