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Online Attention Training for Older Adults

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Abstract

Evidence suggests that cognitive training interventions can improve older adults' cognitive performance. Successful training programs are adaptable and train multiple cognitive domains to target individual strengths and weaknesses. Computerized training programs are useful because they allow older adults to easily access training. This pilot study used an online attention training program, ATTENTION WORKOUT™, to enhance three aspects of attention– *coordination*, *allocation*, and *selective focus* –in community-dwelling older adults randomized to either an abbreviated (n=13) or an extended (n=17) practice training program over a 6-week period. Participants in the extended practice group significantly improved on selective focus reading distraction tasks with unrelated words (U=39.5; Z=-2.34; p=.02) and blanks (U=26.5; Z=-3.05; p=.002) as well as a matching attributes task (U=49.5; Z=-2.33; p=.02). The extended practice group significantly improved on three tasks of coordinating attention – radio-tuning (U=30; Z=-2.73; p=.01), circuit-breaker resetting (U=46; Z=-2.24; p=.03), and the combination of the two tasks (U=15; Z=-3.51; p<.0001) – as well as a memory generalization task (U=20; Z=-3.27; p=.001). A post-test satisfaction survey found both groups enjoyed the program, but the abbreviated practice group felt the tasks were more difficult. These findings suggest online attention training programs, like ATTENTION WORKOUT, can improve attention-related skills in community-dwelling older adults.

Keywords

Attention; Cognition; Training Program; Online; Computerized; Older Adults

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There is considerable evidence that cognitive training interventions improve cognitive performance in healthy older adults (Ball et al., 2002; Mahncke, Bronstone, & Merzenich, 2006; Rebok et al., 2014; Smith et al., 2009). Furthermore, a recent systematic review suggests computerized cognitive training is an effective method of improving cognition in older adults regardless of their familiarity with technology (Kueider, Parisi, Gross, & Rebok, 2012).

Multiple approaches have been adopted in designing cognitive training programs, including nonspecific cognitive stimulation training. These types of nonspecific stimulation programs train participants in different cognitive domains (e.g., memory, auditory processing, attention), with the intent being that training gains will transfer to other nontrained domains. Nonspecific cognitive stimulation training programs, such as the Improvement in Memory with Plasticity-based Adaptive Cognitive Training (IMPACT) Study and the approach used in the current study, have harnessed brain plasticity in order to create cognitive gains in domains beyond those that were trained in the program. For example, participants in the IMPACT Study completed computerized training in exercises focused on improving auditory information processing, but also saw gains in memory and attention (Smith et al., 2009; Zelinski, Peters, Hindin, Petway, & Kennison, 2014). It is also important that such programs are adaptive and adjustable; the greatest benefits occur when difficulty levels are tailored to an individual's performance (Buschkuehl et al., 2008; Saczynski, Rebok, Whitfield, & Plude, 2004; Zelinski et al., 2014). Programs that implement these techniques (i.e., adaptive and tailored) improve cognitive performance and protect against functional declines for up to one year after only short periods of training (Buschkuehl et al., 2008; Edwards et al., 2009; Peretz et al., 2011). Dahlin and colleagues (2008) found that a five-week intervention was sufficient to produce long-term improvements in memory. Additionally, programs that give immediate feedback are more effective at improving higher-level cognitive functions, such as executive function and working memory (Peretz et al., 2011).

Age-related changes in the brain are most pronounced in the prefrontal cortex (Raz et al., 2004), which is related to executive function, attention, inhibition, and working memory (Bisley & Goldberg, 2010; Constantinidis & Procyk, 2004). These same cognitive abilities are also more likely to decline with age (Andres, Guerrini, Phillips, & Perfect, 2008; Grady & Craik, 2000). Training programs have been designed around the theory that the brain, even in old age, is plastic and capable of change (Buonomano & Merzenich, 1998) in several cognitive domains, including task shifting (Kray & Eppinger, 2006), inhibition (Davidson, Zacks, & Williams, 2003), and attention control (Bherer et al., 2006).

Although these results are promising, none of the aforementioned studies examined the efficacy or feasibility of an online cognitive training program, which could significantly cut costs and increase access to training (Morrell et al., 2006). The purpose of the current study was to examine the feasibility and effectiveness of an online attention training program in cognitively normal, community-dwelling older adults. The program, ATTENTION WORKOUT, is intended to optimize cognitive gains as well as accessibility for community-dwelling older adults.

ATTENTION WORKOUT was designed to enhance three aspects of attention, each of which requires executive control: 1) coordination between concurrent tasks; 2) allocation across simultaneous tasks; and 3) selective focus on task-relevant information and inhibition of irrelevant information (Diamond, 2013). During ATTENTION WORKOUT™ training, participants learn that focus of attention may be manifested in many ways, including focus that may be spontaneous, shift from one target to another, or divided between two targets. The training modules prepare users to monitor and track attentional performance in daily life. Two of the training modules were based on pre-existing tasks. The Useful Field of View (UFOV) task has been shown to improve older adults' attention to stimuli for up to six months after practice (Ball, Beard, Roenker, Miller, & Griggs, 1988). Similarly, the Circuit-Breaker Resetting (Radio Switch (RS)-Switch) task has shown improvements in executive functioning in older adults (Kramer, Larish, Weber, & Bardell, 1999).

We hypothesized that extended practice with the attention training program would lead to larger gains on tasks related to attentional control compared to abbreviated practice with the program in this pilot study. Additionally, we hypothesized that participants with extended practice would have improved performance on a memory generalization task, as compared to participants with abbreviated practice. Finally, we hypothesized that participants who had extended practice with the training program would report feeling more comfortable with the program than participants who had abbreviated practice, because of the longer exposure.

Method

Participants

Community-dwelling older adults residing in western Maryland were recruited for this study. All participants signed an informed consent, and were compensated $10 per session for participation. Exclusion criteria were: (1) prior participation in a cognitive training study or in the Phase I feasibility study of the ATTENTION WORKOUT program; (2) age <50 years; (3) living in an institutional setting; (4) vision impairment; (5) reported disability (i.e., extensive assistance or total dependence); (6) diagnosed cancer within the last 5 years with a limited life expectancy; (7) current chemotherapy or radiation treatment; (8) diagnosis of Alzheimer's disease; (9) stroke in the previous year; or (10) impaired communication (e.g., significant difficulty speaking or hearing). Participants were informed they would be randomly assigned to either the control group, referred to as *abbreviated practice,* or intervention group, referred to as *extended practice*. Participants (N=30) were randomly selected using a method similar to “pulling names from a hat” for the abbreviated or extended practice group by a blinded third party. Married couples were assigned together to prevent crossover effects; however, it should be noted that this resulted in an unequal sample size and distribution of men in each group. Following randomization, an experienced research assistant administered the Mini-Mental State Exam (MMSE) (Folstein, Folstein, & McHugh, 1975) to assess baseline cognitive status. Data were collected about participants' performance on the ATTENTION WORKOUT program prior to the intervention and at the conclusion of the study.

Intervention

An attention training module (ATTENTION WORKOUT™) developed by Compact Disc Incorporated (COMPACT, Silver Spring, MD) was used to improve three aspects of attention (i.e., coordinating attention, allocating attention, and focusing attention). The ATTENTION WORKOUT consists of five tasks – three coordinating attention tasks (i.e., radio-tuning, circuit-breaker setting, and the radio-switch combination tasks), one allocating attention task (i.e., Useful Field of View), and two focusing attention tasks (i.e., Matching Attributes and Reading Distraction) – described below. Although each of the tasks was focused on training one aspect of attention (i.e., coordinating, allocating, and focusing), it is likely that each task also required the other facets of attention. All participants were trained in the ATTENTION WORKOUT online training program. All sessions were conducted at a research center and were facilitated by an experienced trainer. Each participant was individually trained to use the computer's mouse, learn program menus, and navigate the online training modules.

The extended practice program consisted of 6 training sessions over a 6-week period. During Session 1, which lasted approximately 60 minutes, all study participants received instructions and background information, and completed an online pre-test using the attention training software. Participants in the extended practice group received training one day per week during Sessions 2 through 5 which lasted approximately 45 minutes. Participants in the abbreviated practice group were not contacted during this period and did not visit the research center. Post-test performance was conducted at Session 6, which lasted approximately 45 minutes, and was completed by all study participants. The extended practice group completed a total of 285 minutes using the program, whereas the abbreviated practice group completed a total of 105 minutes using the program.

Coordinating Attention Tasks—The Circuit-Breaker Resetting (Radio Switch (RS)-Switch) task is modeled from Kramer et al. (1999), and requires coordinating two concurrent tasks for successful performance. In this task, participants were presented with a row of light switches in the “on” position (see Figure 1). Unlike the Kramer et al. (1999) tasks, participants used the computer's mouse instead of keyboard commands. Participants were instructed to click the light switch as soon as it changed to the “off” position. If a second breaker was turned “off” by the computer program before the participant reset the first switch to the “on” position, the trial was scored as an error.

The Radio-Tuning (RS-Radio) task is a one-dimensional pursuit-tracking task (Pew, 1974) in which participants continuously adjust the position of a radio tuner in order to maintain a strong audio signal (see Figure 2). Participants were instructed to keep a dial in the “high” range by adjusting the tuner indicator left or right. Each time the signal strength dipped below the “high” threshold setting, the trial was scored as an error.

Participants performed each of these tasks separately and then concurrently (RS-Combo) on the same screen. In the first two training sessions, participants completed four trials of each single-task tuning (RS-Radio) and resetting (RS-Switch), separately, and four trials of concurrent dual-task (50/50) performance for each session. In the three remaining sessions, participants completed two trials of each single-task tuning and resetting, and nine trials of concurrent dual-task performance for each session. The difficulty level for each participant was determined during the practice sessions; the program adapted to the highest difficulty in which a participant could successfully complete the task, and remained at this level of difficulty throughout the subsequent sessions. This was the only task with adaptive difficulty.

Allocating Attention Task—This task is modeled on the UFOV task (Ball et al., 1988), and consists of a visual display with a central fixation point and four radial arms extending at equal angles from the central fixation. Unlike the discrimination task used by Ball and colleagues (1988), this task involves identification of the central stimulus and a match/mismatch decision about the central versus peripheral stimulus (see Figure 3).

On each trial, participants identified and compared a stimulus presented at the fixation point with probe stimuli presented in the periphery along one of the radial arms. The stimuli are common objects (e.g., dog, keys), and were equated for discriminability and identifiability during pilot testing. The peripheral target's distance from the central fixation point varies as a function of accuracy, such that at the beginning of the task a higher percentage of peripheral targets appear within a few degrees of the fixation point and are easily located. With practice, the peripheral stimuli appear at increasing distances from central fixation thereby testing the limits of the UFOV. Trials consisted of a random mix in which peripheral stimuli may or may not appear along the radial arms.

Focusing Attention Tasks—Two focusing attention tasks were used. The first task, Matching Attributes, is based on a task used by Hoyer, Rebok, and Sved (1979) to assess the impact of irrelevant information on older adults' problem-solving ability. This aspect of attention is trained with a visual matching task of four increasingly difficult levels, and involves the ability to ignore irrelevant information while solving a problem. Each problem consists of three figures (see Figure 4) – the stimulus figure, presented at the bottom of the screen, and two response figures positioned above. Each figure contains attributes of shape, color, number, and position. The two response figures have one or more attributes in common with the stimulus, this being the relevant attribute(s). Each of the other three attributes is either constant (all figures contain the same attribute [e.g., red color]) or variable (the figures differ with regard to that attribute [e.g., different shapes]). To complete the task, participants match the stimulus figure to one of the two figures at the top of the screen that is most similar, while ignoring the stimulus attributes that are irrelevant.

The second focusing task, Reading Distraction, assesses the impact of distraction on reading times. Participants read a short story that is typed in a non-italic font, and presented either in the absence or presence of one of four types of distractions: 1) meaningless stretches of blank space inserted between some words, 2) strings of meaningless Xs inserted between some words, 3) inserted words that are unrelated to the story and appear in an italic font, or 4) inserted words that are related and meaningful to the story. Twelve critical stories and one practice story, developed for assessment of age differences in attention and inhibition, were taken from Connelly and colleagues (1991). Participants were instructed before the task that they would read a series of stories for comprehension, while ignoring any distracting material presented, which was then followed by a set of four comprehension questions.

Generalization Task—This task involved multi-trial word list learning; a word list was presented on the computer screen. During practice trials, the extended practice group, but not the abbreviated practice group, could choose the amount of time they studied the words (range 5 to 50 seconds) and the number of words presented (range 1 to 20). However, excessive preview time counted against the participant, and resulted in a lower score regardless of how many words the participant recalled. During the test trials (pre-test and post-test), participants in the extended and abbreviated practice groups studied 16 words for 40 seconds. The preview time was standardized during the pre-test and post-test in order to measure the effect of ATTENTION WORKOUT across groups.

Satisfaction Survey—At the end of the study, participants completed a 34-item survey. They were asked to rate various aspects of the attention training program using a five-point Likert-type scale (1 = *strongly disagree*, 5 = *strongly agree*).

Analyses

Exploratory analyses were performed to investigate the distribution of performance on the attention training program tasks between practice conditions. Examination of frequency distributions revealed outcome variables with a high degree of skewness. Based on this, we used the nonparametric Mann-Whitney U test to evaluate differences in the pre-post scores for each outcome. Data were analyzed using Stata Version 11.0 (StataCorp, College Station, TX).

Results

Demographic data for participants are summarized in Table 1. Participants were on average 70 years old (SD = 8.3) and mostly female (77%). All participants were Caucasian and had at least a high school education. Exploratory analyses revealed that the extended practice group was younger (M=66.7, SD=7.2) and more likely to be female (p=.01) compared to the abbreviated practice group (M=75.0, SD=7.5). Pre- and post-training accuracy scores on the ATTENTION WORKOUT tasks are presented in Table 2.

Coordinating Attention Tasks

Significant group differences were found for all three coordinating (i.e., Radio-Tuning, Circuit-Breaker Resetting, and the combination of the two) attention tasks. On the Radio-Tuning task (median ranks of extended and abbreviated practice were 0.49 and 0.43, respectively; U=30; z=-2.73; p=.01), Circuit-Breaker Resetting task (median ranks of extended and abbreviated practice were 0.92 and 0.84, respectively; U=46; z=-2.24; p=.03), and the combination of the two tasks (median ranks of extended and abbreviated practice were 0.71 and 0.63, respectively; U=15; z=-3.51; p<.0001), post-training scores were significantly higher for the extended practice group.

Focusing Attention Tasks

At post-training, results of the Mann-Whitney U test showed a significant difference between the extended and abbreviated practice groups on two measures of focusing attention, the Reading Distraction task– unrelated words (U=39.5; z=-2.34; p=.02) and blanks (U=26.5; z=-3.05; p=.002) as well as significant differences on the Matching level 4 task (U=49.5; z=-2.33; p=.02).

Generalization Task

Results of the Mann-Whitney U test showed a significant difference on pre-training scores between the extended practice and abbreviated practice on the number of words recalled (mean rank of extended and abbreviated practice was 5 and 4, respectively; U=47, z= -2.69; p=.01; Table 3). At post-training the difference on the number of words recalled between the extended and abbreviated practice groups remained significant (U=20; z=-3.27; p=.001) indicating that the extended practice group was able to recall more words on average.

Satisfaction Survey

Based on survey data (Table 3), the abbreviated practice group reported more problems navigating the program (p<.05) and thought the tasks were more challenging (p<.05). In particular, the abbreviated practice group reported the UFOV (p<.05) and matching attributes (p<.05) tasks were more difficult than the extended practice group; the extended practice group indicated the information presented was more "at their level" (p<.05). Overall, both groups enjoyed the program (M=4.14, SD=1.03).

Discussion

ATTENTION WORKOUT was designed to improve specific components of attention. We hypothesized that extended practice using the attention training program would result in larger gains on measures of attention and memory relative to abbreviated practice in this pilot study. The extended practice group improved significantly on measures of selective focus (i.e., the reading distraction and matching tasks), coordination of attention (i.e., radio-tuning, circuit-breaker setting, and the radio-switch combination tasks); there were no significant differences observed on the measures of attention allocation. The extended practice group also improved on the memory generalization task (i.e., number of words recalled) as compared to the abbreviated practice group. This suggests that practice with ATTENTION WORKOUT creates a transfer effect The current findings must be presented alongside some limitations. Primarily, randomization was not successful; the extended practice group was significantly younger than the abbreviated practice group, contained a large proportion of females, and had a higher mean level of education. It is possible that significant findings are due to baseline group differences between the abbreviated and extended practice groups and not the result of exposure to the training program. Additionally, because this was a pilot study, the training period was relatively short (i.e., four weeks, plus pre-test training and post-test assessment), and a longer training period may produce more robust effects. However, the findings from this pilot study support conducting future studies with the ATTENTION WORKOUT attention training program as it may be a potential means of improving cognitive function in older adults. Future studies should implement a randomized controlled trial with a larger sample for a longer duration to replicate these results, and understand the full benefits that can be gained from using the program. Studies should also explore the feasibility of dissemination of ATTENTION WORKOUT to better to cognitive domains (i.e., memory) beyond those trained in the program (i.e., attention). Transfer effects have been observed in other nonspecific cognitive stimulation training programs, and indicate that older adults do not need to train in a specific domain in order to experience gains in that cognitive domain (Smith et al., 2009; Zelinski et al., 2014).

Although the extended practice group did show improvements, the gains were small. Considering the extended practice group's high baseline performance on the ATTENTION WORKOUT, there was little room for improvement after completing the six-week program. At baseline both groups were over 90 percent accurate on the figure matching task (levels 1, 2, and 4) and the UFOV no-distraction task, thus making it difficult to determine if extended, as compared to abbreviated, practice with ATTENTION WORKOUT resulted in larger gains. Ceiling effects are not uncommon in cognitive training intervention studies (Mahncke et al., 2006; Peretz et al., 2011), because they often use cognitively healthy, community-dwelling older adults. Similar studies have reported that low levels of difficulty could contribute to null findings (Berry et al., 2010). Additionally, the small effects could be attributed to the intervention duration. Despite findings from other studies (Dahlin et al., 2008) suggesting a five-week intervention is sufficient to improve cognitive function, in the current high-performing sample six weeks may not have been long enough to produce significant improvements.

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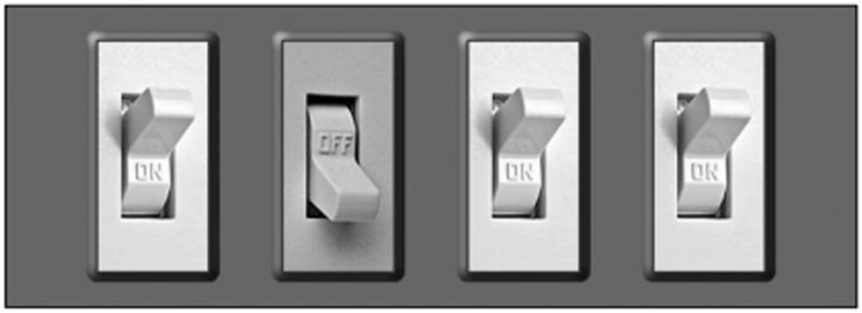

Figure 1. Circuit breaker resetting task

Note: The light switches turned "off" at different time intervals measured in milliseconds (ms) depending on difficulty level (i.e., 4988ms (least difficult), 3342ms, 2239ms, 1500ms, 1005ms, 673ms, 451ms (most difficult)).

Figure 2. Radio-tuning task

Note: "Strong signal strength" equates to five or more bars of signal strength in the middle screen below the station frequency window. The frequency with which the signal changed, as measured in milliseconds (ms) depended on the difficulty level (5000ms (least difficult), 3000ms, 1900ms, 1200ms, 900ms, 500ms, 300ms (most difficult)).

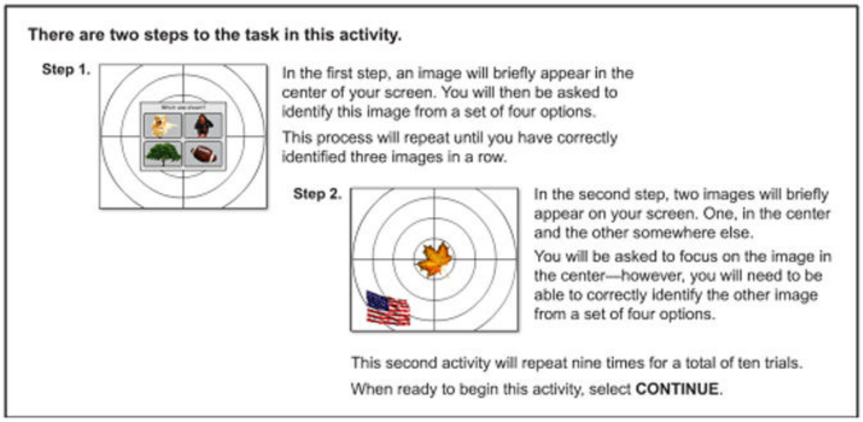

Figure 3. Useful Field of View task

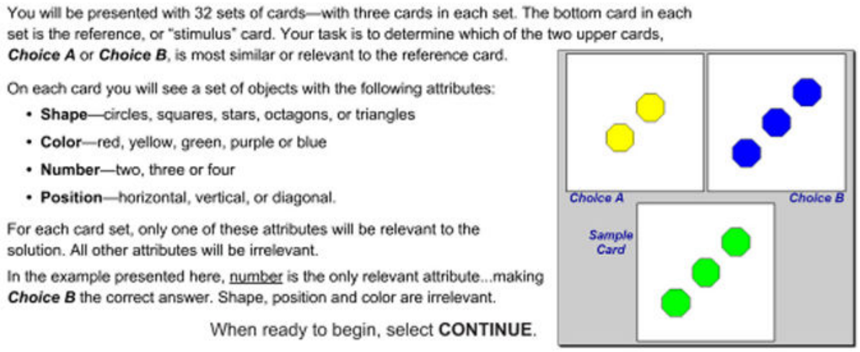

Figure 4. Matching task

Table 1

Participant Characteristics

	Extended practice (*n*=17)	**Abbreviated practice (*n*=13)**	***p*-value**
Age, *M* ± *SD*	66.7 ± 7.17	75.0 ± 7.51	**.01**
Sex, *n* (%)			**.01**
Male	1 (5.9)	6 (46.2)	
Female	16 (94.1)	7 (53.8)	
Education, *n* (%)			>.05
High school	7 (41.2)	10 (76.9)	
Bachelor's degree	7 (41.2)	2 (15.3)	
Master's degree	3 (17.7)	1 (7.7)	
MMSE, *M* ± *SD*	28.6 ± 1.66	28.2 ± 2.05	>.05
Marital status, *n* (%)			>.05
Married	11 (64.7)	10 (76.9)	
Widow	4 (23.5)	0	
Divorce	2 (11.7)	2 (15.4)	
Never married	0	1 (7.7)	
Self-rated health, *n* (%)			>.05
Excellent	4 (23.5)	5 (38.4)	
Very good	6 (35.2)	5 (38.4)	
Good	5 (29.4)	2 (15.3)	
Fair	2 (11.7)	1 (7.7)	
Employment, *n* (%)			>.05
Employed	3 (17.6)	1 (7.7)	
Retired	12 (70.5)	11 (84.6)	
Unemployed	2 (11.7)	1 (7.7)	

Abbreviations: Mini-Mental State Exam (MMSE); Mean (*M*); Standard Deviation (*SD*)

Table 2

Pre- and Post-test performance on ATTENTION WORKOUT™

	Pre- and post-test performance		Mann-Whitney Results		
Task	**Extended practice (*n*=17)**	**Abbreviated practice (*n*=13)**	***U***	***z***	**p-value**
Coordinating Attention					
Radio tuning, Median (IQR)					
Pre-test	0.43 (0.32, 0.64)	0.38 (0.28, 0.41)	72	-1.62	.11
Post-test	0.49 (0.42, 0.84)	0.38 (0.29, 0.45)	30	-2.73	**.01**
Circuit-breaker resetting, Median (IQR)					
Pre-test	0.84 (0.78, 0.92)	0.82 (0.68, 0.91)	93	-0.73	.46
Post-test	0.92 (0.84, 0.97)	0.82 (0.69, 0.84)	46	-2.24	**.03**
Radio-Switch combination, Median (IQR)					
Pre-test	0.63 (0.56, 0.68)	0.59 (0.52, 0.66)	89	-0.90	.37
Post-test	0.71 (0.65, 0.89)	0.56 (0.56, 0.65)	15	-3.51	**<.0001**
Allocating Attention					
UFOV—No distractors, Median (IQR)					
Pre-test	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	102	-1.14	.74
Post-test	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	76.5	-1.79	.43
UFOV— Distractors, Median (IQR)					
Pre-test	1.00 (0.90, 1.00)	0.90 (0.90, 1.00)	76	-1.65	.16
Post-test	1.00 (1.00, 1.00)	1.00 (0.90, 1.00)	52.5	-2.48	.21
Focusing Attention					
Matching level 1, Median (IQR)					
Pre-test	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	104	-0.87	.38
Post-test	1.00 (1.00, 1.00)	1.00 (0.88, 1.00)	61.5	-1.48	.14
Matching level 2, Median (IQR)					
Pre-test	1.00 (0.88, 1.00)	0.88 (0.88, 1.00)	100	-0.49	.62
Post-test	0.88 (0.88, 1.00)	1.00 (0.88, 1.00)	66.5	-0.95	.34
Matching level 3, Median (IQR)					
Pre-test	0.88 (0.75, 1.00)	0.88 (0.75, 0.88)	87.5	-1.01	.31
Post-test	0.88 (0.88, 1.00)	0.88 (0.88, 1.00)	58.5	-1.14	.15

	Pre- and post-test performance		Mann-Whitney Results		
Task	**Extended practice (*n*=17)**	**Abbreviated practice (*n*=13)**	***U***	***z***	**p-value**
Matching level 4, Median (IQR)					
Pre-test	1.00 (1.00, 1.00)	1.00 (0.75, 1.00)	87	-1.18	.24
Post-test	1.00 (1.00, 1.00)	1.00 (0.88, 1.00)	49.5	-2.33	**.02**
RD – related words, Median (IQR)					
Pre-test	0.75 (0.50, 1.00)	0.50 (0.50, 0.75)	67	-1.92	.06
Post-test	0.75 (0.75, 1.00)	0.50 (0.50, 1.00)	52.5	-1.65	.10
RD – unrelated words, Median (IQR)					
Pre-test	0.75 (0.75, 1.00)	0.75 (0.75, 1.00)	105	-0.26	.79
Post-test	1.00 (0.75, 1.00)	0.75 (0.50, 1.00)	39.5	-2.34	**.02**
RD – Xs, Median (IQR)					
Pre-test	0.75 (0.75, 0.75)	0.75 (0.75, 0.75)	108.5	-0.11	.91
Post-test	1.00 (0.75, 1.00)	0.75 (0.75, 1.00)	63	1.10	.27
RD – blank, Median (IQR)					
Pre-test	0.75 (0.75, 1.00)	0.75 (0.75, 1.00)	95	-0.69	.49
Post-test	1.00 (0.75, 1.00)	0.50 (0.25, 0.75)	26.5	-3.05	**.002**
Generalization Task					
Word recall—time, Median (IQR)					
Pre-test (sec)	70.92 (63.70, 80.55)	78.56 (61.20, 93.26)	101	-0.40	.69
Post-test (sec)	86.82 (56.49, 112.88)	69.59 (61.31, 128.20)	81	-0.08	.94
Word recall— number correct, Median (IQR)					
Pre-test	5 (7, 9)	4 (3, 7)	47	-2.69	**.01**
Post-test	8 (7, 11)	5 (4, 7)	20	-3.27	**.001**

Abbreviations: IQR = Interquartile range; RD = Reading Distraction; UFOV = Useful Field of View

Table 3

Opinion Survey Responses by Group

	Extended Practice (*n*=17) Mean* (*SD*)	Abbreviated Practice (*n*=15) Mean (*SD*)	*p*-value
Overall opinion of the ATTENTION WORKOUT			
I liked the program	4.13 (1.02)	4.15 (1.07)	.23
I would use the program if it were available	3.56 (1.46)	3.62 (1.45)	.85
I would recommend the program	3.75 (1.48)	4.08 (1.12)	.47
The program was “user friendly”	4.06 (0.99)	4.08 (1.12)	.06
The program was “interesting”	4.00 (1.03)	4.23 (1.09)	.16
I see how the program can improve my attention skills	3.87 (1.19)	4.15 (1.06)	.34
Section Average	3.83 (1.06)	4.05 (1.07)	.59
Navigating the ATTENTION WORKOUT			
I had no problems moving around the program	4.25 (1.00)	3.00 (1.35)	**.02**
Sections were well labeled	4.56 (0.51)	3.92 (1.12)	.12
I did not feel lost moving around the program	4.50 (0.52)	3.62 (1.26)	.10
I had no problems navigating the program	4.56 (0.51)	3.92 (1.04)	.13
The program was easy to use	4.50 (0.52)	3.42 (1.44)	**.04**
Section Average	4.48 (0.57)	3.36 (1.04)	**.01**
Information presented on the ATTENTION WORKOUT			
The information was easy to understand	4.50 (0.52)	4.08 (1.04)	.30
The information was right “at my level”	4.19 (0.75)	3.75 (0.75)	**.02**
The information was well organized	4.44 (0.73)	3.85 (1.21)	.30
The information was presented in a simple manner	4.38 (0.62)	3.92 (1.19)	.31
The style of the writing was clear and straightforward	4.44 (0.81)	3.92 (1.19)	.37
Section Average	4.39 (0.59)	3.83 (0.95)	.07
Design of the ATTENTION WORKOUT			
The text was large enough to read easily	4.69 (0.48)	3.84 (1.34)	.10
I liked the colors used in the design of the various tasks	4.20 (0.78)	4.00 (1.22)	.14
The underlined links and icons were easy to click	4.50 (0.52)	3.54 (1.51)	.06
The style of writing was easy to read	4.63 (0.50)	3.92 (1.19)	.16
I did not have to do scroll too much to use the program	4.50 (0.63)	3.46 (1.39)	.12
The audible male voice was easy to understand	4.63 (0.50)	4.23 (1.09)	.35
I had enough computer experience to feel comfortable with the program	4.63 (0.50)	4.15 (1.14)	.31
I had enough time to complete the tasks in the program	4.63 (0.50)	3.92 (1.32)	.12
I like that you can work at your own pace	4.50 (0.63)	4.08 (1.24)	.43
I like that you can see your score immediately after the task	4.63 (0.50)	4.38 (1.12)	.43
Section Average	4.53 (0.47)	3.97 (1.12)	.09
Specific Tasks in the ATTENTION WORKOUT			
I found the Radio/Light switch task challenging	4.73 (0.46)	4.25 (1.22)	.32

	Extended Practice (*n*=17) Mean* (*SD*)	**Abbreviated Practice (*n*=15) Mean (*SD*)**	***p*-value**
I found the Field of View task challenging	2.00 (1.13)	4.17 (0.94)	**<.001**
I found the Word Recall task challenging	4.85 (0.38)	4.50 (1.00)	.35
I found the Reading Distraction task challenging	3.27 (1.22)	4.42 (0.67)	.06
I found the Matching Attributes task challenging	2.87 (1.25)	4.00 (1.21)	**.04**
Section Average	3.68 (0.54)	4.27 (0.66)	**.02**

*5=Strongly Agree; 4=Agree; 3=No Opinion; 2=Disagree; 1=Strongly Disagree