Females Meditate and Males Play Games: Gender Differences in the Benefits of Meditation Training

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Abstract

Although extensive research has shown the benefits of meditation on attention, evidence for the benefits of short-term meditation training remains scarce. In addition, prior studies on these benefits have included considerably more females than males, potentially concealing gender differences in attention training effects. Here we present a longitudinal study including equal-sample male and female participants to explore potential gender differences in short-term meditation training effects on an attentional blink (AB) task. One hundred and sixty-five college students were randomly divided into three groups: meditation training, video game training and control (no training). Participants were asked to complete the Five-Facet Mindfulness Questionnaire and the State-Trait Anxiety Inventory, and to rate their level of emotional state and time spent on video game playing per day. Participants then completed a 4-day, 20-min training including meditation training, video game training, or a waiting period (control). After training, participants rated their arousal state and emotional state, and performed the AB task. Results showed that participants who completed either short-term meditation training or video game training showed significant improvement on AB performance. Interestingly, meditation training was more effective in females, while video game training was more effective in males. Meditation training, but not video game training, decreased anxiety scores. The current results indicate that gender plays an important role in the benefits of attention training. It is essential that clinicians take gender into consideration when implementing meditation based therapy.

Full Text

Preamble

Females Meditate and Males Play Games: Gender Differences in the Benefits of Meditation Training

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Abstract

Although extensive research has demonstrated the benefits of meditation on attention, evidence for the advantages of short-term meditation training remains scarce. Moreover, prior studies investigating these benefits have included considerably more females than males, potentially concealing gender differences in attention training effects. Here we present a longitudinal study with equal numbers of male and female participants to explore potential gender differences in the effects of short-term meditation training on an attentional blink (AB) task. One hundred sixty-five college students were randomly assigned to three groups: meditation training, video game training, or a control condition (no training).

Participants completed the Five-Facet Mindfulness Questionnaire and the State-Trait Anxiety Inventory, and rated their emotional state and daily video game playing time. They then underwent four days of 20-minute training in their assigned condition. Following training, participants rated their arousal and emotional states before performing the AB task. Results showed that participants in both the short-term meditation training and video game training groups demonstrated significant improvements in AB performance. Interestingly, meditation training proved more effective for females, while video game training was more effective for males. Additionally, meditation training—but not video game training—decreased anxiety scores. These findings indicate that gender plays an important role in the benefits of attention training and suggest that clinicians should consider gender when implementing meditation-based therapy.

Keywords: meditation; gender differences; attentional blink; short-term; game

Introduction

Meditation is defined as a set of self-regulation practices that train attention and awareness to gain greater voluntary control over mental processes (Walsh & Shapiro, 2006). Numerous meditation types exist, including mindfulness, Vipassana, Zen, yogic meditation, Tibetan Buddhism, Transcendental Meditation, and loving-kindness-compassion (Travis & Shear, 2010). Based on traditional meditation texts and modern neuroscientific concepts, standard practices are grouped into two broad categories: focused attention (FA) and open monitoring (OM) meditation. FA meditation entails voluntary and sustained attention on a specific focal point, such as the breath, while OM meditation involves developing the ability to openly monitor physical and mental states, including meta-awareness of ongoing thought contents (Cahn & Polich, 2006; Lutz, Slagter, Dunne, & Davidson, 2008). Generally, FA is cultivated as a prerequisite to OM (Cahn & Polich, 2006; Lutz et al., 2008).

The past decade has witnessed rapid growth in meditation research within cognitive fields (Chiesa & Serretti, 2011), including attentional processes (Cahn & Polich, 2006; Jha, Krompinger, & Baime, 2007), working memory (Zeidan, Johnson, Diamond, David, & Goolkasian, 2010), and executive control (Tang et al., 2007; Zanesco, King, Maclean, & Saron, 2013). The primary and direct effects of meditation lead to improvements in attention, with meta-analyses showing medium effect sizes for meditation' s impact on attention (Eberth & Sedlmeier, 2012).

Meditation modifies both attentional processes and attentional networks. Specifically, meditation training produces significant improvements in attention subsystems such as alerting (i.e., sustaining attention or vigilance; Brefczynski-Lewis, Lutz, Schaefer, Levinson, & Davidson, 2007; Carter et al., 2005; Jha et al., 2007; MacLean et al., 2010), orienting (i.e., selective attention or concentration; Brefczynski-Lewis et al., 2007; Jha et al., 2007), and conflict monitoring (i.e., executive attention or divided attention; Jha et al., 2007; Lutz et al., 2008; MacLean et al., 2010; Tang et al., 2007). For example, MacLean et al. (2010) demonstrated that intensive meditation training improves visual discrimination and vigilance during sustained attention, with effects maintained at five-month follow-up. In an fMRI study, Brefczynski-Lewis et al. (2007) found that experienced FA meditators, compared to resting conditions, activated brain regions involved in orienting (visual cortex), alerting (superior frontal sulcus and intraparietal sulcus), and monitoring (dorsolateral prefrontal cortex, dlPFC).

Most research demonstrating meditation' s effectiveness on attention has employed cross-sectional designs comparing meditation experts to novices, making it difficult to establish clear cause-effect relationships. Longitudinal studies are needed to eliminate confounding factors (e.g., pre-existing differences between experts and novices) and clarify the precise developmental trajectory of trained abilities (Davidson & Kaszniak, 2015; Lutz et al., 2008). Short-term meditation training has demonstrated significant effects on sustaining attention (Semple, 2010), selective attention (Pratzlich, Kossowsky, Gaab, & Krummenacher, 2016), and conflict monitoring (Ainsworth, Eddershaw, Meron, Baldwin, & Garner, 2013; Tang et al., 2007). For instance, five days of 20-minute meditation training improved conflict monitoring performance on the attention network task (Tang et al., 2007). Additionally, Prätzlich et al. (2016) demonstrated improved attentional performance after three days of 20-minute meditation training when positive, but not negative, expectations were suggested.

Beyond the need for more longitudinal studies, males have been underrepresented in meditation research. A review of 117 randomized controlled trials of mindfulness-based therapies found that male participants accounted for less than 29% of 9,820 total participants (Bodenlos, Strang, Gray-Bauer, Faherty, & Ashdown, 2016). It is therefore essential to conduct studies with more balanced male-to-female ratios. Available literature suggests that females may benefit more from mental skill training than males, possibly due to higher motivation levels. A national American survey found that frequencies of private prayer and spiritual experiences are greater among females than males (Maselko & Kubzansky, 2006). Furthermore, research indicates that females benefit more from meditation training than males. For example, a review found that mindfulness-based treatments for substance use disorders are more effective for women than men (Katz & Toner, 2012).

Different coping strategies for psychological distress between men and women may account for this gender difference in meditation training suitability. When coping with psychological distress, men tend to "externalize" their distress through outward-directed action (e.g., playing sports or video games), whereas women tend to internalize distress through inward-directed action (e.g., ruminating or writing about negative events; Broderick, 1998; Li, Digiuseppe, & Froh, 2006). This difference in internalizing versus externalizing strategies may result in women preferring and benefiting more from mindfulness-based treatments than men (Katz & Toner, 2012). Recent research revealed that women benefit more than men from meditation training in response to negative affect (Rojiani, Santoyo, Rahrig, Roth, & Britton, 2017). Specifically, participants completed self-report questionnaires of affect, mindfulness, and self-compassion before and after a 12-week meditation training. Compared to men, women showed greater decreases in negative affect and greater increases in mindfulness and self-compassion scales, while men showed non-significant increases in negative affect. Despite this initial work on divergent gender effects on negative affect, broader investigation of divergent gender effects in meditation training is still needed.

Here we report a longitudinal study of a 4-day meditation training program with equal numbers of male and female participants. We analyzed the effects of meditation on an attentional blink (AB) task and examined how gender influences training effects. A previous study demonstrated that video game playing can enhance performance on selective attention tasks (Green & Bavelier, 2003), so we included a computer game playing group for comparison.

The current study tested two hypotheses:
H1: Both meditation training and video game training improve performance on a selective attention task, with meditation training being more effective than video game training.
H2: Gender differences exist in training effectiveness, such that meditation training is more effective for females while video game training is more effective for males.

Methods

Participants

A power analysis using G*Power 3.1 revealed that 76 participants were needed to detect a small-to-medium effect size (f = 0.25) of a Group × Gender × Lag interaction with 95% power (ANOVA: repeated measures, within-between interaction; at the 0.05 significance level; Faul et al., 2007). The expected effect size was based on a recent meta-analysis of mindfulness intervention (Bohlmeijer et al., 2010) and a review of acceptance-based treatments (including mainly mindfulness studies) in pain (Veehof et al., 2011).

One hundred sixty-five healthy, right-handed Chinese college students from the Chinese Academy of Sciences participated and received 80 yuan RMB for their participation. Three participants dropped out and two were lost to follow-up. Eleven participants (7 females) were excluded for scores beyond ±3 standard deviations; all results remained consistent regardless of whether these participants were included. In total, 149 Chinese participants (83 females) completed the study (Mage = 22.80 years, SD = 2.10). The study design is illustrated in Figure 1 [Figure 1: see original paper]. All participants reported normal or corrected-to-normal vision, no meditation experience, and were naïve to the experimental purpose. None reported current sleep or emotional disorders. Participants provided written informed consent, and the experimental protocol was approved by the institutional review board of the Institute of Psychology, Chinese Academy of Sciences.

Procedure

Participants completed the AB task individually on an HP computer in a quiet laboratory with temperature set at 22-24°C. Subjects viewed experimental materials from a distance of 40 cm. An E-prime program (version 1.0; Psychology Software Tools, Pittsburgh, PA, USA) controlled the experiment and recorded data.

During pre-testing, we assessed mindfulness level, state/trait anxiety, mood, and daily video game playing time. Subjects were then randomized into three groups: meditation training, video game training, or control. Participants in the meditation group completed 4 days of meditation training (20 min/day). Those in the video game training group played a link-link game for 20 min/day. The control group received no training. Arousal level, state anxiety, mood, and AB performance were assessed at post-test on the fourth day. See Figure 1 for a CONSORT diagram of participant flow.

Interventions

Meditation training. Meditation training occurred over four consecutive days following pre-test. Instructions focused on teaching naïve participants step-by-step meditation practice without any spiritual or religious emphasis. The training content was adapted from Wallace (2006) and Zeidan et al. (2010). Participants meditated according to an audio file recorded by a female researcher. Each training session lasted approximately 20 minutes, completed individually.

The training program progressed from FA to OM meditation (Wallace, 2006; Zeidan, Gordon, et al., 2010). On day 1, subjects were instructed to relax with eyes closed and focus on breathing by counting breaths from one to ten while attending to pauses between breathing cycles. If random thoughts arose, they were told to passively notice and acknowledge them, then simply "let them go" by returning attention to breathing sensations. On days 2-4, participants developed mindfulness skills. On day 2, subjects focused on the full flow of breath, including bodily sensations (e.g., rise and fall of abdomen and chest). On day 3, subjects attended to subtle sensations at the nostrils or above the upper lip during breathing, noticing and acknowledging any bodily sensations before returning attention to breathing. On day 4, participants consolidated skills from days 1-3, with more time spent in silent meditation.

Video game training. Video game playing has become ubiquitous in modern society, making it easily accepted by participants (Green & Bavelier, 2003). Video game playing enhances attention capacity and spatial distribution (Green & Bavelier, 2003), provides psychological benefits for the elderly (Allaire et al., 2013), and benefits surgeons (Boyle, Kennedy, Traynor, & Hill, 2011). Consequently, video gaming is now frequently used in psychology and neuroscience

(Lorenz, Gleich, Gallinat, & Kuhn, 2015). Unlike meditation training, video game training requires active attention to increase speed and skill, making it an acceptable attention-matched control group.

We selected a link-link game as the training task. Participants viewed various similar icons in a randomly ordered square matrix and were asked to discriminate and link pairs of icons. Participants clicked on two identical icons; if connecting lines required no more than three segments and did not touch other icons, the pair was removed. Participants had 20 minutes to complete the task.

Video game training served as a comparison to meditation training for two reasons. First, successful task completion required focused attention to discriminate between icons while ignoring distracting similar icons nearby. Second, participants had to monitor targets scattered across various locations. Both focusing and monitoring are important for attention allocation and correspond to meditation training components. As with meditation training, video game training abilities developed progressively, with complexity and difficulty increasing from day 1 to day 4. Game matrices had four difficulty levels: easy (12 × 7 icons, 6 species), normal (14 × 8 icons, 8 species), difficult (16 × 9 icons, 16 species), and very difficult (18 × 10 icons, 24 species).

Measures

The Five-Facet Mindfulness Questionnaire (FFMQ). The FFMQ is a 39-item self-report mindfulness measure (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006) with five subscales: observing (8 items; e.g., "When I' m walking, I deliberately notice the sensations of my body moving"), describing (8 items; e.g., "I' m good at finding words to describe my feelings"), acting with awareness (8 items; e.g., "I don' t pay attention to what I' m doing because I' m daydreaming, worrying, or otherwise distracted"), non-judging (8 items; e.g., "I criticize myself for having irrational or inappropriate emotions"), and non-reacting (7 items; e.g., "I watch my feelings without getting lost in them"). Items are rated on a 5-point Likert scale from 1 (never or very rarely true) to 5 (very often or always true). The Chinese version demonstrates good test-retest reliability and acceptable internal consistency in all facets (Cronbach' s alphas: 0.75, 0.84, 0.79, and 0.66) except non-reacting (0.45), with confirmatory factor analysis supporting a 5-factor model (Deng, Liu, Rodriguez, & Xia, 2011). Thus, the FFMQ is suitable for Chinese college students (Deng et al., 2011). In the current study, Cronbach' s alphas for the entire questionnaire and five subscales were 0.76, 0.75, 0.85, 0.81, 0.73, and 0.52, respectively.

The State-Trait Anxiety Inventory (S-TAI). The S-TAI is a 40-item inventory with the first 20 items assessing state anxiety and the second 20 assessing trait anxiety (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1970). Items are rated on a 4-point Likert scale from 1 (not at all) to 4 (very much so). Confirmatory factor analysis has shown the Chinese version is suitable for measuring state and trait anxiety (Shek, 1993). In the current study, Cronbach' s alpha coefficients were 0.89 for state anxiety and 0.87 for trait anxiety.

Mood. Participants rated their current emotional level on a visual analogue scale from -50 (extremely unpleasant) to 50 (extremely pleasant), with 0 representing neutral.

Arousal state. Participants rated their current arousal level on a visual analogue scale from -50 (extremely tired) to 50 (extremely excited), with 0 representing neither tired nor excited.

Time spent on video gaming. Participants reported daily hours spent playing video games during the week.

The AB task. The AB task is a rapid serial visual presentation task. Stimuli were 16 capital letters from 18 available in Courier New font (48 pt), with 8 letters omitted to avoid pattern confusion (I, L; O, Q; U, V; and X, Y). Each letter appeared on a 4 cm × 4 cm grey background (RGB: 127,127,127). Viewed from 40 cm, each stimulus subtended approximately 5.72° × 5.72° of visual angle. E-prime software conducted the test (Version 1.1; Psychology Software Tools Inc., Sharpsburg, PA).

Each trial consisted of 16 items (2 white letters and 14 black letters). Letters were randomly generated under the constraint that identical letters could not appear in one trial. Two randomly sampled (but not identical) uppercase letters, designated T1 and T2, served as targets. T1 position varied randomly across serial positions 3-7 with equal frequency. Six lags between T1 and T2 were used: Lag 1 (no intervening items, stimulus onset asynchrony [SOA] = 67 ms) to Lag 5 (4 intervening items, SOA = 268 ms), and Lag 7 (6 intervening items, SOA = 402 ms). These were crossed with five T1 serial positions, replicated eight times for 240 total trials (40 trials per lag). One practice block of 20 trials preceded three experimental blocks of 80 trials each. The experiment was self-paced, with at least one minute rest between blocks. The AB paradigm is illustrated in Figure 2 [Figure 2: see original paper].

Participants initiated each trial by pressing the spacebar. A plus sign fixation point appeared for 500-1,000 ms, followed by the stimulus stream presented successively without inter-stimulus intervals at the same location for 67 ms each (presentation rate = 15 items/second). Participants entered T1 and T2 after each trial and were encouraged to guess when uncertain. No feedback was provided.

The primary measure was the percentage of correct T2 responses on trials where T1 was accurately identified. Subjects frequently fail to report T2 when it appears within 200-500 ms after T1. However, when instructed to ignore T1, T2 is usually reported accurately regardless of lag (Raymond, Shapiro, & Arnell, 1992), suggesting the AB task measures attention to T1 and its consolidation into working memory (Chun & Potter, 1995) rather than a perceptual deficit.

Data analysis

Statistical analyses were performed with SPSS 22.0 (SPSS Software, Armonk, NY, USA) and GraphPad Prism 5.0 (GraphPad Software, La Jolla, CA, USA), with significance set at $p < 0.05$. Group differences in gender were analyzed via chi-square analysis. Two-way ANOVAs (Gender × Training Group) examined age, education, FFMQ, TAI, arousal scores, and video gaming time. Three-way repeated measures ANOVAs (Training Group × Gender × Lag) analyzed SAI, mood scores, and gender effects on AB. Partial eta square (^{2}p) indicated effect size. Greenhouse-Geisser correction applied when data failed Mauchly' s test of sphericity, and Bonferroni correction was used for post-hoc tests. Pearson' s correlations examined associations between AB and self-reported measures.

Results

Demographic Characteristics

No significant baseline differences in gender distribution existed between groups (^{2} = 0.515, p = 0.773). A series of 3 (training group) × 2 (gender) ANOVAs revealed a significant main effect of training group on the FFMQ description subscale (F(2, 141) = 4.016, p = 0.020, ^{2}p = 0.054), with the meditation group scoring lower than both the video game (p = 0.008) and control groups (p = 0.038). A significant gender effect emerged on arousal (F(1, 141) = 6.909, p = 0.010, ^{2}p = 0.047), with females scoring lower than males. No other statistically significant effects were observed. Descriptive statistics are shown in Table 1 .

Effect of Gender on AB

T2 accuracy was analyzed via a 3 (training group) × 2 (gender) × 6 (lag) repeated measures ANOVA. A significant lag effect on T2 accuracy emerged (F(5, 139) = 95.657, p < 0.001, ^{2}p = 0.775), reflecting the classic AB pattern: accuracy decreased at lags 2-3 then increased through lags 4-7 (see Fig. 3C [Figure 3: see original paper]). The ANOVA also revealed a main effect of gender (F(1, 143) = 5.751, p = 0.018, ^{2}p = 0.039), with males showing higher accuracy than females (see Fig. 3A). Additionally, significant gender × training group (F(2, 143) = 6.105, p = 0.003, ^{2}p = 0.079) and gender × lag interactions (F(5, 139) = 3.069, p = 0.012, ^{2}p = 0.099) indicated that gender effects were influenced by training type and AB task demands. No other significant effects were observed (see Table 2).

The three-way ANOVA for T1 accuracy (Fig. 3B) revealed significant main effects of lag (F(5, 139) = 67.533, p < 0.001, ^{2}p = 0.708) and gender (F(1, 143) = 4.324, p = 0.039, ^{2}p = 0.029), plus a significant gender × training group interaction (F(2, 143) = 4.259, p = 0.016, ^{2}p = 0.056). No other significant effects were found (Table 2).

Effect of Training Type on AB

Two 3 (training group) × 6 (lag) repeated measures ANOVAs assessed training effects on T2 accuracy separately for male and female participants.

For males, significant main effects emerged for lag (F(5, 59) = 34.196, p < 0.001, ^{2}p = 0.743) and training group (F(2, 63) = 4.155, p = 0.020, ^{2}p = 0.117). Post-hoc comparisons revealed significant differences between all three groups, with video game training producing higher T2 accuracy than both meditation (video game vs. meditation: 78.2 ± 4.8% vs. 65.2 ± 4.2%, $p = 0.045$) and control groups (video game vs. control: 78.2 ± 4.8% vs. 60.2 ± 4.2%, $p = 0.006$). No difference emerged between meditation and control groups ($p > 0.05$). No significant group × lag interaction was found.

For females, significant main effects appeared for lag ($F(5, 76) = 68.007$, $p < 0.001$, $^{2}p = 0.817$) and training group ($F(2, 80) = 4.198$, $p = 0.018$, $^{2}p = 0.095$). Interestingly, meditation training proved more effective, yielding higher T2 accuracy than both video game (meditation vs. video game: 68.8 ± 4.0% vs. 53.1 ± 4.0%, $p = 0.007$) and control groups (meditation vs. control: 68.8 ± 4.0% vs. 57.1 ± 3.8%, $p = 0.038$). No difference emerged between video game training and control groups ($p > 0.05$). As with males, no significant training group × lag interaction was found among females.

ANOVAs on T1 accuracy (Fig. 3B) showed significant lag effects for both genders (males: $F(5, 59) = 28.707$, $p < 0.001$, $^{2}p = 0.709$; females: $F(5, 76) = 39.724$, $p < 0.001$, $^{2}p = 0.723$). For females, a main effect of training group ($F(2, 80) = 3.606$, $p = 0.032$, $^{2}p = 0.083$) and a training group × lag interaction ($F(10, 154) = 1.957$, $p = 0.042$, $^{2}p = 0.113$) were also found (but not for males).

Effect of Gender and Training Type on Mood and State Anxiety

A 2 (gender) × 3 (training group) × 2 (session) repeated measures ANOVA assessed effects on mood and state anxiety. No main effects or interactions emerged for mood scores (all ps > 0.05), suggesting mood was unaffected by any independent variable. In contrast, a significant session effect ($F(1, 141) = 7.850$, $p = 0.006$, $^{2}p = 0.053$) and session × training group interaction ($F(2, 141) = 5.402$, $p = 0.005$, $^{2}p = 0.071$) appeared for state anxiety. Post-hoc comparisons revealed that anxiety scores decreased significantly in the meditation training group (post vs. pre: 33.84 ± 8.24 vs. 38.51 ± 8.88, $t = 4.124$, $p < 0.001$) but not in video game training or control groups. No other effects were observed.

Correlations between AB and Self-reported Measures

Table 3 presents correlations between T1/T2 accuracy and self-reported measures (arousal, mood, anxiety, depression, and FFMQ). As predicted, T1 accuracy was negatively associated with arousal state, and T2 accuracy was negatively associated with both arousal state and pre-training mood score, suggesting that higher arousal and mood levels may impede AB performance. FFMQ scores were positively correlated with pre-training mood and negatively correlated with anxiety and depression, indicating that higher trait mindfulness is associated with more positive and less negative emotions. In contrast, the FFMQ-observing subscale was positively associated with post-SAI scores, suggesting that high observation levels may increase anxiety.

Discussion

Previous studies have shown that meditation experts maintain superior attentional skills, yet little research has investigated short-term meditation training effects on attention. Additionally, prior studies have underrepresented male participants. The current longitudinal study with equal numbers of male and female participants demonstrates that both short-term meditation and video game training significantly benefit selective attention. Interestingly, meditation training was more effective for females, while video game training was more effective for males.

This study provides evidence that systematic short-term attention training can influence how people allocate attention resources over time, as measured by the AB task. AB is a robust phenomenon observable across various task conditions and in most subjects (Martens & Wyble, 2010). Previous research shows that meditation experts exhibit smaller AB than controls (Slagter et al., 2007; van Leeuwen, Muller, & Melloni, 2009; van Vugt & Slagter, 2014), indicating that long-term meditation affects the distribution of limited cognitive resources. For example, Slagter et al. (2007) reported that a 3-month intensive meditation retreat reduced AB and decreased brain-resource allocation to the first target, reflected by a smaller T1-elicited P3b (a brain-potential index of resource allocation). However, cross-sectional studies cannot establish causality. The present study shows that 4 days of 20-minute meditation training improved T2 detection without impairing T1 detection, suggesting that short-term mental training (both meditation and video game training) can improve attention allocation.

While prior meditation research has included far more females than males (Bodenlos et al., 2016), this study highlights the importance of balanced gender representation. The type of mental training that proved most beneficial differed by gender: meditation training was more effective for females, while video game training was more beneficial for males. Previous studies found that video games are more popular and frequently played by males than females (Lucas & Sherry, 2016), while frequencies of private prayer and spiritual experiences are greater among females than males (Maselko & Kubzansky, 2006). Additionally, female physicians are significantly more likely than male physicians (89% vs. 67%) to use meditation training for both patients and themselves, and hold significantly stronger beliefs about meditation' s health benefits (Sierpina, Levine, Astin, & Tan, 2007).

Hormones play an important role in gender behavioral differences (Erlanger, Kutner, & Jacobs, 1999). Androgens are present at higher levels in males, while ovarian hormones are higher in females, and small variations can produce large effects (Erlanger et al., 1999). Previous studies suggest women generally outperform men on certain verbal tasks, while men surpass women on certain visuospatial tasks (Terlecki & Newcombe, 2005). The current study also found that females had lower arousal states than males, suggesting females may benefit more from low-arousal mental training (i.e., meditation) while males benefit more from high-arousal training (i.e., video game training).

Moreover, divergent gender effects of meditation training may stem from different coping strategies. The internal activity induced by meditation might better accommodate females' internal coping strategies, while the external activity of game playing might better accommodate males' external coping strategies

(Broderick, 1998; Li et al., 2006; Rojiani et al., 2017).

Although both training types improved attention, only meditation training reduced state anxiety. Compared to meditation, video games satisfy the need for competence (Przybylski, Rigby, & Ryan, 2010) and demand more complex cognitive resources for success (Lorenz et al., 2015). Game players must devote active attention to achieve high scores, whereas meditators may engage effortless attention (Garrison et al., 2013). Thus, consistent with previous studies, video game training specifically affects visual selective attention (Green & Bavelier, 2003), while meditation may also improve inner peace (Liu et al., 2013).

Contrary to our hypothesis, the 4-day training did not reduce AB magnitude. Previous studies showed that meditation experts in 3-month intensive retreats reduced AB magnitude more than novices (Slagter et al., 2007; van Leeuwen et al., 2009; van Vugt & Slagter, 2014). To our knowledge, only one study examined short-term (17 min) meditation training effects on AB, finding that FA meditation produced greater AB magnitude than OM meditation (van Vugt & Slagter, 2014). That 17-minute training primarily affected accuracy at lag 3 (210 ms after T1), with FA decreasing and OM increasing lag 3 accuracy. The current 4-day progressive training increased accuracy at each lag, suggesting more training time optimizes attention resource distribution. These results align with findings that expert meditators (1-29 years experience) performed significantly better than age-matched controls at lags 2, 6, and 7 (200 ms, 600 ms, and 700 ms after T1) (van Leeuwen et al., 2009).

While this study contributes important findings to mental training and attention research, caution is warranted when generalizing. Gender differences in mental training were tested on AB performance in college students. Future studies should explore effects of different meditation and video game training types on various attentional performances in other age groups, especially given varying hormone levels across ages (Vermeulen, 2002).

In summary, this study demonstrates that short-term meditation training impacts attention allocation over time, with stronger effects in females than males. These findings support brain plasticity and mental functioning effects while illustrating the efficacy of short-term, systematic mental training. It is crucial for clinicians to consider gender when implementing meditation-based therapy, as males and females benefit from different training forms.

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Note: Figure translations are in progress. See original paper for figures.