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The efficacy of the nootropic supplement Mind Lab Pro on information processing and memory in adults: pseudo randomised, double blind, placebo-controlled studies.

A team based in Biomedical Sciences at the University of Leeds have conducted a series of studies on the efficacy of the nootropic supplement Mind Lab Pro. These studies have examined the impact of taking Mind Lab Pro on information processing and memory. In addition, we have also examined the impact of taking Mind Lab Pro over an extended period and then monitored performance changes after ceasing to take the supplement for two months.

Across the world, the use of supplements has increased dramatically in the last 20 years (Asher et al., 2017; Wu et al., 2014). In the United States alone, it is reported that 25% of the population take some form of supplement. However, in the United Kingdom this rises to 45 %, making it the largest population of dietary supplement usage worldwide. The growth of the supplement market globally is expected to continue to rise at an annual growth rate of 6% from 2017 to 2025 (Asher et al., 2017). While supplements can be used to correct micronutrient deficiency or maintain an adequate intake, over-the-counter supplements are most often taken by people with no clinical signs or symptoms of deficiency. Interestingly, people who use supplements tend to have a better overall diet quality than those who do not use them and their nutrient intake from foods mostly meets recommended intake levels (Zhang et al., 2020). There is widespread use of supplements at all levels of sport and a prevalence of 60–90 % supplement use is reported among high-performance UK athletes, including juniors under the age of 18 (Maughan et al., 2011).

Much of the recent growth has been in supplements that claim to provide cognitive benefits. These supplements are known as ‘nootropics’. Nootropics are especially popular with 18–30 year olds who are keen to enhance their cognitive function (McCabe et al., 2005; Smith and Farah, 2011). Nootropics are also employed for several clinical populations including Parkinson’s and Alzheimer’s (Goswani et al., 2011). In these studies, we consider the efficacy of taking Mind Lab Pro, a nootropic that contains 11 active ingredients. These ingredients have been well researched in terms of the impact they have on cognitive functions such as attention, multi-tasking and focus. For example, Mind Lab Pro contains 250 mg of *Citicoline* which has been found to improve memory and attention by activating biosynthesis in the neural membranes and increasing specific hormone levels in the central nervous system to protect cell membranes (Nakazaki et al., 2021; McGlade et al., 2012; Gareri et al., 2015). *Bacopa Monnieri* has been found to increase dendritic branching and pruning, which in turn can lead to improved cognitive function (Gareri et al., 2015), specifically in older patients. However, it has also been seen to help Alzheimer patients and improve memory, focus and attention in the elderly (Calabrese et al., 2008; Goswani et al., 2011; Sadhu et al., 2014). Another study noted improvements in attention and memory in healthy medical students from taking 150mg of *Bacopa Monnieri* for six weeks (Kumar et al., 2016). Other ingredients in Mind Lab Pro such as *Lion's Mane Mushroom*, *Tyrosine* and *Phosphatidylserine* has also been found to improve memory and attention in a variety of contexts for a range of healthy and unhealthy populations (Saitsu et al., 2019; Thomas et al., 1999, Tabassum et al., 2011 and Steenbergen et al., 2015). *Phosphatidylserine* has also been found to improve memory in individuals reporting to have memory issues and research states that it supports human cognitive functions, including the formation of short-term memory, the consolidation of long-term memory and the ability to create new memories (Glade and Smith., 2015; Kato-Katooka., et al 2010). Reductions in fatigue and stress have also been found in studies looking at the impact of taking *Rhodiola Rosea* in healthy populations (Darbinyan et al., 2000 and Cropley et al., 2015) as well as cognitive improvements in adults with physical and cognitive difficulties (Fintelmann and Gruenwald., 2007). Studies on *L- Theanine* (Hidese et al., 2019), *Maritime pine bark extract* (Belcaro et al., 2014), and *N-Acetyl* (Lewis et al., 2021) also report improvement in cognitive functions in healthy adults. Vitamins such as B6, B9 and B12 support multiple functions within the central nervous system which may help to maintain brain health, intellectual performance and cognitive functioning (Moore et al., 2012; Martinez et al., 2018). It has been shown that vitamin B6 supports many important brain functions such as biosynthesis of neurotransmitters, receptor binding, macronutrient metabolism and gene expression (Zhang et al., 2020). Lower vitamin B6, B9 and B12 levels have also been associated with increased rates of cognitive decline (Rutjes et al., 2018; Wang et al., 2022). The use of B vitamins is clearly an important means of maintaining cognitive function and this is especially true for healthy individuals (Markun et al., 2021). Mind Lab

Pro therefore clearly contains a range of ingredients that research indicates could benefit cognitive function and enhance memory in a variety of ways

Research Team

- Dr Andrea Utley is a Reader in motor control, learning and development who leads the human performance initiative at the University of Leeds. Human performance at Leeds explores how age, diet, lifestyle, technology and other factors influence performance in a variety of contexts. Dr Utley is especially interested in how we control complex movements in diverse contexts and how we can develop, learn and enhance skilled performance.

- Dr Yadira Gonzalez is a food scientist with a research focus on understanding the role of oral processing in the perception of food texture and the development of measurement methods (physical and physiological) capable of predicting mouth-feel attributes. Yadira gained her PhD at the University of Leeds and then worked as research assistant in the School of Food Science before moving to Marlow foods to investigate texture and formulation of confectionery products.

- Ms Carlie Abbott –Imboden gained her MRes at the University of Leeds and now works as a research assistant at the University of Leeds within human performance. Her research interests include neurological rehabilitation with the emphasis on neural pathways in relation to exercise.

- Dr Camilla Nykjaer is a Nutritional Epidemiologist with experience in the areas of epidemiology, nutrition and public health. She has worked in nutritional epidemiology for seven years and her previous research has included work on a Food Standard Agency commissioned systematic literature review on the effects of dietary carbohydrates on cardio metabolic health. Camilla is also experienced in statistical analysis and data handling.

Study 1- The efficacy of the nootropic supplement Mind Lab Pro on information processing in adults

Participants

A total of 105 healthy individuals completed the study with 61 in the experimental group and 44 in the control group. Participants were also asked to complete the healthy eating index (HEI) which is a scoring metric that can be used to determine overall diet quality (Reedy et al., 2018). The experimental group had a mean score of 63.2 with a standard deviation of 9.0 and the control group had a mean score of 65 with a standard deviation of 2.5. In terms of age, participants in the experimental group over the age of 30 had a mean score of 71.25 with a standard deviation of 6.5 and participants under the age of 30 had a mean score of 56.8 with a standard deviation of 4.34. The higher the score the healthier the diet.

Task

The first task was a simple reaction time task (SRT), where participants had to respond to one stimulus (a light) and produce a discrete response once the stimulus was presented. Participants knew in advance which light would be illuminated and were instructed to move their finger as quickly as possible from point A to B (see Figure 1) when the light above point B was illuminated. The second task was a choice reaction task (CRT) where participants had to respond to a stimulus with eight alternatives (see Figure 1). For CRT they therefore had to respond to one of eight lights and move from point A to the illuminated light (one of eight) and press the sensor below it. In both SRT and CRT, the time taken from the stimulus having been illuminated to the first initial movement was recorded in milliseconds (ms).

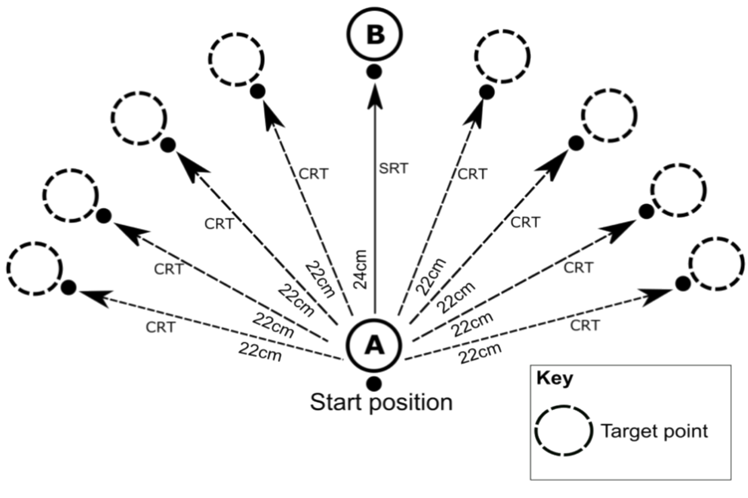

Figure 1- Reaction timer used to measure SRT and CRT. Participants would start with their figure on position **A**, and a light would illuminate which they had to respond to as quickly as possible by tapping the respective sensor by the illuminated light. SRT would just be light **B**, however CRT would be any one of the 8 lights. Measurements in ms. Made by Lafayette instruments.

The final task was an anticipation task using a Bassin timer (see Figure 2) to measure anticipation response in seconds (s). Participants were instructed to watch a light as it travels down a runway. They had to anticipate the light reaching the target (finish) and press a button to coincide with the arrival of the light at the target. For the anticipation task the runway speed was set at 30 miles per hour with a cue delay of two to three seconds (the cue was a warning light; refer to Figure 2, where the black dot represents the warning light which was illuminated before the runway lights came on in sequence). The Reaction Timer and Bassin Timer are produced by Lafayette Instruments and these instruments have been used in numerous studies (Kosinski, and Cummings., 1999; Crocetta et al., 2018).

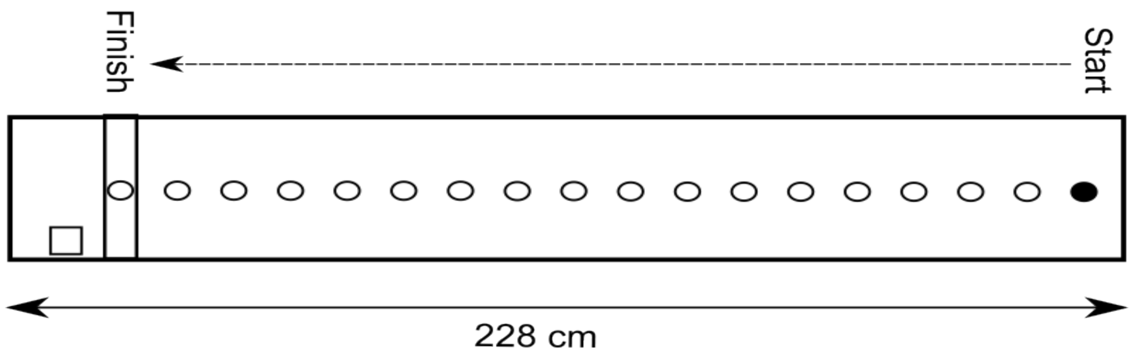

Figure 2. Bassin timer used to measure participants anticipation. Participants were instructed to watch a light as it travels down a runway. They had to anticipate the light reaching the target (finish) and press a button to coincide with the arrival of the light at the designated target.

Results

Results of the study indicated improvement when performing all three tasks for the experimental group taking Mind Lab Pro which was significant $p < 0.05$, compared to those in the control group taking the placebo. Additionally, there was a significant difference in scores between the experimental and control group for all three tasks ($p < 0.05$). The results of the current study therefore suggest that there are benefits to cognitive performance when taking Mind Lab Pro. In this study there has been a significant positive impact on information processing for the experimental group and given the nature of the tasks this would indicate improvements in focus, attention and decision making. It is interesting to note that this has been especially beneficial for those over the age of 30 but still significant for those under the age of 30.

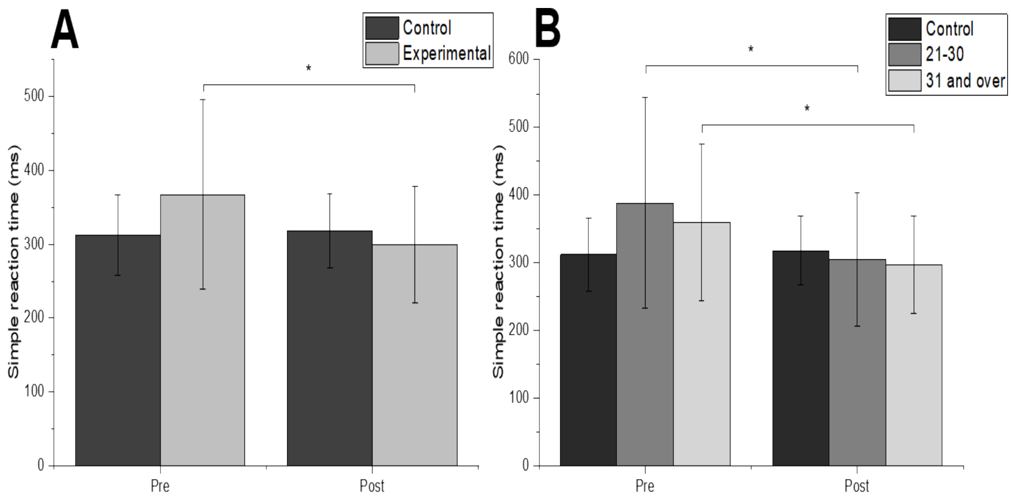

Figure 3- Simple reaction time results from pre and post-test. Results show that the experimental group significantly improved from pre- to post-test ($p < 0.001$), whilst the control group did not improve ($p = 0.616$). Additionally, when subdivided into age categories, both the under 30 and over 30 age group improved from pre- to post- test ($p = 0.015$ and $p < 0.001$).

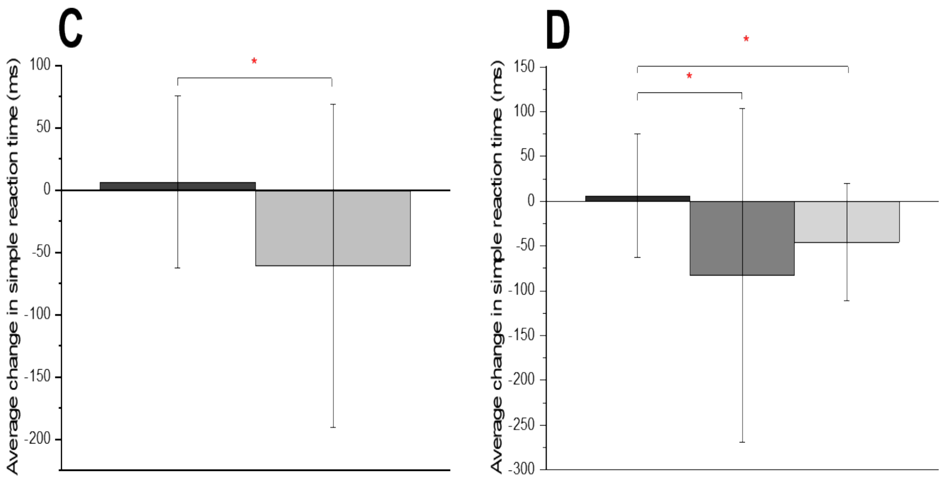

Figure 4- Simple reaction time. The difference between the control and experimental group. Results showed that there was a significant difference between the control and experimental group ($p = 0.002$). When further subdivided based on age, results showed that there was a significant difference between the control and under 30 age group ($p = 0.001$) and the control and over 30 age group ($p < 0.001$).

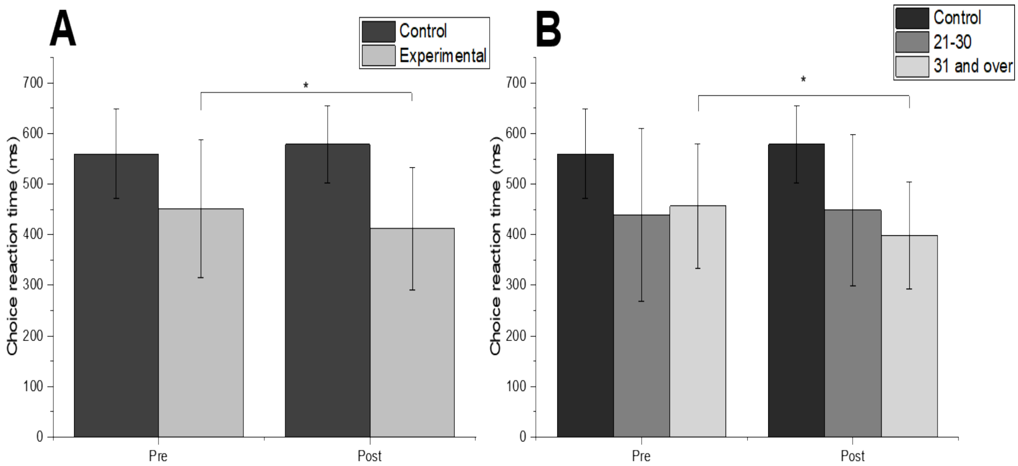

Figure 5- Choice reaction time results from pre- and post-test. Results show that the experimental group significantly improved from pre to post test ($p = 0.007$), whilst the control group did not improve ($p = 0.491$). When subdivided into age categories, the over 30 age group improved from pre- to post- test ($p < 0.001$).

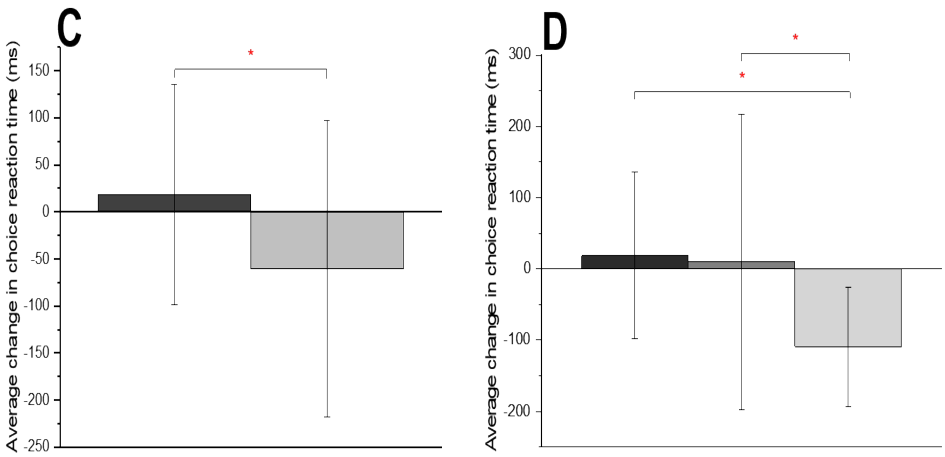

Figure 6- Choice reaction time. The difference between the control and experimental group. Results showed that there was a significant difference between the control and experimental group ($p = 0.002$). When further subdivided based on age, results showed that there was a significant difference between the control and over 30 age group ($p < 0.001$) and the under 30 and over 30 age group ($p < 0.001$) and the control group and under 30 age group ($p = 0.713$).

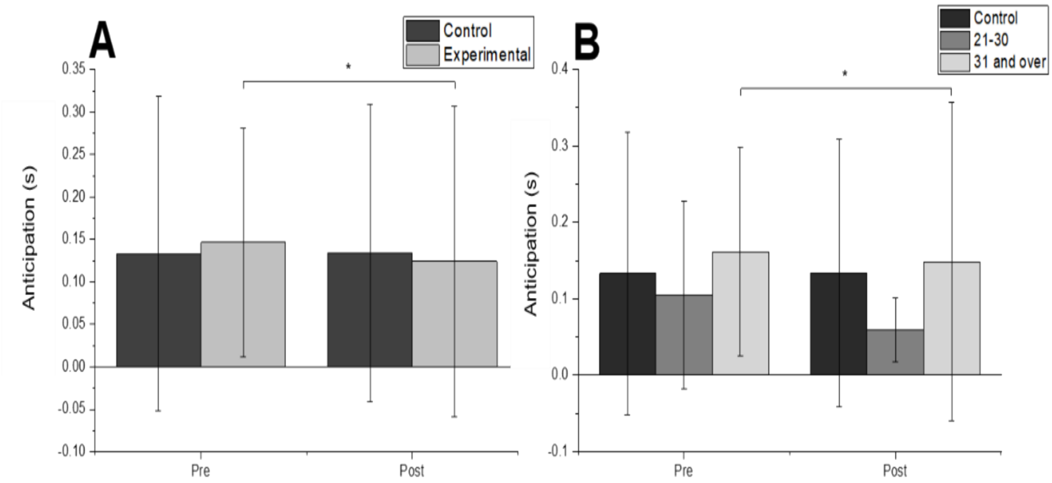

Figure 7- Anticipation results from pre- and post-test. Results show that the experimental group significantly improved from pre- to post- test ($p < 0.001$), whilst the control group did not improve ($p = 0.307$). When subdivided into age categories, the over 30 age group improved from pre- to post- test ($p < 0.011$), but not the 21-30 years old group category ($p = 0.094$).

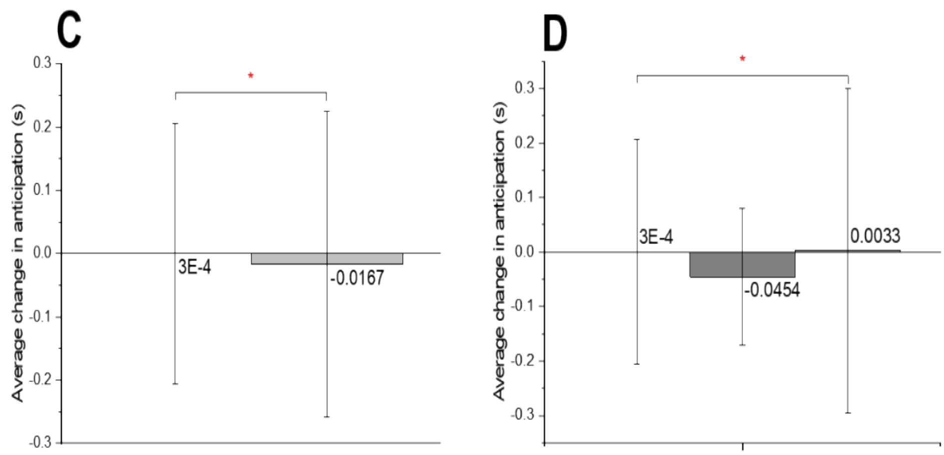

Figure 8- Anticipation scores. The difference between the control and experimental group. Results showed that there was a significant difference between the control and experimental group ($p = 0.001$). When further subdivided based on age, results showed that there was a significant difference between the control and over 30 age group ($p = 0.003$) but not between the control and 21-30 age group, or 21-30 and 30 and above age groups (p

Study 2- The efficacy of the nootropic supplement Mind Lab Pro on memory in adults

In this study we aimed to examine the efficacy of Mind Lab Pro on improving memory in adults by examining their performance on the Weschler Memory Test pre and post one month of taking the supplement compared to a control group who took a placebo.

Participants

A total of 49 healthy individuals completed the study with 36 in the experimental group and 13 in the control group. The experimental group consisted of 36 participants with n=27 females and n=9 males with a mean age of 32.7 years old and an age range from 20 to 68 (SD = 15.8). The control group consisted of n=9 females and n=4 males with age ranging from 20 to 45 ($\bar{x}$ = 27.9 years old, SD = 9.5).

Task

Participant's memory scores were assessed using the Weschler Memory Scale Fourth UK Edition (WSM-IV UK). The WMS-IV UK is a revised version of the WMS (1945) developed by David Wechsler. The battery is designed to clinically measure different forms of human memory (Chlebowski et al, 2011). There are two batteries contained within the WSM-IV UK, one for individuals aged 16-69 and an older battery for individuals aged 65-90. In this study we only used the battery for individuals aged 16-69. The WSM-IV UK contains a total of seven subtests; the first of these, a brief cognitive status exam, was not used in this study as it was not deemed necessary for the participants involved and it is optional. The remaining six subtests are outlined below in the order that they were completed by the participants.

Table 2. Subtests of the Weschler Memory Scale Fourth UK Edition (WSM-IV UK)

Subtest	Explanation
Logical memory	Participants are told two short stories. After each story, they were asked to repeat as much information about the each of the story (Logical memory I). After 20-30 minutes, the participants were asked to recall the stories for the delayed recall aspect (Logical memory II). Both stories were marked out of 25.
Verbal pairs associates:	Participants were read 14-word pairs, some of which made sense, and other which did not. After all pairs were read out, the examinee would read out the first word of each pair, and the participant was to answer with the correct word pair. This was repeated four times, with word pairs read out in different order each time to avoid learning (Verbal pairs associates I). After 20-30 minutes, the examinee would again say the first word of each pair, and the participant had to answer with the correct pair (Verbal pairs associates II).
Visual reproduction:	Participants were shown a design for 10 seconds, and after the time elapsed, the design was hidden and participants were asked to draw the design from memory. A total of five designs were shown to the participant (Visual reproduction I). After 20-30 minutes, participants were asked to draw all five designs from memory (Visual reproduction II). After this, a recognition task was completed, where the participant had to choose the design they saw previously from six similar designs.
Designs	Participants were shown a grid with 4-8 unfamiliar designs for 10 seconds, and then asked to select the correct design from a set of cards and place in a grid in the same place as they previously saw. The participant would get marks for selecting the correct design and for the design to be placed in the correct position.
Spatial addition	Participants were shown sequentially two grids with blue and red circles for five seconds each design. After both designs were shown, the participant was asked to place the certain colours that coincided with the correct positioning of the coloured circles: a blue circle if there was a blue circle shown on only one of the grids, a white circle if a blue circle was shown in the same place on both grids, and to ignore the red circle.
Symbol span	Participants were shown a series of abstract designs that ranged from 1 to 7 long for five seconds, and then asked to select from a selection of designs the

	correct designs in order.

Results

Results are presented for the five index scores with comparisons made pre and post taking Mind Lab Pro and between the experimental and control group. Results showed that there was a significant improvement in all subcategories of memory when taking Mind Lab Pro (AM: $p < 0.001$, VM: $p < 0.001$, VWM: $p = 0.038$, IR: $p < 0.001$, DR: $p < 0.001$), whilst the control group only significantly improved in auditory memory and immediate recall ($p = 0.004$ and $p = 0.014$). pre to post

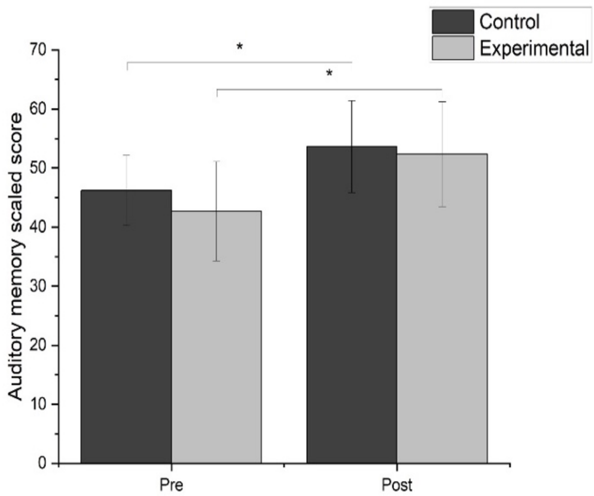

Figure 9- Auditory memory results from pre and post-test. Results show that the experimental group significantly improved from pre- to post-test ($p < 0.001$), and the control group also improved ($p = 0.004$).

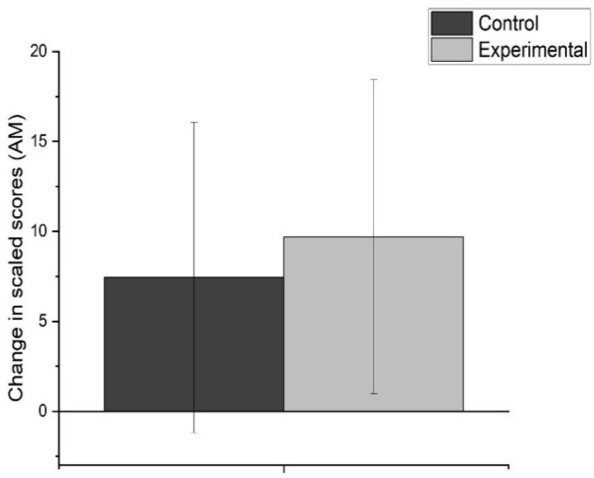

Figure 10- Auditory memory scores. The difference between the control and experimental group. Results showed that there was not a significant difference between the control and experimental group ($p = 0.297$).

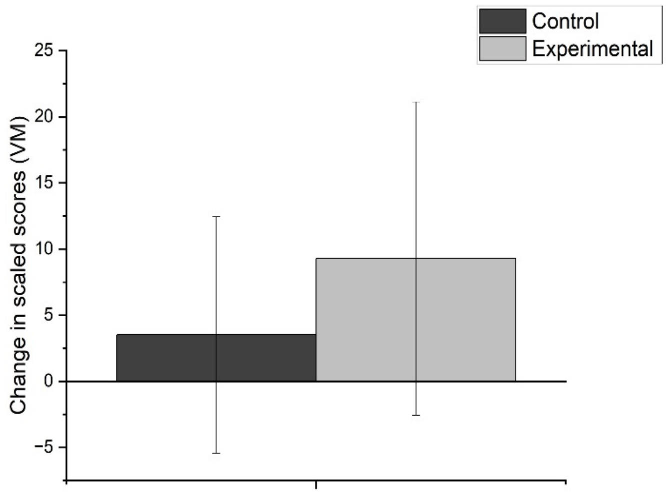

Figure 11- Visual memory results from pre and post-test. Results show that the experimental group significantly improved from pre- to post-test ($p < 0.001$), whilst the control group did not improve ($p = 0.138$).

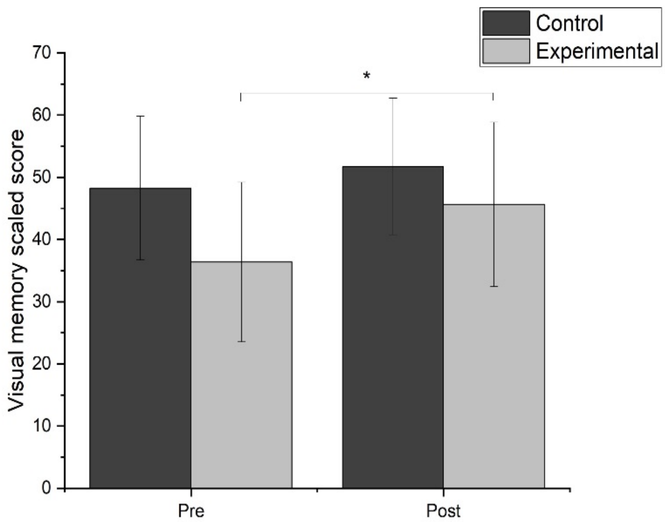

Figure 12- Visual memory scores. The difference between the control and experimental group. Results showed that there was not a significant difference between the control and experimental group ($p = 0.055$).

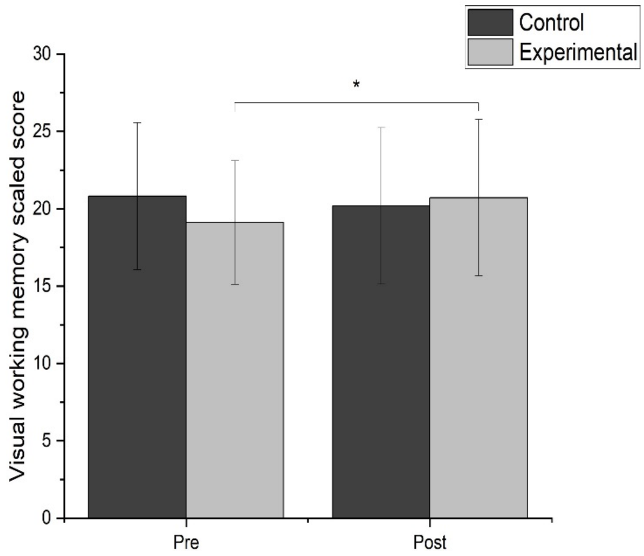

Figure 13- Visual working memory results from pre and post-test. Results show that the experimental group significantly improved from pre- to post-test (p = 0.038), whilst the control group did not improve (p = 0.608).

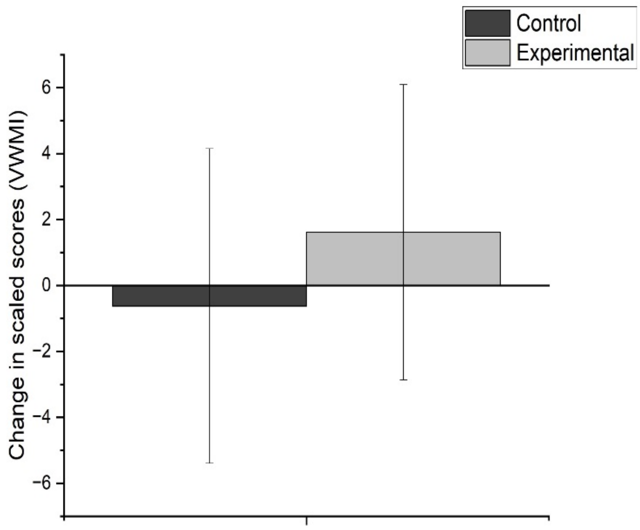

Figure 14- Visual working memory scores. The difference between the control and experimental group. Results showed that there was not a significant difference between the control and experimental group (p = 0.132).

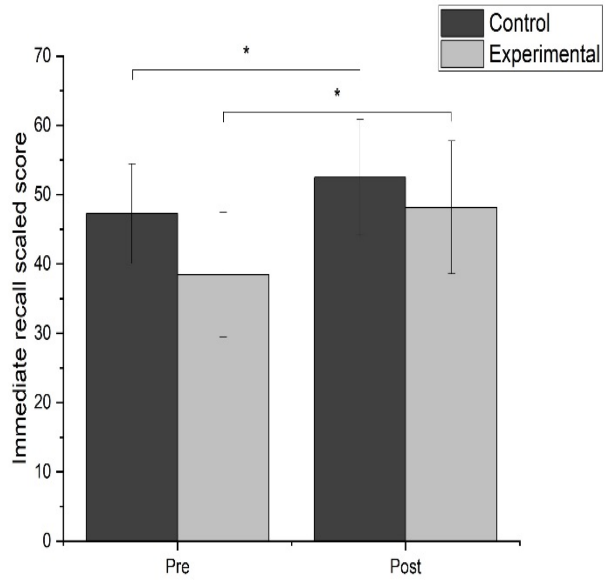

Figure 15- Immediate recall results from pre and post-test. Results show that the experimental group significantly improved from pre- to post-test ($p < 0.001$), and the control group also improved ($p = 0.014$).

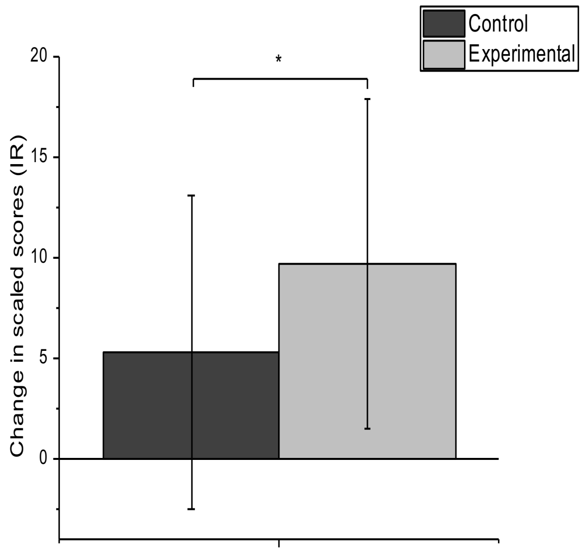

Figure 16- Immediate recall scores. The difference between the control and experimental group. Results showed that there was a significant difference between the control and experimental group ($p = 0.05$).

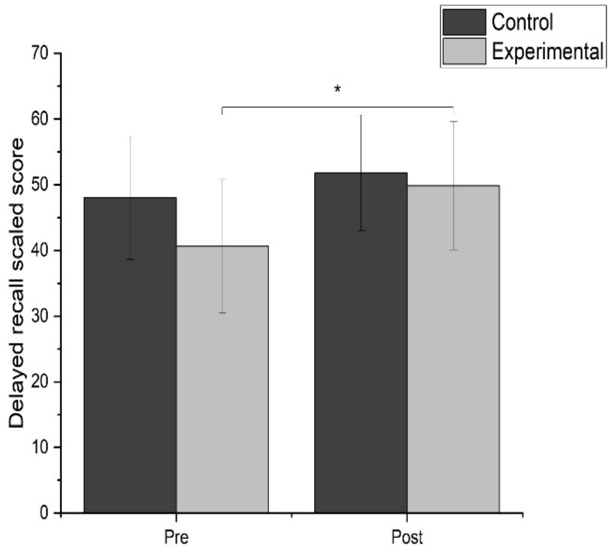

Figure 17- Delayed recall results from pre and post-test. Results show that the experimental group significantly improved from pre- to post-test ($p < 0.001$), whilst the control group did not improve ($p = 0.060$).

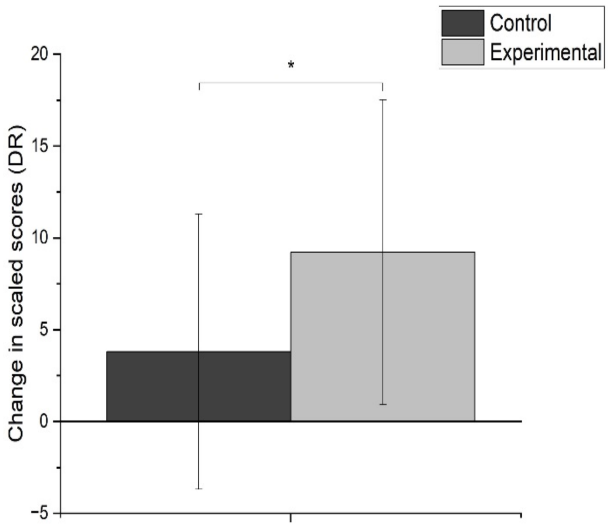

Figure 18- Delayed recall scores. The difference between the control and experimental group. Results showed that there was not a significant difference between the control and experimental group ($p = 0.034$).

With regards to differences between the two groups, there was a significant difference found between immediate recall and direct recall and between the control and experimental group ($p = 0.05$ and $p = 0.034$ respectively). It can therefore be assumed that the use of Mind Lab Pro significantly improves memory and recall tasks.

Study 3 – The effect of the nootropic supplement Mind Lab Pro on information processing and memory for a duration of three months followed by two months withdrawal.

In this study we aimed to examine the efficacy of Mind Lab Pro on improving information processing and memory in adults over time (three months) and examined how soon any positive effects declined after no longer taking the supplement (two months).

Participants

A total of 14 healthy individuals completed the study with six in the experimental group and six in the control group. The experimental group consisted of four females and four males with a mean age of 29.7 years and an age range from 20 to 52 (SD = 10.8). The control group consisted of n=3 females and n=3 males with a mean age of 26.5 years with an age ranging from 18 to 45 (SD = 9.5).

Task

The tasks employed for this study included the same tasks as used in study 1 (simple reaction time, choice reaction time and anticipation) and a shortened version of the memory tasks including visual and verbal memory.

Results

The results for the five tasks are presented below with both the experimental group and the control group presented. A baseline test was conducted on all participants in both groups.

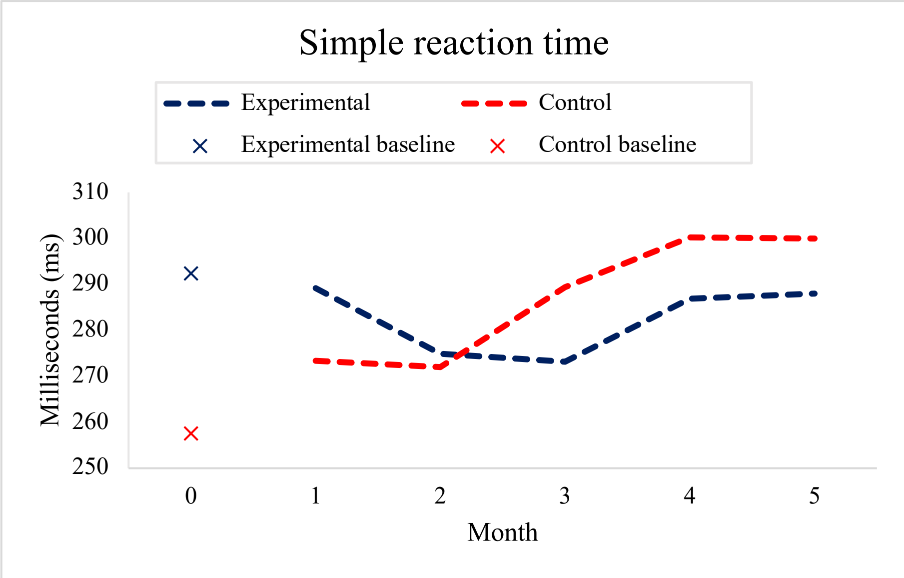

Figure 19. Simple reaction time for both the control and experimental group from month 1 to 5 with baselines scores displayed as **X**.

The experimental group improves for the first three months and then performance declines towards the base line measure. Most improvement takes place in the first two months for the experimental group. In contrast the control group makes no improvement from the baseline and then performance declines. It should be noted that the low base line for the control would be difficult to improve upon.

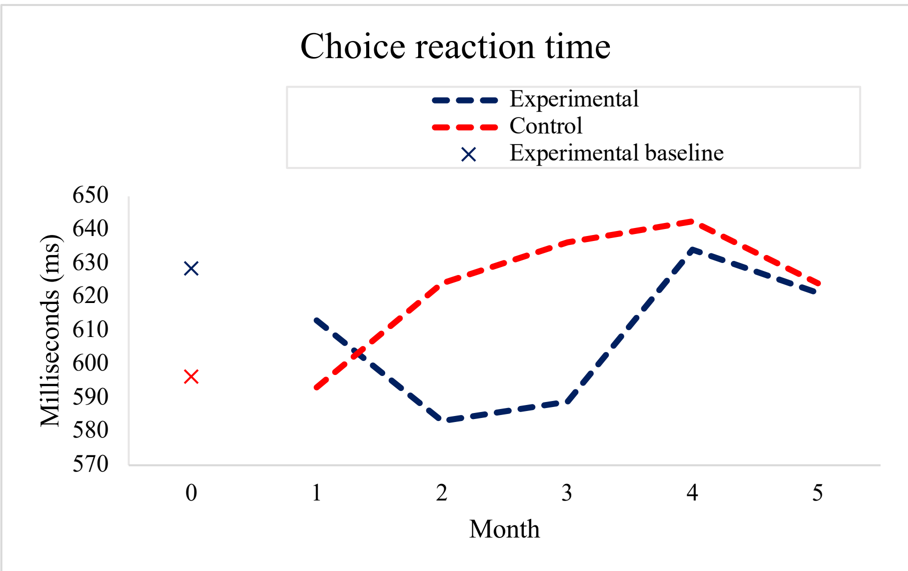

Figure 20. Choice reaction time for both the control and experimental group from month 1 to 5 with baseline scores displayed as **X**.

The experimental group improves for the first three months with the greatest improvement in the first two months, performance then declines towards the base line measure. This is an encouraging finding as choice reaction time is a more involved decision making process. In contrast the control group makes little improvement from the baseline and then performance declines.

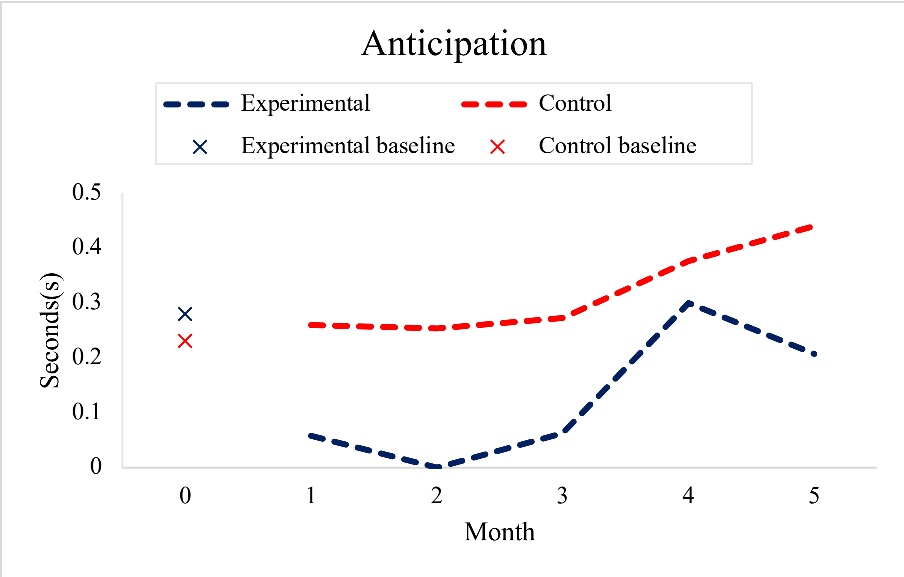

Figure 21. Anticipation for both the control and experimental group from month 1 to 5 with baselines scores displayed as **X**.

The experimental group improves for the first two months, performance then declines towards the base line measure. In contrast the control group makes little improvement from the baseline and then performance declines.

(It should be noted that for simple reaction time, choice reaction time and anticipation that some learning effect can be expected. We did counter balance for this and obviously the control provided a comparison to the experimental group).

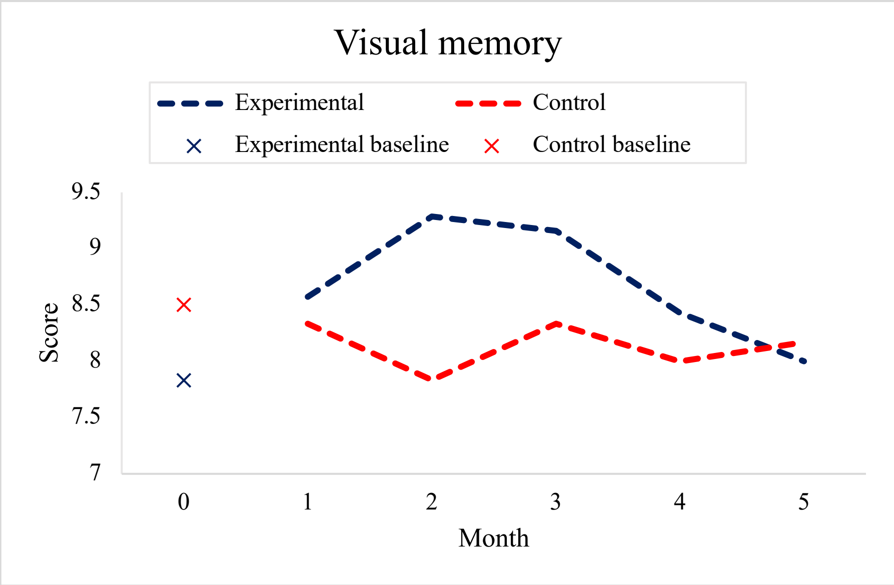

Figure 22. Visual memory for both the control and experimental group from month 1 to 5 with baselines scores displayed as **X**.

The experimental group improves for the first two months, performance then declines towards the base line measure. In contrast the control group makes little improvement from the baseline and then performance remains relatively static.

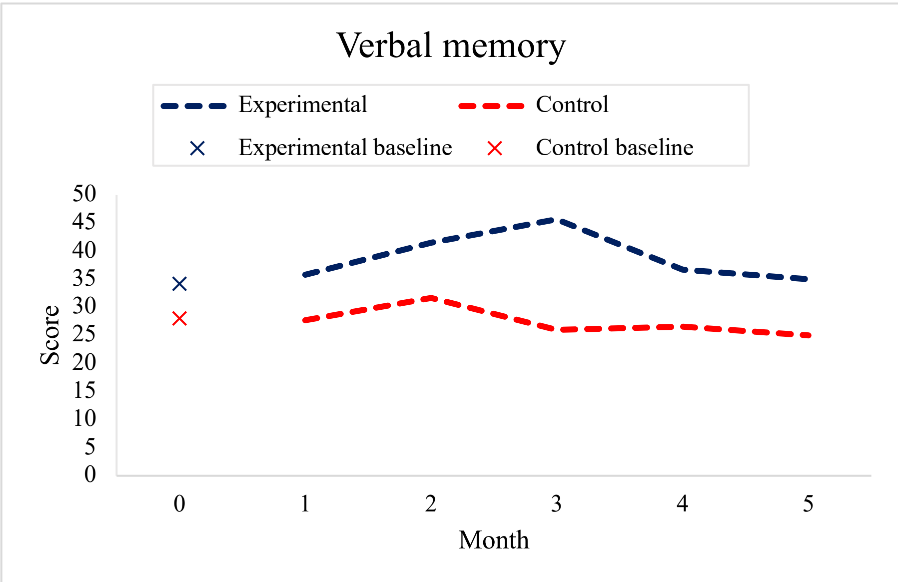

Figure 23. Verbal memory for both the control and experimental group from month 1 to 5 with baselines scores displayed as **X**.

The experimental group improves for the first three months, performance then declines towards the base line measure. In contrast the control group makes little improvement from the baseline and then performance remains relatively static.

Overall summary across the three studies of the benefits if Mind Lab Pro.

- Significant improvement in simple and choice reaction time
- Significant improvement in anticipation
- Appears that in terms of information processing especially effective for the over 30's
- Significant improvements in memory especially in terms of immediate recall and direct recall
- In terms of information processing Mind Lab Pro usage improves performance over three months and improvements are seen after two months. After stopping use a decline is seen after one month.
- In terms of memory Mind Lab Pro usage improves performance over three months and improvements are seen after two months especially in visual memory. After stopping use a decline is seen after one month.

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