THE EFFECTS OF A FOUR-WEEK TECHNOLOGY-DELIVERED MINDFULNESS INTERVENTION DURING A ROWING TASK

by

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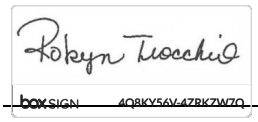

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ABSTRACT

Mindfulness can be defined as paying attention nonjudgmentally, in the present moment, and being accepting of thoughts (Kabat-Zinn, 1994). Previous research has highlighted how mindfulness can be used to build physical activity habits, namely through enjoyment of physical activity, and utilizing associative attention during an exercise task which contradicts typical thinking about enjoyment of exercise (Cox et al., 2018; Cox et al., 2020; Yang & Conroy, 2019). The purpose of the current study was to examine if mainstream mindfulness delivered via technology could be used to increase the enjoyment of exercise within an active population. A total of 32 participants between 18 and 37 years of age (21.09 $\pm$ 3.66) who met World Health Organization (WHO) physical activity guidelines and had no previous experience with mindfulness or meditation were included. Participants were either in the mindfulness intervention (n = 17) or control condition (n = 15). Participants completed ten visits over four weeks, each visit consisting of watching an episode of either Headspace Guide to Meditation or Wild Babies on Netflix, followed by a 25-minute rowing task. Results found that the intervention group exercised at a higher intensity and with associative attention, whereas the control group exercised at a lower intensity, with dissociative attention, and all participants reported the same rating of perceived exertion. The mindful exercisers experienced improved forecasted and remembered pleasure from the intervention, indicating that they had better positive perceptions of the exercise they completed, leading them to be more optimistic about their next exercise bout. This research benefits exercise professionals to understand better how mindfulness can be used to improve enjoyment of exercise, leading future research to investigate if the same results can be found for inactive populations, who could use the intervention to create and sustain exercise habits.

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Chapter I: Introduction

Approximately 80% of Americans do not reach current physical activity recommendations and are more likely to experience cardiovascular disease, type-2 diabetes, and site-specific cancers such as breast, colon, and bladder (World Health Organization (WHO)), 2020). The current worldwide adult physical activity recommendations are at least 150 minutes per week of moderate intensity aerobic activity or 75 minutes of vigorous intensity aerobic activity, and resistance training at least two times a week (WHO, 2020). By engaging in the recommended physical activity amount weekly, individuals can improve sleep and mental health (WHO, 2020). Additional psychological outcomes that can be seen after any duration of physical activity are improved mood, decreased depression and anxiety, increased self-esteem, and improved cognitive functioning (Sharma et al., 2006). There is also a greater ability to cope with life stress after exercising, which can be particularly beneficial for college students who face abnormally high levels of academic stress (Chiodelli et al., 2020; Flett et al., 2020).

To increase physical activity behaviors, researchers are now considering the impact of affective variables, such as enjoyment. Affective responses to exercise play a role in shaping exercise and physical activity behaviors (Rhodes & Kates, 2015). Improvements in enjoyment, an associative attentional allocation, and lower ratings of perceived exertion during exercise can help promote exercise habits and long-term sustained exercise meeting the guidelines (Bagheri et al., 2021; Cox et al., 2020; Hanley et al., 2014; Meggs & Chen, 2021; Tsafou et al., 2016a; Tsafou et al., 2016b). Mindfulness has been postulated to improve the experiences of physical activity and sustainable exercise habits to enhance well-being for all individuals (Cox et al., 2018; Cox et al., 2020; Meggs & Chen, 2021; Tsafou., 2016a; Tsafou et al., 2016b).

Mindfulness is defined as “paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally,” which sounds simplistic and achievable, but can be difficult for even the most experienced practitioners of mindfulness (Kabat-Zinn, 1994, p. 4). Awareness of the present and acceptance of the moment are key components of being mindful, but many struggle with what it means to be accepting of the thoughts they experience (Kabat-Zinn, 1994). Typically, an emotion and direction are assigned, either positive or negative, to our thoughts (Kabat-Zinn, 1994). To practice mindfulness, an individual must override their automatic thoughts and processes of assigning directionality to their thoughts, to be actively engaged in their lives rather than passively floating through their life (Kabat-Zinn, 1994). This can be accomplished through mindful meditation, first focusing on breathing and developing neutral thoughts, but then applying it to other aspects of one’s life like walking, eating, and even washing dishes (Hanley et al., 2014). By taking time to be mindfully aware and present, it forces an individual to take an active role in their thoughts and be purposeful to accept any thoughts, while remaining neutral.

Once an individual has taken an active role in their consciousness, it may manipulate their perception of exertion. Perceived exertion is used to determine the subjective intensity of effort, strain, discomfort, and/or fatigue, and was coined by Gunnar Borg to measure perceptual intensity during exercise (Nobles & Robertson, 1996). The Borg Rating Perceived Exertion (RPE) scale ranges from 6 (no exertion at all) to 20 (maximal exertion) and is found to correlate with heart rates ranging from 60-200 beats per minute, respectively (Robertson, 1998). A novice exerciser is more likely to report a higher RPE score and have a higher exercising heart rate when compared to an experienced exerciser doing the same task at the same relative workload (Tenenbaum & Connolly, 2008).

Mindfulness is not definitively associative attention, but it shares the same properties that emphasize self-awareness and attention to bodily sensations seen in associative attention (Salmon et al., 2010). With greater sensitivity to physiological symptoms through mindfulness, it can enhance appraisal and acceptance of challenges one may face during physical activity, and lead to a better holistic exercise bout (Salmon et al., 2010). Associative attention has been defined as focusing on the body and the sensations being felt within the body (Masters & Ogles, 1998). Dissociative attention can be defined as focusing on anything outside of the body. At lower intensities and during training, individuals tend to use dissociative attention, meaning they are distracting themselves and not paying attention to their bodies (Hutchinson & Tenenbaum, 2007; Masters & Ogles, 1998; Stanley et al., 2007; Tenenbaum & Connolly, 2008). As intensity increases, bodily demand increases as well, which leads to a shift in the use of associative attention, especially during races and competition (Hutchinson & Tenenbaum, 2007; Masters & Ogles, 1998; Stanley et al., 2007; Tenenbaum & Connolly, 2008).

The roots of mindfulness can be traced back to traditional Buddhist practice, but the mindfulness practiced today has evolved. Dr. Kabat-Zinn has connected root mindfulness techniques to the Western techniques seen in mindfulness-based interventions led by competent practitioners (Kabat-Zinn, 2003). Three mindfulness-based interventions are predominantly used to aid in teaching mindfulness in sport and exercise: the Mindful-Acceptance-Commitment (MAC) approach, the Mindfulness Meditation Training in Sport (MMTS), and Mindful Sport Performance Enhancement (MSPE) (Glass et al., 2020).

Mindfulness has been further adapted from these structured interventions, to being incorporated into technology in the form of smartphone applications (apps) to increase accessibility. These apps allow individuals access to the traditional intervention benefits, in a

shorter amount of time (Economides et al., 2018). Research has shown similar effects on well-being, stress, anxiety, and depression from a digital online intervention compared to traditional in-person interventions (Spijkerman et al., 2016). Some of the most popular apps available for download are Headspace and Calm. Headspace is geared towards beginners, offering quick sessions of mindfulness through guided meditation (Timmons, 2022). Calm is a better option for experienced users because it incorporates longer mindful meditation sessions when compared to Headspace (Timmons, 2022). In a review, researchers found that Headspace was ranked first using the Mobile Application Rating Scale (MARS) out of twenty-three possible apps available for download (Mani et al., 2015). Headspace ranked first on the following subscales from the MARS: engagement, functionality, aesthetics, information, and satisfaction (Mani et al., 2015). With almost one million reviews on the iTunes App Store, the app Headspace has an average rating of 4.8 out of 5 stars, but little is known of how long users will complete meditation sessions, or how long they use the app before letting it sit dormant and untouched.

Mindfulness should be investigated because of the positive benefits one can incur from this practice, especially with how readily available the practice is for users since they can conveniently open an app at any time to practice. Mindfulness practice has been linked to a reduction in depression, anxiety, binge-drinking, binge-eating, and stress (Cavanagh et al., 2014; Chatzisarantis & Hagger, 2007; Roberts & Danoff-Burg, 2010). With all of these suggested positive outcomes related to high levels of dispositional mindfulness, it would be a logical progression to believe implementing a mindfulness-based intervention in populations who can benefit from these outcomes is worthwhile. A link to physical activity has been made, showing mindful individuals are more physically active throughout a given week, enjoy their physical

activity more, and perceive their daily physical activity to be higher than those not practicing mindfulness (Roberts & Danoff-Burg, 2010).

Those who are mindful and hyper-aware of their current situation may believe they are spending more time doing a specific task but also tend to enjoy those tasks to a greater degree than those not exhibiting mindfulness (Hanley et al., 2014). This can be applied to physical activity, where an individual may perceive their exercise bout to be longer, but once it is over, they have a higher level of enjoyment than if they completed the physical activity without being mindful. One study implementing the use of mindfulness during physical activity found that the associative state was linked to greater enjoyment, remembered affect, and forecasted affect when compared to a dissociative state induced by music (Cox et al., 2020). Since the exercisers seemed to forget any of their negative feelings associated with physical activity, it would be logical to assume they would be more likely to engage in physical activity in the future.

Another study investigating mindfulness during physical activity found that being more aware of the physical activity, increased satisfaction with the activity, and the ability to cope with the negative thoughts experienced during physical activity prevented changes in satisfaction (Tsafou et al., 2016). By not assigning judgment to the thoughts experienced during exercise, these participants were more satisfied after the completion of physical activity, and it can be theorized that they would then engage in more physical activity in the future.

Research has also been conducted on how mindfulness can help an individual detach themselves from the sensory pain dimension experienced while exercising, thus improving the exercise experience (Bagheri et al., 2021). This aligns with research on how mindful cycling improves self-awareness of physiological cues encountered during exercise such as heart rate, and accurately predicts perceived exertion ratings correlating with the experienced heart rates

during exercise (Meggs & Chen, 2021). By exercising mindfully, studies lead to the conclusion that physical activity will be enjoyed and sustained over time by blocking out or reframing the typical negative sensations of physical activity.

Purpose of the Study

The purpose of this study was to explore the effect of a four-week, low-dose, technology-delivered mindfulness-based intervention on ratings of perceived exertion, heart rate, attentional allocation, exercise enjoyment, state mindfulness, and trait mindfulness during and after laboratory-based rowing physical exercise tasks.

Chapter II: Review of Literature

Past studies have shown improvements in mindfulness to increase intrinsic motivation and enjoyment through associative attention and lowered ratings of perceived exertion, which can be appealing to individuals needing to establish healthy exercise habits (Bagheri et al., 2021; Cox et al., 2018; Cox et al., 2020; Meggs & Chen, 2021; Robin et al., 2020; Ruffault et al., 2015; Wankel 1993). Many different mindfulness intervention formats exist, from traditional face-to-face to those delivered via technology. A wide variety of benefits stem from a mindfulness intervention, especially those that can impact exercisers looking to change their relationship and exercise perception. The purpose of this literature review was to explore previous research to understand how physical activity is perceived by individuals and investigate ways to increase physical activity in those who do not meet recommendations for physical activity. A secondary purpose of this literature review was to synthesize mindfulness research and postulate how it can be applied to exercisers looking for a solution to their failure of meeting physical activity guidelines.

This literature review will begin with a broad physical activity discussion, followed by discussion on how enjoyment of physical activity can increase the amount of physical activity completed weekly by those not meeting current recommendations. The next section will explain mindfulness, how it can be used as an effective intervention for many populations, and how technology has changed the way mindfulness is delivered. Lastly, how mindfulness can be applied to exercisers to increase physical activity, specifically by altering perceived exertion and attentional focus during exercise will be addressed.

Physical Activity

Physical activity is necessary to maintain a healthy lifestyle and combat disease. The World Health Organization (WHO) defines physical activity "as any bodily movement produced by skeletal muscles that requires energy expenditure" and "refers to all movement including during leisure time, for transport to get to and from places, or as part of a person's work" (WHO, 2020, para. 1). The current WHO physical activity guidelines are that adults ages eighteen to sixty-four engage in 150-300 minutes of moderate intensity, or 75-150 minutes of vigorous intensity aerobic physical activity a week, with resistance training twice a week (WHO, 2020). Moderate intensity activity is considered a brisk walk, and vigorous intensity activity to be a jog or run (Office of Disease Prevention and Health Promotion, 2018).

The American Medical Association (AMA) also has guidelines for suggested physical activity, especially since in 2018, annual health care costs in America were upwards of $117 billion, and 10% of premature fatalities are associated with not meeting the recommended guidelines (Carlson et al., 2015; Carlson et al., 2018; Office of Disease Prevention and Health Promotion, 2018). The revised guidelines from the U.S. Department of Health and Human Services of 2018 align with those of the WHO, 150-300 minutes of moderate intensity aerobic exercise or 75-150 minutes of vigorous intensity aerobic exercise each week, with muscle-strengthening activities at least twice a week (Piercy et al., 2018). Research stresses that any physical activity is better than none, and the health benefits of improved cognitive function and sleep, and reduced anxiety and blood pressure can result from meeting the guidelines (Piercy et al., 2018). Although, with sustained and prolonged activity, the benefits improve and strengthen the ability to protect against cardiovascular disease (Marcus et al., 2000; Piercy et al., 2018). To

combat the sedentary nature of our current world, changes must be made to promote sustained physical activity to reap the protective benefits.

The physiological physical activity benefits are expansive and can occur for all ages. Improved cardiorespiratory fitness and maintaining a healthy body weight can be seen as key protective benefits of meeting the current physical activity guidelines (WHO, 2020). Long-term, habitual physical activity can reduce the risk of hypertension, stroke, diabetes, cancer, and depression (WHO, 2020). Other physiological benefits of physical activity include reduced risk of osteoporosis, hypertension, coronary heart disease, and colon cancer (Blair, 1995). Debate exists on how many minutes of physical activity in a week are required to see the greatest benefits in the protective factors of exercise. From the New Zealand Medical Journal, it is suggested that two vigorous-intensity physical activity bouts be conducted each week, but five to eight sessions a week would be associated with the highest VO_{2max}, therefore greatest cardiorespiratory fitness, and protective effects against chronic conditions, including psychological stress (Dearing & Paton, 2022).

The psychological physical activity benefits are just as influential as the physiological benefits, namely because of the ability to decrease symptoms associated with depression and anxiety (Sharma et al., 2006). Psychological benefits include improved mood, depression, and anxiety, increased self-esteem, and elevated cognitive function (Sharma et al., 2006). A longitudinal study of South Korean adults, with 30.3% exhibiting depressive symptoms, found those who did not regularly exercise over the ten-year study were more likely to experience depressive symptoms than those who did exercise regularly (Kim, 2022). By feeling more accomplished and enthusiastic after finishing a bout of physical activity, an individual may be more likely to exercise again, until it forms a habit. Research has been conducted on the

comparison of prescription antidepressant drugs and exercise on depression (Blumenthal et al., 1999). It has been found that exercise alone can have improvements on major depressive disorder over time and that those with less severe depression responded quickly to a combination of medication and exercise (Blumenthal et al., 1999).

Similar findings exist for the relationship between exercise and anxiety, with a jogging intervention reducing state and trait anxiety in adults with similar results to traditional stress reduction interventions (Long, 1984; Long & Haney, 1988). A dose-dependent relationship may exist between the best outcomes towards alleviating depression and anxiety, with higher frequencies of aerobic activity, three to five times during the week compared to only once, leading to greater improvements (Legrand & Heuze, 2007). These values support the rationale for why the worldwide and national recommendations are set at 150 minutes of moderate intensity activity, with easy division over the course of three to five exercise bouts being easier to fit into busy schedules and optimize physiological and psychological benefits (Legrand & Heuze, 2007).

The key psychological benefit of improved mood state is integral in habitual exercise across the lifespan. Through numerous studies, exercise has been found to be the most effective technique to improve a bad mood and an integral technique in raising energy and reducing tension (Thayer et al., 1994). Those less likely to use exercise as a self-regulating technique for mood were sedentary individuals and introverts (Thayer et al., 1994). A dose-dependent relationship was found between exercise duration and positive mood states, with a duration of only ten minutes of aerobic exercise necessary to see improvements (Hansen et al., 2001). Only ten aerobic exercise minutes are needed for individuals to experience increased vigor, decreased fatigue, and decreased total negative mood state (Hansen et al., 2001). These benefits can be seen

for thirty-minute exercise bouts as well, which if done five times per week can reach the recommended amount minutes of aerobic exercise (Hansen et al., 2001).

Many Americans do not meet the recommended physical activity guidelines and do not receive the physiological and psychological exercise benefits because they face many barriers to participation. Approximately 80% of Americans do not reach the guidelines, with only 26% of men, 19% of women, and 20% of adolescents reaching the guidelines (Office of Disease Prevention and Health Promotion, 2018). Many American adults cite lack of time and lack of enjoyment during exercise as the primary reasons they do not reach the recommended physical activity guidelines (Leslie et al., 1999; Stutts, 2002). To promote long-term physical activity participation, choice of activity and intensity are critical components because they allow the exerciser to feel in control and provides ownership in the behavior change (Marcus et al., 2000).

Physical Activity Enjoyment

A key determinant in replacing sedentary behaviors with physical activity and then moving from practice to a habit is if individuals enjoy themselves while exercising and feel satisfied once they are finished. Enjoyment in exercise can be defined as “an optimal psychological state (i.e., flow) that leads to performing an activity primarily for its own sake and is associated with positive feeling states” (Kimiecik & Harris, 1996, p. 256). To optimize exercise enjoyment, an individual must be intrinsically motivated to complete the exercise. An individual exhibits intrinsic motivation when they do things that interest them, freely, without the promise of rewards or punishment (Deci & Ryan, 1985). This contrasts with extrinsic motivation, where the purpose of performing an activity is not for pleasure, but for the purpose of rewards like money, praise, social approval, and scholarship, or fear of punishment (Deci & Ryan, 1985).

To combat lack of time and lack of enjoyment, Overstreet and colleagues (2017) investigated how two activities that take up substantial time can be integrated to achieve maximal efficiency and enjoyment, by having college students exercise while watching television. With the time engrossed in leisurely activities incorporated within exercise, it may be more achievable for individuals to meet the recommended physical activity guidelines (Overstreet et al., 2017). Their study found that enjoyment was experienced more for those cycling with television than those without, and those with higher intrinsic motivation experienced more enjoyment than individuals with low intrinsic motivation (Overstreet et al., 2017). Intrinsic motivation is a key indicator of sustained physical activity and is referenced in the definition of enjoyment as completing the activity for its own sake, and not focusing on external pressures to complete the activity (Kimiecik & Harris, 1996).

Along with intrinsic motivation, self-efficacy, one's belief in their ability to execute a certain skill or pattern, is also a predominant feature in physical activity research (Bandura, 1978). Research has investigated intrinsic motivation and self-efficacy in physical activity and has found that low self-efficacy and low intrinsic motivation are linked to lower reported physical activity (Leslie et al., 1999, Stutts, 2002; Wankel, 1993). Stutts (2002) investigated adults working full-time and found that the time constraint for not participating is experienced by both sedentary and active individuals and is felt as the lack of control over their responsibilities. Their research was based on Bandura's Social Cognitive Theory, that expectancies about ability to perform the behavior to achieve a specific outcome (efficacy expectations) will impact how much effort is put forth toward the outcome, and how long one will persist towards a particular outcome (Bandura, 1986; Stutts, 2002). Those with high self-efficacy will put forth more effort, and persist longer, which can be applied to physical activity, so interventions should stress self-

efficacy and intrinsic motivation. Leslie and colleagues (1999) investigated college students with insufficient physical activity levels, with a sample of over 2,700 participants, and found those with higher levels of self-efficacy had higher physical activity levels, and those who did not enjoy physical activity exhibited lower physical activity levels. In contrast to Stutts (2002), Leslie and colleagues found students who were employed had higher physical activity levels, suggesting they are better able to overcome the lack of time barrier, by having better time management and organization skills (Leslie et al., 1999; Stutts, 2002). With 40% of the study participants not participating in physical activity levels sufficient for long-term health benefits, and with physical activity levels that drastically dropped in the period between adolescence and adulthood, college students are a vulnerable population needing attention and interventions to improve their physical activity both short- and long-term (Leslie et al., 1999).

For an individual to experience greater intrinsic motivation during exercise, it is suggested that the activity be self-selected or preferred rather than prescribed (Berger et al., 2016). Activity that is self-selected is usually influenced by goals such as weight loss, whereas preferred activity is purely a choice that is not influenced by outside factors (Berger et al., 2016). Berger and colleagues (2016) found that when college students exercise for at least fifteen minutes at a preferred intensity, they self-select intensities that are harder than moderate, yet their perceived exertion is lower than what would correlate with exercising at higher intensities. This demonstrates when the activity is intrinsically chosen, an individual will exercise at harder intensities, and may only need 75 minutes of aerobic activity a week rather than 150 minutes and will still see the positive psychological benefits of mood alteration from exercising (Berger et al., 2016). These findings expound upon those by Parfit and colleagues (2000) who found individuals chose to exercise at higher intensities in preferred conditions compared to prescribed,

and there was greater self-determination indications and intrinsic motivation for the preferred condition. Both conditions demonstrated high positive well-being and low psychological distress, but the element of choice in the preferred condition was related to higher levels of interest-enjoyment in the Intrinsic Motivation Inventory (Parfit et al., 2000).

The linkage between preferred selection of exercise intensity and enjoyment has been further researched, Raedeke (2007) demonstrated that enjoyment contributes to high levels of positive affect rather than low levels of negative affect during short bouts of aerobic exercise. However, with higher intensities comes higher perceived exertion levels during exercise, which may lead an individual to feel bad during exercise, but enjoyment may override those feelings once the exercise is completed (Raedeke, 2007). Plante and colleagues (2018) also found that higher perceived fitness levels are indicative of lower levels of perceived exertion. Level of exertion is independent of enjoyment during exercise but is correlated with levels of perceived fitness (Plante et al., 2018). Perceived fitness level has been found to indicate exercise at a higher intensity when selection is preferred, and this will lead to higher enjoyment after the conclusion of the workout (Plante et al., 2018). Those of higher fitness levels may inherently believe high intensity exercise does not require high exertion on their part and will enjoy the exercise even though they are working harder.

The importance of exercise enjoyment has also been investigated while aiming to promote exercise for primary healthcare patients in Sweden (Hagberg et al., 2009). An intervention involving group exercise sessions resulted in higher levels of enjoyment compared to no intervention of exercise education and guidance (Hagberg et al., 2009). They suggested future research to promote physical activity should investigate exercise enjoyment for long-term effectiveness and exercise habit sustainability (Hagberg et al., 2009). Wankel (1993) explored

how to increase physical activity enjoyment and found that focusing on social interaction and the elements of flow could help overcome the barrier of lack of ability and perceived competence. Flow has been found to increase life satisfaction, self-esteem, and well-being, and is directly related to mindfulness (Wankel, 1993). Leslie and colleagues (1999) had similar findings that college students with low social support exhibit lower levels of physical activity, which can be improved by interventions that focus on a sense of community and awareness. By increasing one's mindfulness and stressing active involvement by being present, it directly relates to one's capability to achieve flow and increase intrinsic motivation to enjoy physical activity (Wankel, 1993). An area of research trying to improve enjoyment during exercise has focused on the practice of mindfulness to achieve greater enjoyment of the activity and maintain exercise habits long-term.

Mindfulness

Mindfulness has been defined by many who seek to capture the essence of the practice in a tangible way but fail to realize that every individual will practice mindfulness differently and each person utilizes mindfulness for different purposes (Kabat-Zinn, 1994). The definition that garners the most consensus from the mindfulness community is Dr. Jon Kabat-Zinn's definition that mindfulness as paying attention nonjudgmentally, in the present moment, and being accepting of thoughts (Desbordes et al., 2015; Kabat-Zinn, 1994). Many have tried to conceptualize and organize the mindfulness construct into different components and facets, but they all refer and cite back to this original definition of Western mindfulness (Desbordes et al., 2015; Grossman, 2008). A key component of mindfulness is not assigning an emotion to thoughts that arise to attention, this is done to be accepting of the thoughts, simply recognizing them, and letting them go (Kabat-Zinn, 1994). Mindfulness is not just an increase in attention,

because the attention becomes confident and purified, meaning that when practicing mindfulness, one cannot be angry and mindful at the same time (Olendzki, 2011). One should not grasp either the past or the future, just rest in the present (Dunne, 2011). Those attempting practice should also keep in mind that mindfulness is not trying to fix anything or get you anywhere, it is just a way to enlighten what is already inside you (Kabat-Zinn, 2003).

Mindfulness-based interventions are part of the most recent wave, the third wave of cognitive and behavioral therapies (CBT), utilized by psychologists and therapists (Hayes, 2004). Previous CBT emphasized changing thoughts and feelings that are maladaptive and causing problems, whereas the current landscape of CBT emphasizes changing the relationships with these thoughts and feelings to overcome barriers of growth (Hayes, 2004). Dr. Kabat-Zinn used this principle by implementing mindfulness into a stress reduction and relaxation program for patients suffering from chronic pain (Kabat-Zinn, 1982; Kabat-Zinn et al., 1985). Utilizing the deep breathing associated with mindfulness, patients could use their breathing to re-center attention when pain arises and learn to detach the sensory and cognitive components of pain to cope with the sensory dimension of pain but not cognitively acknowledge the pain (Kabat-Zinn, 1982; Kabat-Zinn et al., 1985). Over the ten-week intervention, regular practice of mindful meditation was able to decrease perceptions of pain (Kabat-Zinn, 1982; Kabat-Zinn et al., 1985). Since that original study in 1982, mindfulness has been used in stress reduction therapies, treatment of eating disorders, pain, clearing psoriasis, and prostate cancer interventions (Kabat-Zinn, 2003).

History and Evolution

The mindfulness practiced today is considered Western mindfulness, with the roots of the practice dating back to traditional Buddhist practice, but Buddhist scholars feel the essential

meaning of mindfulness has been exploited and distorted from the original, deeper meaning (Williams & Kabat-Zinn, 2011). Right Mindfulness is the Buddha's teaching that emphasizes accepting everything without judgment or reaction, being inclusive and loving, and finding ways to sustain appropriate attention throughout the day to always come back to the present moment (Hanh, 1999). The Buddha's Way of Mindfulness is seen many times within his Doctrines, including being the Seventh Factor of the Eight Noble Eightfold Path, which the Fourth of the Four Noble Truths (Thera, 1969). The Four Noble Truths are suffering, creating suffering, cessation of creating suffering, and the Eightfold Path (Hanh, 1999). The eight components of the Eightfold Path are Right View, Right Thinking, Right Speech, Right Action, Right Livelihood, Right Diligence, Right Mindfulness, and Right Concentration (Hanh, 1999).

Right Mindfulness is also seen as the first of Seven Factors of Enlightenment, one of the Five Faculties, and is categorized with Right Effort and Right Concentration within a threefold division of the Eightfold Path (Thera, 1969). Right Mindfulness can be divided fourfold into contemplation of the body, contemplation of breathing, contemplation of state of mind, and contemplation of mental contents (Thera, 1969). Other resources divide Right Mindfulness into four objects being our body, our feelings, our mind, and the objects of our mind (phenomena) (Hanh, 1999). Contemplation of the body should contain mindfulness of the body in the body, preaching kindness and positive treatment of one's body (Hanh, 1999). By paying close attention to the body, it does not leave as much room for judging and doubting thoughts (Goldstein, 2002). Contemplation of the mind should contain mindfulness of the mind in the mind, reminding ourselves that anything in our mind is simply a formation and one must practice mere recognition to diminish strong reactions to formations of the mind (Hanh, 1999).

Regarding mindfulness of feelings, there is a tendency to cling to the pleasant and chase away unpleasant feelings, but when practicing mindfulness one should identify the feeling, simply recognize the feeling, and store the feeling to better respond next time is arises (Hanh, 1999). If one is not being mindful, then it may be easy to personify emotions and drown in them (Goldstein, 2002). However, with mindfulness acting as a life preserver, one can still experience emotions without drowning in them, and better recognize triggers and free us from conditioned responses (Goldstein, 2002).

To achieve Right Mindfulness, individuals progress through three stages, the first being initially taking notice and turning attention towards the stimulus, where the conscious breaks through the subconscious (Thera, 1969). The second stage consists of attending to details and relationships with the stimulus, associative thinking, and abstract thinking. The final stage is achieving Right Mindfulness, keeping the mind free from bad influences, knowing right from wrong, and serving the purpose of the Extinction of Suffering. To advance through the stages requires both an increase in the intensity and quality of attention.

The Buddha's Way of Mindfulness is "the heart of Buddhist meditiation" and is as practical today as it was 2,500 years ago when the Doctrine came to be (Thera, 1969, p. 7). Right Mindfulness is also "at the heart of the Buddha's teaching" (Hanh, 1999, p. 64). Mindfulness "is what makes any spiritual practice possible … [meaning] we need to make mindfulness the heart of our practice" (Goldstein, 2002, p. 88-90). It serves the purpose of keeping the mind away from greed, hatred, and delusion because those who master their mind can develop greater strength and happiness (Thera, 1969). In the Buddhist Doctrines, the mind is the starting point, focal point, and culminating point (Thera, 1969). The Doctrine of the Mind is to know the mind, shape

the mind, and free the mind, meaning that mindfulness is the master key for knowing, the perfect tool for shaping, and allows for the manifestation of achieving freedom (Thera, 1969).

Right Mindfulness is divided into Bare Attention and Clear Comprehension, calling upon perception and attentiveness (Thera, 1969). This can be demonstrated by the Contemplation of Body which was previously mentioned. Contemplation of the Body can be demonstrated through both mindfulness breathing and mindfulness body posture. Mindful breathing should be perceived and appraised, but not interfered with in the sense of holding, stopping, or deliberately breathing in a rhythmic pattern (Hanh, 1999; Thera, 1969). The Bare Attention is provided towards breathing, and the Clear Comprehension is used to not disrupt to the normal bodily function of breathing, which is at the heart of Buddhist meditation (Thera, 1969). Knowing that mindfulness of the body should not disrupt breathing, it should be noted that when paying attention to one's breathing, it will naturally become slower and deeper which is okay and should not be cause for distress (Hanh, 1999). Mindful meditation breathing should not be considered a breathing exercise, but rather an exercise of awareness (Goldstein, 2002).

Through Theravada Buddhist tradition, mindfulness is the direct way to awakening, and no matter how many branches of practice stem from the one Buddhist tree, the diversity of the practices all respect and honor the Buddha's Doctrines (Goldstein, 2002). Monasteries in the 20th century opened their doors to common people to teach the practice of meditation, and from there it has spread globally. With mindful meditation not as exclusive, it began to evolve and differ depending on the individual practicing. For example, instead of focusing on breathing in and out through the nostril, some shifted to focusing on the rise and fall of the abdomen to achieve greater balance of the mind. The basic principle of paying full attention to the present moment has remained in all variations of mindful meditation.

It has been warned against using spiritual practices for personal gain, specifically meditation and Buddhist principles, for personal gain and ego-building because it directly contradicts the purpose of the practice (Trungpa, 1973). Spiritual materialism represents a distorted, egocentric version of spirituality that opposes the Buddhist philosophy of uncovering an awakened state of mind to achieve enlightenment (Trungpa, 1973). An example of this that can be seen today is intensive meditation retreats that may last only a weekend, that the primary motivation for attending is self-bettering for purposes like material or worldly gain (Fields, 1992; Trungpa, 1973).

Buddhism has made its way West over generations and has evolved just like the diversity of traditions that have existed in Asia for centuries (Fields, 1992; Goldstein, 2002). The practice of mindfulness remains somewhat the same, even though it can be practiced in over 50 different ways, with the key components of paying attention, resting in awareness, and leading down the path of awakening (Goldstein, 2002). The Buddha taught that developing the foundations of mindfulness is an intensive process that could take anywhere from seven days to six years, but the process of mindful meditation has remained somewhat the same, crediting technology making accessibility to the practice more widespread (Goldstein, 2002). Current Buddhists are split in opinion about how mindfulness has been manipulated and twisted for therapy and secular purposes but has shown success in medical schools and prisons (Bodhi, 2011). It has been noted that if this is working and showing success for these purposes, if the sacredness is understood, then its use should be continued (Bodhi, 2011).

Benefits of Mindfulness

Now that mindfulness has shifted into what it is known as today, there are countless benefits for both clinical and non-clinical populations, and both brief and intensive interventions.

The primary mindfulness benefit is seen by a decrease in psychological distress, and an increase in psychological well-being (Baer et al., 2012; Roemer et al., 2021). Others have identified this benefit as an increase in positive affect, with a decrease in negative affect (Hanley et al., 2014). This is accomplished through a reduction in depression and anxiety, as evidenced by self-help interventions that enhance mindfulness (Cavanagh et al., 2014). Other outcomes from these benefits are an improved mood, immune functioning, and sport performance among athletes, outcomes that are like those resulting from exercise (Gardner & Moore, 2017). Those exhibiting high levels of mindfulness also demonstrate better cardiovascular health than those low in mindfulness, one of the contributing factors being more physical activity (Loucks et al., 2014).

Chatzisarantis & Hagger (2007) have explored other benefits describing, the intention-behavior relationship with the theory of planned behavior, contrasting individuals of high and low mindfulness with how habits, awareness, and attention all impact intentions and self-control. It was found that mindful individuals are more likely to follow through on their intentions when compared to those who are less mindful, and that mindful individuals are better able to control counter-intentional habits, specifically binge-drinking, when compared to less mindful individuals.

Research examining mindfulness and health behaviors found those with higher mindfulness levels had better quality of sleep, less binge eating, were more physically active, with perceptions of higher physical and psychological functioning, and decreased stress (Roberts & Danoff-Burg, 2010). With all these suggested positive outcomes related to high levels of dispositional mindfulness, it would be a logical, and worthwhile progression to implement a mindfulness-based intervention to populations who can benefit from these outcomes. A link to physical activity has been established, that mindful individuals are more physically active

throughout a given week, enjoy their physical activity more, and perceive their daily physical activity to be higher than those not practicing.

The mindfulness intervention duration does not seem to mitigate the positive effects of the intervention. Research has shown regardless of the number of hours spent on the intervention, there are still improvements (Chiodelli et al., 2020). One study comparing the durations of eight-, fifteen-, and twenty-minute sessions found improvements for all lengths in the facets of mindfulness (Banks et al., 2015). Other research has shown that the ideal, most realistic duration for a mindfulness session be twenty minutes in length for non-clinical populations (Demarzo et al., 2017). This length of session allows for focus on the most important topics within the module and eliminating any unnecessary "fluff" to make it time efficient (Demarzo et al., 2017). Carmody & Baer (2009) in a review of the literature, found the most common intervention length to be eight weeks in duration with the most evidence supporting it, but studies of shorter lengths have proven to be effective as a more time efficient option. Demarzo and colleagues (2017) compared a four- and eight-week intervention and found similar improvements on measured variables of mindfulness facets, positive and negative affect, and hospital anxiety and depression. The common traditional mindfulness interventions are historically between six and twelve weeks in length and will be elaborated upon in the next section (Glass et al., 2020).

Mindfulness Interventions

Mindfulness-Acceptance-Commitment (MAC). There are three mindfulness-based interventions commonly used by practitioners when working with non-clinical populations. The first being the Mindfulness-Acceptance-Commitment (MAC) program developed by Gardner and Moore (2004). The MAC protocol is heavily influenced by Acceptance Commitment

Therapy, which illuminates why the program heavily emphasizes acceptance and the relationship of altering perception of thoughts rather than trying to change them (Glass et al., 2020). The MAC focuses on mindful awareness and acceptance in a nonjudgmental manner in sport and exercise. The program consists of seven modules: (1) preparation and psychoeducation, (2) introducing mindfulness and cognitive defusion, (3) introducing values and values-driven behavior, (4) introducing acceptance, (5) enhancing commitment, (6) skill consolidation and poise – combining mindfulness, acceptance, and commitment, and (7) maintaining and enhancing mindfulness, acceptance, and commitment (Glass et al., 2020).

In a recent randomized controlled trial study, the MAC protocol was applied towards elite athletes of many sports (golf, soccer, cycling, and wrestling) and was found to have greater improvements in dispositional sport-specific mindfulness and emotional regulation, when compared to a traditional Psychological Skills Training (PST) intervention (Josefsson et al., 2019). The MAC protocol has also been applied to a case study of an adolescent springboard diver, where it was found to result in increased awareness and ability to be nonjudgmentally aware and accepting, while also objectively improving diving performance (Schwanhausser, 2009). Although improved performance is not the inherent goal of a mindfulness-based intervention, it can be seen as an unintended outcome of undergoing the protocol for athletes of high skill (Josefsson et al., 2019; Schwanhausser, 2009).

The MAC protocol can also be adapted or shortened to fit the target population. For an adolescent springboard diver, the Mindfulness-Acceptance-Commitment for Adolescents (MAC-A) was used to make the content age appropriate, but also resulted in the intended outcomes of awareness and acceptance of experiences (Schwanhausser, 2009). The protocol can be shortened to a brief intervention while still exhibiting positive outcomes. Meggs & Chen (2021) used a

brief-mindfulness intervention to investigate the effect on exertion and flow-state for sedentary adults and found that mindful cycling brings increased awareness and accuracy of physical exertion when comparing rating of perceived exertion (RPE) and actual heart rate. An increased absorption with activity and self-awareness of physiological state and immersion in activity was found (Meggs & Chen, 2021). This shows not only is the MAC protocol impactful for elite athletes, but could also aid in sedentary adults becoming more active and encourage engagement and awareness while developing exercise habits.

Mindfulness Meditation Training in Sport (MMTS). The second intervention commonly used is Mindfulness Meditation Training in Sport (MMTS) developed by Baltzell and Summers. The three key components of the MMTS 2.0 are to enhance attention, poise, and adaptation (Cote et al., 2019). The program consists of six sessions: (1) mindfulness and self-compassion (2) mindfulness: labeling experience, (3) concentration and performance, (4) self-compassion and performance, (5) values and somatic regulation, and (6) adapting, adjusting to the Now during performance (Glass et al., 2020).

MMTS has been shown to have success when implemented with Division I student athletes by enhancing the athlete's ability to recognize and accept experiences, alter relationship with emotions during competition, and express self-compassion for managing sport distress (Baltzell et al., 2014; Cote et al., 2019). When MMTS was incorporated into the training of Division I female soccer players, the players expressed via semi-structured interview that they experienced altered relationships with negative emotions on both the soccer field and in the classroom to better focus and persevere (Baltzell et al., 2014). The athletes conveyed they would have benefited more if the sessions occurred before their practice rather than after, and going through it as a team with their coaches provided meaningful support and motivation to continue

(Baltzell et al., 2014). Baltzell and colleagues (2015) conducted a concurrent qualitative study specifically examining coach perceptions and experiences with the MMTS intervention. The researchers reported coaches found aspects to apply to their coaching and personal lives, while also better understanding the sensitivity of their players and finding new ways to interact with their players (Baltzell et al., 2015). The coaches viewed MMTS as beneficial and valuable for their players and enjoyed their experiences through the activities and structural aspects of the intervention (Baltzell et al., 2015). When provided in a team setting including the coaches, MMTS was able to produce positive outcomes and achieve the goals of the intervention, while also enhancing the team culture and environment.

Cote and colleagues (2019) conducted a qualitative study to gain an understanding on how MMTS impacts Division I tennis players, an individual sport rather than team. Using a male and female sample, the study found benefits on the court along with positive gains in academic and personal development. A common theme found through their research of learned performance strategies (heightened awareness of distractions, bringing kindness to self, use of breath) highlighted the outcome of self-compassion in relation to managing sport distress, and coping for non-sport stressors (academic and personal). MMTS can be provided to both teams and individuals to increase dispositional mindfulness and respond optimally toward challenges in both sport and personal domains.

Mindful Sport Performance Enhancement (**MSPE).** The third intervention commonly used is Mindful Sport Performance Enhancement (MSPE) by Kaufman, Glass, and Pineau. The six sessions of MSPE are: (1) mindfulness, flow, nonjudgment, and autopilot, (2) present-moment attention and performance facilitators, (3) expectations, limits, and somatic awareness, (4) attachments and acceptance, (5) nonstriving and sport-specific anchors for attention, and (6)

program review, building an ongoing practice (Glass et al., 2020). The sessions are sequenced from a stationary mindfulness practice, to practice in motion, and lastly the integration into sport-specific movements.

The MSPE protocol can be used for recreational athletes or exercisers, and elite athletes of many sports. A study of recreational long-distance runners found that those who received a MSPE intervention had less striving for perfectionism, increases in state and trait mindfulness, and decreases in sport anxiety (De Petrillo et al., 2009). Those runners were then involved in a follow-up study one year later, where performance enhancement was shown from the pre-test and post-test to the follow-up in mile time (Thompson et al., 2011). In the follow-up, it was also shown there was an increased ability to act with awareness, increased trait mindfulness, and decreases in worries and task-irrelevant thoughts (Thompson et al., 2011).

In recent randomized controlled studies investigating Division III athletes, it was found those who completed MSPE protocols had improved satisfaction with life and sport performance, along with improvements in mindfulness (Glass et al., 2019; Hut et al., 2021). Glass and colleagues (2019) studied 52 athletes of many sports in a six-week MSPE program and determined that those who practiced mindfulness on their own between sessions had greater improvements in flow and ability to balance demands from many domains of life. The athletes in that study who experienced greater enjoyment had greater improvements in stress and flow, but also increased anxiety, possibly explained by increased awareness (Glass et al., 2019). Hut and colleagues (2021) studied 30 track and field athletes through either a six-week MSPE protocol or PST protocol, and found both groups to be less anxious, more relaxed, and better able to wind down. The difference between groups came from sport performance satisfaction, with the MSPE improving while the PST reduced (Hut et al., 2021). Whether experienced by elite athletes or

recreational exercisers, mindfulness-based interventions can be helpful to improve well-being, but the typical session layout is not enough to see optimal benefits, there needs to be practice outside of the typical intervention to see the greatest benefits.

Mindfulness and Technology

The traditional mindfulness-intervention required time commitment limits accessibility for those who have demanding work schedules or other demands in their life. To combat this, mindfulness techniques and protocols have been adapted and incorporated into technology by way of smartphone applications (apps). Mindfulness apps shorten the amount of time required to reap the benefits of a traditional intervention, personified by the app Headspace and the "Take 10" program, with ten introductory sessions that can be completed in ten minutes or less (Economides et al., 2018). Numerous studies have investigated the "Take 10" program within the Headspace app, and have found reduced stress and depressive symptoms, increased average mood ratings, increased resilience, and college adjustment (Economides et al., 2018; Flett et al., 2018, Howells et al., 2014).

Economides and colleagues (2018) compared the Headspace protocol with an audiobook created by the founder of Headspace, but usage of the app had better outcomes of reduced self-reported stress and irritability, with an increase in average mood ratings. Flett and colleagues (2018) investigated 208 undergraduate college students using Headspace, another mindfulness app, and an organizational app, and found that Headspace had the better app interface, and the mindfulness apps showed improvements in outcomes such as depressive symptoms, anxiety, and college adjustment. Howells and colleagues (2014) studied 121 participants and highlighted that those seeking happiness had gains in positive affect after using the app and reduced depressive symptoms. The study also concluded the delivery of a mindfulness intervention via technology is

an effective delivery medium because it resulted in significant positive impacts in ten days or less (Howells et al., 2014).

Other research focused on the use of mindfulness apps in full-time workers who experience a tremendous amount of stress in their daily lives. Bostock and colleagues (2019) studied 238 male and female employees of two large companies, one pharmaceutical and one high-tech, over eight weeks to compare the use of 45 sessions within the Headspace app with reading the National Health Service online advice for work stress. It was found that those in the mindfulness condition had improved well-being, daily positive affect, and workplace social support (Bostock et al., 2019). The mindfulness condition also resulted in decreases in anxiety and depressive symptoms, job strain, and overall distress (Bostock et al., 2019). Two other studies investigating the effects of mindfulness training for working individuals found that the common barriers for participants included lack of time, negative expectations about mindfulness, dealing with uncomfortable emotions (Laurie & Blackford, 2016; Rung et al., 2020). If working individuals can overcome the barriers to completing a digital mindfulness intervention, then they will see improvements in many aspects, primarily stress and depressive symptoms.

College students also need to be able to withstand stress and depressive symptoms since they are adjusting to new, unfamiliar environments, and dealing with immense academic and life pressure. The same benefits of decreased depressive symptoms, anxiety, and stress were seen for this population, whether the Headspace app was used for the ten-day program or a whole semester (Flett et al., 2018; Flett et al., 2020). There is a lack of research on how college students can benefit from brief mindfulness interventions, such as the Headspace app.

The Headspace app has been found to be easier to navigate by beginners of mindfulness practice, but other avenues such as the Calm app have also shown benefits but may be better for

those who already have baseline knowledge of mindfulness (Timmons, 2022). The Calm app has been used in research of college students and was found to benefit those with better perception of self and did not need to be used daily to see benefits such as improvements in well-being, trait mindfulness, and self-efficacy, intermittent practice was sufficient to see improvements (Clarke & Draper, 2020). With lack of time being a common barrier of using a brief mindfulness intervention such as an app, if daily practice is not necessary for improvements and benefits, then individuals may be more likely to continue usage of the apps.

Minimal research has compared mindfulness interventions delivered via technology or face-to-face in college students, but it has been investigated in children. At two Irish primary schools, ninety-three children ages 10-12 underwent either a face-to-face mindfulness intervention or one delivered on a computer game, *Mindful gNATs* (Tunney et al., 2017). It was found that both groups learned to let go of their thoughts, but the children preferred the computer game because it was more engaging compared to the "boring" face-to-face delivery (Tunney et al., 2017). Other research has also found that online interventions have similar effects on mindfulness as traditional face-to-face, but for the best results on clinical populations suffering from depression and anxiety, the traditional intervention is better (Spijkerman et al., 2016).

Another alternative for a traditional mindfulness intervention is utilizing a different realm of technology, specifically Netflix, to teach users about mindfulness and how to practice. The Netflix docuseries *Headspace Guide to Meditation* is an example of how the content from the Headspace app can be redesigned into longer sessions and still make an impact for users (Grosso et al., 2021). The series was created by the founder of Headspace, Andy Puddicombe, a British monk who travelled to the Himalayas to study Buddhism and meditation during college, and ended up creating what would become Headspace back in 2004 (Headspace, n.d.). The series has

an 8.4/10 rating on IMDb, with over 1.7 thousand ratings contributing to this score, and won the Daytime Emmy Award for Outstanding Main Title and Graphic Design (IMDb, 2021). The series consists of eight episodes, each with a different content focus and each approximately twenty minutes in length (Grosso et al., 2021). The content focus for the episodes are (1) How to Get Started, (2) How to Let Go, (3) How to Fall in Love With Life, (4) How to Deal With Stress, (5) How to Be Kind, (6) How to Deal With Pain, (7) How to Deal With Anger, and (8) How to Achieve Your Limitless Potential (Grosso et al., 2021). The first ten minutes of each episode has teaching aspects of what mindfulness is and how to apply it in each of the scenarios, and then the final ten minutes are a guided mindfulness meditation (Augustus & Zizzi, 2022). The series provides a comprehensive introduction to mindfulness in an interactive format and highlights the principles of mindfulness in an accurate manner (Augustus & Zizzi, 2022).

A possible explanation suggested by the research as to why digital interventions have greater improvements in outcomes when compared to traditional intervention is the digital placebo effect (Flett et al., 2020; Linardon, 2020; Torous & Firth, 2016). The digital placebo effect can be thought of like the placebo effect seen with medications and treatments, where the treatment itself is not the cause for changes, but the efficacy of the treatment is the root cause (Torous & Firth, 2016). Society today is inseparable from their phones and technological devices, so when an intervention is implemented via their phone, the phone usage itself can be the determinant of improvements rather than the content of the intervention (Flett et al., 2020; Linardon, 2020; Torous & Firth, 2016). The digital placebo effect is cited as a limitation of studies investigating the use of mindfulness-apps, but if there are improvements of mindfulness seen in those participants, then it can be argued that the digital interface simply aided in the teaching and internalizing the teachings of mindfulness (Flett et al., 2020). With these benefits of

mindfulness interventions, digital or traditional, it can be investigated how the effects of mindfulness impact exercisers who may struggle to maintain habits and motivation to engage in physical activity.

Mindfulness and Physical Activity

Mindfulness can be used to build physical activity habits that will be sustained, namely through enjoyment of the physical activity (Yang & Conroy, 2019). A component of enjoyment, satisfaction, can also be considered when implementing mindfulness and physical activity (Tsafou et al., 2016a; Tsafou et al., 2016b). In cross-sectional studies of over 300 participants each, it was found that satisfaction mediated the relationship between physical activity and mindfulness, that increased mindfulness during physical activity results in more physical activity being completed (Tsafou et al., 2016a). The other cross-sectional study found that mindfulness during physical activity resulted in a greater ability to cope with negative thoughts and tolerate unpleasant sensations that accompany physical activity (Tsafou et al., 2016b). Through both studies, higher state mindfulness, and higher perceived satisfaction, was able to predict an increase in physical activity (Tsafou et al., 2016a; Tsafou et al., 2016b).

The positive relationship between mindfulness and physical activity can be found for both active and inactive populations as well. In a study investigating inactive males, by implementing an aerobic exercise program over twelve weeks, the participants dispositional mindfulness increased (Mothes et al., 2014). The participants of the aerobic exercise group exhibited higher body awareness and self-regulation of attention when compared to the control group who only received a relaxation program over the twelve weeks (Mothes et al., 2014). In a study conducted by Salmoirago-Blotcher and colleagues (2013) through a seven-week mindfulness intervention, the proportion of participants who are sedentary decreased over the

program. Kangasniemi and colleagues (2014) conducted research comparing active and inactive individuals, and found that active individuals demonstrated better mindfulness skills, and found a strong positive correlation between being physically active and having good mindfulness skills.

The same is true for competitive athletes, in just five mindfulness sessions student athletes were able to demonstrate better mental health and mindfulness abilities, with a decrease in perceived stress (Evers et al., 2021). Scott-Hamilton & Schutte (2016) investigated twelve competitive athletes (cyclists, mountain bikers, downhill skier, and swimmer) and implemented an eight-week mindfulness intervention. Those who adhered to the protocol had improvements in mindfulness, flow, and reductions in anxiety and pessimism (Scott-Hamilton & Schutte, 2016). Contrasting the high adherence seen in Scott-Hamilton & Schutte (2016), Kittler and colleagues (2021) attempted to administer an app-based mindfulness intervention to six youth goalkeepers, but due to the COVID-19 pandemic, there was low app engagement so there were no changes in mindfulness seen.

Links between mindfulness and physical activity can also be seen for exercisers. In a poll of 226 YMCA exercisers, it was found those who had higher levels of dispositional mindfulness were more successful in maintaining their exercise regimen (Ulmer et al., 2010). Specific research on female exercisers has similar findings, of increases of mindfulness and acceptance when undergoing a mindfulness intervention, doubling the amount of physical activity in a week (Butryn et al., 2011). Research on people who practice yoga has found increases in state mindfulness over the course of an eight-week program, and that the reasons for practicing were for intrinsic reasons, including increases in mood and enjoyment (Cox et al., 2016). Intrinsic motivation has also supported that more mindful individuals are more likely to increase their physical activity levels by accepting the negative sensations of exercise (Ruffault et al., 2015;

Schneider et al., 2019). Other variables besides enjoyment and intrinsic motivation, need to be considered as well, specifically perceived exertion and attentional focus, because the typical response of these variables to exercise is different when one is exercising mindfully (Cox et al., 2018).

Perceived Exertion during Physical Activity

Perceived exertion is used to determine the subjective intensity of effort, strain, discomfort, and/or fatigue, and was coined by Gunnar Borg to measure perceptual intensity during exercise (Nobles & Robertson, 1996). The Borg Rating Perceived Exertion (RPE) scale ranges from 6-20 or 1-10 depending on the mode of exertion being completed, either aerobic or resistance training (Robertson, 1998). An individual's RPE score is indicative of the intensity of effort put forth for the exercise task and is mediated by physiological and psychological variables (Nobles & Robertson, 1996). During light and moderate-intensity exercise, the psychological variables are more impactful on an individual's RPE, but at vigorous-intensity, the physiological variables hold more weight (Nobles & Robertson, 1996). Examples of physiological variables influencing perceived exertion are pulmonary ventilation, oxygen up-take, and heart rate (Nobles & Robertson 1996; Robertson, 1998). With increases in these variables, an individual is more likely to perceive higher exertion, as they can sense their heart racing or their rate of breathing picking up. Examples of psychological variables that influence perceived exertion are locus of control, self-efficacy, and personality (Nobles & Robertson, 1996).

If an individual has an external locus of control, meaning they tend to attribute outcomes to outside forces, they may be more likely to exhibit a higher RPE because they lack the ability to control their intensity or duration of the exercise (Nobles & Robertson, 1996). Self-efficacy was mentioned earlier regarding intrinsic motivation to perform, and in terms of perceived

exertion, those with higher self-efficacy would put forth more effort towards the task, thus resulting in a higher RPE (Nobles & Robertson, 1996).

Personality can influence RPE in way of the more extroverted an individual is, the lower their RPE will be in comparison to an introvert at the same objective intensity level (Nobles & Robertson, 1996). As previously stated, introverts are less likely to use exercise as a mood regulator (Thayer et al., 1994). Perhaps introverts do not embrace exercise as a technique for mood improvement because they feel they are exerting themselves harder than they are. And, when comparing Type A and B individuals, Type A exercisers were found to report fatigue lower than their Type B counterparts, leading to the hypothesis that those Type A individuals refuse to acknowledge their fatigue because it would cause them to lose sight of the task mastery at hand (Nobles & Robertson, 1996).

The primary determinant of exertion seems to be task intensity, in that the higher the exercise intensity, the higher the perceived effort exhibited (Tenenbaum & Connolly, 2008). As relative workload is increased for a participant, heart rate and perceived exertion increase proportionately (Tenenbaum & Connolly, 2008). The individual must work harder for a longer period as the duration increases, resulting in a higher RPE as the test progresses (Tenenbaum & Connolly, 2008). The Borg 6-20 RPE Scale and heart rate are highly correlated, meaning that one can accurately predict the other (Borg, 1982; Borg, 1998; Williams, 2017). An RPE score of eight can be multiplied by ten to predict a heart rate of 80 beats per minute, but it depends on age, sex, and fitness level whether this prediction is completely accurate (Braun-Trocchio et al., 2022). A novice exerciser is more likely to report a higher RPE score and have a higher exercising heart rate when compared to an experienced exerciser doing the same task at the same relative workload (Tenenbaum & Connolly, 2008). Even though the intensity is the same for

these participants, relative to their maximal heart rate, those with less experience may not be as familiar with exercising at such high intensities, and think that this is their maximum, when they can do much more work, it just may not be safe for them if their heart rate is perceived to be maxed out at only 65% effort. This reduction in RPE and ability to increase intensity safely comes with time and practice, something that can be accomplished when building long-term exercise habits.

Mindfulness has been postulated as an intervention that can impact perceived exertion and possibly allow for endured performance when experiencing pain and discomfort. Through mindfulness, there is an increased self-awareness and sensitivity to interoceptive cues that may lead one to believe pain would be exacerbated and lead to termination of activity (Bagheri et al., 2021; Salmon et al., 2010). Through research specifically focusing on knee pain, the opposite outcome has been found, that a mindfulness intervention can decrease pain intensity, fear of re-injury, and pain catastrophizing for a female population with patellofemoral pain (Bagheri et al., 2021). These individuals were able to detach themselves from the sensory dimension of pain, while still being ultra-aware of it, and push through and see improvements in both knee function and coping with the pain. Although not measured in this study, their RPE could be hypothesized to decrease over the course of their 18-week intervention as their mindfulness increased, because they were able to compartmentalize and accept those sensory cues without assigning negative meaning and ruminating on the cues. Other research on knee pain and mindfulness has found that mindfulness may moderate the influence of pain and alter how one copes with pain (Lee et al., 2017). Lee and colleagues (2017) postulated that by being more aware of the sensory dimensions of pain, the individual can react less to the stimuli, which results in the positive coping of pain. Lange and colleagues (2012) postulated that the relationship between mindfulness and pain is a

result of hyper-awareness of pain stimuli and redirecting attention away from the pain to the sensations of breathing.

Research regarding mindfulness and RPE has shown conflicting conclusions for increased and decreased RPE when exercising mindfully. Meggs & Chen (2021) found after listening to a mindfulness script and completing a 20-minute cycling task, participants were more accurate in their RPE prediction of their heart rate when compared to a control condition. The cycling task was completed at 85% of their maximum heart rate, and these participants were inactive individuals, leading to the conclusion that since they were working harder their RPE would increase with this increase in intensity. Their inexperience in exercising at this intensity could lead them to believe this is their maximum effort. But, since their heart rate was highly correlated with their RPE scores, it can be concluded with their immersion in the task and improved self-awareness, they were not blinded by their inexperience.

Conversely, Cox and colleagues (2018) found RPE was found to be lower in mindful exercise. Their sample also included inactive individuals, with low intrinsic motivation to exercise. They listened to a mindfulness track while walking on a treadmill at their own pace. Although it was self-paced, the participants had to reach 65% of their heart rate reserve for the ten-minute walking task for moderate intensity. Results showed exercise was more enjoyable and the RPE was reported lower when compared to the control condition without the mindfulness track playing during the task. Mindfully exercising made these participants believe they were not working as hard at moderate intensity, while the previous study presented that at vigorous intensity, participants were working harder, and that was corroborated with their heart rate values (Cox et al., 2018; Meggs & Chen, 2021). All leading back to the primary determinant of perceived exertion being the intensity of the task, the greater intensity the higher the RPE, no

matter the intervention in place (Tenenbaum & Connolly, 2008). In line with perceived exertion increasing with intensity, the primary focus of attention also shifts with increases in intensity.

Attentional Focus during Physical Activity

Stevinson and Biddle (1999) developed a two-dimensional framework to expand upon cognitive strategies that are commonly used in running, which included the internal vs. external dimension, and task-relevant (association) vs. task-irrelevant (dissociation) dimension. Associative attention has been defined as focusing on the body and the sensations being felt within the body (Masters & Ogles, 1998). Dissociative attention can be defined as focusing on anything outside of the body (Masters & Ogles, 1998). The focus of attention differs with each combination of dimensions, resulting in internal association, internal dissociation, external association, and external dissociation (Stevinson & Biddle, 1999). Examples of internal association could be thinking of fatigue or breathing sensations, whereas internal dissociation can be seen as daydreaming or imagining music (Stevinson & Biddle, 1999). External association is exemplified by thinking of strategy and split times, and external dissociation is observing spectators or conversing with an opponent (Stevinson & Biddle, 1999).

Research has shown athletes and exercisers use a combination of associative and dissociative attentional focus to their advantage, although many may not understand why it changes (Hutchinson & Tenenbaum, 2007; Masters & Ogles, 1998; Stanley et al., 2007; Tenenbaum & Connolly, 2008). At lower intensities and during training, individuals tend to use dissociative attention, meaning they are distracting themselves and not paying attention to their bodies (Hutchinson & Tenenbaum, 2007; Masters & Ogles, 1998; Stanley et al., 2007; Tenenbaum & Connolly, 2008). As intensity increases, bodily demand increases as well, which leads to shift in use of associative attention, especially during races and competition (Hutchinson

& Tenenbaum, 2007; Masters & Ogles, 1998; Stanley et al., 2007; Tenenbaum & Connolly, 2008). This can be explained by the level of effort, with low effort allowing for easy shifts between both internal and external attention, along with narrow or wide attention (Tenenbaum & Connolly, 2008). Once more effort is required, attentional focus is no longer voluntary, and sticks as narrow and internal attention (Tenenbaum, 2008).

These findings have been replicated in studies investigating both collegiate rowers and recreational exercisers completing a cycling task (Connolly & Janelle, 2003; Stanley et al., 2007). For collegiate rowers, they were assigned to use either associative or dissociative attention, and the results showed that the associative group rowed further and faster than the dissociative group, highlighting that these advantages were present for skilled but not elite rowers (Connolly & Janelle, 2003). Support for associative strategies being beneficial for trained individuals has been shown in other studies as well (Deris et al, 2022). For female exercisers completing a cycling task, also split into associative or dissociative groups, those in the associative group demonstrated higher RPE, whereas the dissociative group demonstrated a lower RPE, possibly explained by the associative group working harder and exerting more energy (Stanley et al., 2007). Associative strategies have been linked to an increase in RPE in other research as well, accounting for the working harder and being more in-tune with bodily sensations (Masters & Ogles, 1998). Some have pondered whether this associative strategy exacerbates or diminishes pain and fatigue, and it has been speculated that directing attention towards the painful sensations experienced during exercise can lead to improved performance because monitoring that information can be used to maintain effort (Deris et al., 2022). One may think it is more beneficial to dissociate away from feelings of fatigue, but by meeting those

feelings head-on, by implementing the practice of mindfulness, it can be used to the individual's advantage (Masters & Ogles, 1998; Salmon et al., 2010).

Mindfulness is not definitively associative attention, but it does share the same properties, and emphasizes the self-awareness and attention to bodily sensations seen in associative attention (Salmon et al., 2010). With greater sensitivity to physiological symptoms through mindfulness, it can enhance appraisal and acceptance of challenges one may face during physical activity, and lead to a better holistic exercise bout (Salmon et al., 2010). Through research on mindfulness and physical activity, attention during an exercise task tends to be more associative in nature (Cox et al., 2018; Cox et al., 2020). In a study comparing control to a mindfulness condition, the mindfulness condition exhibited associative focus when measured after completion of a self-paced walking task (Cox et al., 2018). In a similar study with an added music condition, the mindfulness condition exhibited associative focus whereas the music condition exhibited dissociative focus, but both had similar outcomes for affective responses and enjoyment (Cox et al., 2020). The mindfulness condition exhibited higher forecasted affect when compared to the music condition, meaning even though the participants were more in-tune with their fatigue and discomfort, they seemed to forget the bad memories of exercising and were excited for the next time they would exercise (Cox et al., 2020). This property of mindfulness could be integral in promoting long-term exercise habits, that by associating during exercise, your RPE may be higher, but you will enjoy that bout of exercise more, and look forward to the next time you get to exercise.

Conclusion

Overall, mindfulness can be implemented with physical activity to benefit the exerciser in building and sustaining habits to reap long-term physical and psychological benefits.

Mindfulness can be implemented with either a traditional intervention, or a technology intervention, like ones utilizing apps or videos to reach a broader audience at a cheaper price. Benefits of a mindfulness intervention include improved enjoyment, more accurate estimation of perceived exertion, and the use of associative attention for positive outcomes. Previous literature demonstrates that mindfulness is a worthwhile intervention for performance and well-being benefits primarily using elite athletes. Researchers should continue to explore and study other groups of exercisers to have a more comprehensive conclusion about the implementation of mindfulness in physical activity.

Research Question and Hypotheses

The first research question was what effect did a four-week technology-delivered mindfulness-based intervention have on ratings of perceived exertion, heart rate, and attentional allocation during a laboratory-based rowing exercise task?

1. First it was hypothesized exercisers would experience a significant decrease in perceived exertion for the mindfulness condition compared to the control condition after the four-week intervention. It was hypothesized that there would be no change in heart rate after the four-week intervention.
2. Second, it was hypothesized that exercisers would experience a shift in associative attention during exercise for the mindfulness condition compared to the control condition after the four-week intervention.

The second research question was what effect did a four-week technology-delivered mindfulness-based intervention have on enjoyment, remembered pleasure, forecasted pleasure, state mindfulness, and trait mindfulness after physical activity?

1. It was hypothesized that exercisers would experience significantly higher exercise enjoyment, remembered pleasure, forecasted pleasure, state mindfulness, and trait mindfulness after the four-week mindfulness-based intervention compared to the control condition.

Significance of the Study

Many studies have focused on how mindfulness-based interventions can be used to enhance performance for elite athletes, but few have examined how these interventions can be applied to other populations, such as college students and average exercisers. The college student population is worth investigating because of the high perceived stress and anxiety they face on a consistent basis. If this stress and anxiety is left untreated it can lead to chronic stress and trait anxiety which will have further negative health implications as these individuals enter the workforce. An emphasis on the importance of regular physical activity for college students so they can experience the physical and psychological exercise benefits, which will protect them from those chronic health problems. The population of average exercisers is also worth investigating because they are underrepresented, at only 20% of the American population, so researchers must give them exposure and data to support their habits. If others can see the positive benefits associated with exercising regularly and meeting the physical activity guidelines, then they may be more motivated to do it themselves.

By combining mindfulness and physical activity in this study it fostered the growth of intrinsic motivation, with the participants being more excited to exercise on a regular basis. Not only were the benefits of physical activity be at play, but also the benefits of mindfulness. Mindfulness also helps this population of exercising college students, improving mood and awareness, which can help them in their studies, their relationships, and future endeavors. This

study is also significant in seeing the effects of a mindfulness-based intervention on perceived exertion, with conflicting research supporting both an increase and decrease in self-reported perceived exertion while exercising mindfully.

There is also conflicting research and opinions on whether a digital mindfulness-intervention application can have the same positive outcomes associated with a traditional intervention. This present study addressed these concerns by investigating a digital mindfulness-based intervention and added to the knowledge base of alternatives such as the Headspace Netflix series. By comparing the Headspace Guide to Meditation with an educational series also on Netflix, it negates any possibility of the digital placebo effect because the interventions were easily comparable and equal in delivery, only differing in content.

The conclusions drawn from this study allow for how future mindfulness-based interventions can be applied to exercisers who do not currently meet physical activity guidelines, and specifically how college students adjusting to new lifestyles can utilize mindfulness to improve both mental and physical health. It could also be applied to older adults who struggle to keep active in their older age, by motivating them through the awareness and acceptance of thoughts during exercise. Further research will also be able to expand upon this study to specifically examine how perceived stress and anxiety differ when undergoing a mindfulness intervention or control, which will support the notion both mindfulness and physical activity are key to maintaining physical activity habits and reaping the long-term physical and psychological benefits.

Assumptions and Limitations

The assumptions made for this study were that participants answered items on the questionnaires honestly and that they used the mindfulness skills they were taught while

completing the exercise tasks. Honesty in responses was assumed since they were self-reporting their perceived exertion and attentional allocation during each exercise task. Assumption of honesty in questionnaire responses was also necessary, which was maintained by keeping the number of questions they were responding to at a minimum. Assuming they were using the mindfulness skills being taught during the video while completing the exercise task was the primary assumption, but participants were encouraged to do so. The assumption that participants were committed to the study was also present, along with assuming they were paying attention to the videos before conducting the rowing task each visit.

One delimitation that was made to include any individual over the age of 18 to not restrict recruitment and make it more achievable to reach power. Another possible delimitation is that the mindfulness-based intervention was delivered via Netflix series, so that there was no room for error or inconsistency from visit to visit and participant to participant. The control group also watched a Netflix series, so that the delivery and interface are the same for both groups, with the only difference being in content, educational compared to mindfulness based. Another delimitation for the study was that it would only be four weeks in length. This was decided to ensure less attrition and increased adherence of participants. Lastly, only individuals who met physical activity guidelines were eligible to participate in the study, not allowing for data to be collected on those who did not meet the guidelines. Those who do not meet the guidelines could benefit from this intervention, so future research will need to investigate those effects.

Variables

The independent variable of this study was the condition assignment of either the technology-delivered mindfulness intervention or the control condition. The dependent variables measured in this study were rating of perceived exertion, heart rate, attentional focus, physical

activity enjoyment, forecasted pleasure, remembered pleasure, state mindfulness, and trait mindfulness.

Chapter III: Method

Participants

Throughout Fall of 2023 and Spring of 2024, 39 participants from a Texas university community were recruited to complete this intervention. A total of 32 participants (females = 25: height 169.28 ± 7.54 cm, weight 72.99 ± 15.02 kg and males = 7: height 179.50 ± 5.17 cm, weight 80.54 ± 9.63 kg) between the ages of 18 and 37 years of age (21.09 ± 3.66) completed the intervention in totality with all ten visits. Participants were either in the mindfulness intervention (n = 17) or control condition (n = 15). White was the predominant race (n = 29) of the participants included in this study, followed by Multiracial *(*n = 2), and American Indian or Alaskan Native (n = 1). The ethnicity of the participants was primarily Not Hispanic or Latinx (n = 25), with the minority being Hispanic or Latinx (n = 6) or preferring not to answer (n = 1). The primary occupation of the participants was student (n = 29), followed by professional (n = 3). Participants were deemed eligible to participate if they did not currently practice mindfulness or meditate, did not have a diagnosis of ADHD, and if they met current physical activity guidelines of 150 moderate or 75 vigorous minutes of exercise per week.

Instrumentation

Measures

Informed Consent. An informed consent document was provided verbally and written, for participants detailing the procedure and requirements of this study. Participants were informed of confidentiality and the right to terminate participation at any point in the study. The document was signed by the participant and researcher if they agreed to participate.

Demographic Questionnaire. A demographic questionnaire was administered to collect information about the participant's age, sex, race, ethnicity, exercise history, and history with mindfulness and meditation. Individuals were not excluded from participation if they had a history of mindfulness and meditation if they were not currently practicing.

International Physical Activity Questionnaire (IPAQ). The International Physical Activity Questionnaire (IPAQ) was used to determine if the participants met the inclusion criteria of 150 minutes of moderate of 75 minutes of vigorous physical activity each week. The questionnaire consists of a 7-day physical activity recall, asking about both moderate and vigorous intensity physical activity.

Physical Activity Readiness Questionnaire (PAR-Q). The Physical Activity Readiness Questionnaire (PAR-Q) was administered to ensure the participants are physically able to complete the rowing exercise task. To do so, they must answer "No" to all items on the questionnaire.

Rating Perceived Exertion (RPE). Rating of perceived exertion was measured before, during, and after each physical activity task. The Borg Rating of Perceived Exertion scale is a 15-point Likert scale to assess perceived exertion during physical activity. The Borg RPE scale is considered the gold standard for assessing perceived exertion, and is strongly correlated, 0.80-0.90, with heart rate (Borg, 1982; Borg, 1998; Williams, 2017). When prompted, participants stated their perceived exertion using the scale from 6-20, with "6" meaning no exertion at all, and "20" meaning hard maximal exertion. The Borg Rating Scale of Perceived Exertion has test-retest reliability score of $r > 0.83$ (Borg, 1998).

Attention Scale. Attentional allocation was measured before, during, and after the physical activity task. Attentional focus was measured using the 10-point scale with "0" meaning

external thoughts and "10" being internal thoughts (Tammen, 1996). The scale ranges from pure dissociation (0) to pure association (10) (Tenenbaum & Connolly, 2008). This 1-item measure has been found to be an efficient and valid measure of attention in runners and rowers (Tammen, 1996; Tenenbaum & Connolly, 2008).

Physical Activity Enjoyment Scale (PACES). Post-exercise enjoyment was measured with the Physical Activity Enjoyment Scale questionnaire, administered via Qualtrics on an iPad. The PACES is an 18-item, 7-point Likert-type scale from "1" (I enjoyed it) to "7" (I hated it) (Murrock et al., 2016). The PACES has been found to be a reliable and valid measure for physical activity enjoyment, with a reliability and internal consistency $\alpha = 0.95$, and validity of $r = 0.38$ (Murrock et al., 2016). For the current study, Cronbach alpha was 0.925, which is considered acceptable (Nunnally, 1967).

Forecasted & Remembered Pleasure. Post-exercise remembered pleasure was measured with the Empirical Valence Scale, administered via Qualtrics on an iPad. The participant answered the single question of "How did the exercise session make you feel?" by manipulating the slider between -100 (most unpleasant" to +100 (most pleasant) (Lishner et al., 2008). Higher scores indicated more positive remembered pleasure. Zenko and colleagues (2016) have provided construct validity for this scale in the context of exercise by correlating it with enjoyment.

Post-exercise forecasted pleasure was measured with a visual analog scale administered via Qualtrics on an iPad. Participants answered the single question of "If you repeated the exercise session again, how do you think it would make you feel?" by manipulating the slider between -100 (most unpleasant) to +100 (most pleasant) (Zenko et al., 2016). Zenko and

colleagues (2016) have provided construct validity for this scale in the context of exercise by use of correlating it with enjoyment.

State Mindfulness Scale for Physical Activity (SMS-PA). Post-exercise state mindfulness was measured with the State Mindfulness Scale for Physical Activity (SMS-PA) questionnaire, administered via Qualtrics on an iPad. The SMS-PA is a six-item, four-point Likert-type scale that has internal consistency reliability of each subscale ranging from 0.87 to 0.93 (Cox et al., 2015; Cox et al., 2016). The scale ranges from "0" not at all to "4" very much, for the subscales of mindfulness of body and mindfulness of mind during physical activity, with higher averaged scores of each subscale resulting in overall higher levels of state mindfulness (Cox et al., 2016; Cox et al., 2020). For the current study, Cronbach alpha ranged from 0.847 to 0.871, which are considered acceptable (Nunnally, 1967).

Mindfulness in Physical Activity (MFPA). Post-exercise state mindfulness was measured with the Mindfulness in Physical Activity (MFPA) questionnaire, administered via Qualtrics on an iPad. The MFPA is a six-item, five-point Likert-type scale that is validated and demonstrates moderately high internal consistency of $\alpha = 0.84$ (Mitchell et al., 2021; Tsafou et al., 2016). The scale ranges from "1" totally agree to "5" totally disagree, for questions specific to mindfulness in physical activity, with no subscales (Tsafou et al., 2016). For the current study, Cronbach alpha was 0.79, which is considered acceptable (Nunnally, 1967).

Mindful Attention Awareness Scale (MAAS). Pre- and post-intervention trait mindfulness was measured with the Mindful Attention Awareness Scale questionnaire, administered via Qualtrics on an iPad. The MAAS is a fifteen-item, six-point Likert-type scale that validates and demonstrates high reliability of $\alpha = 0.92$ (Brown & Ryan, 2003; Tsafou et al., 2016). The scale ranges from "1" almost always to "6" almost never, with higher scores

indicating higher scores of mindfulness (Brown & Ryan, 2003; Tsafou et al., 2016). For the current study, Cronbach alpha was 0.83, which is considered acceptable (Nunnally, 1967).

Heart Rate. Heart rate was measured and monitored throughout the exercise task with the Polar H10 heart rate sensor with Pro Strap. Heart rate was monitored by using the Polar Heart Rate application on an iPad.

Interventions

Netflix Series. Each digital mindfulness condition visit consisted of watching a 20-minute Netflix docuseries episode, Headspace Guide to Meditation. Created and narrated by the founder of the app Headspace, Andy Puddicombe, each episode guides the viewer through mindfulness education and guided practice, with accompanying images to sustain attention. The series consists of eight episodes, with titles of (1) How to Get Started, (2) How to Let Go, (3) How to Fall in Love with Life, (4) How to Deal with Stress, (5) How to be Kind, (6) How to Deal with Pain, (7) How to Deal with Anger, and (8) How to Achieve Your Limitless Potential.

Each control condition visit consisted of watching a 30-minute Netflix series Wild Babies episode, a nature series about the lives of baby animals narrated by Helena Bonham Carter. The series consists of eight episodes, with titles of (1) New Arrivals, (2) Home Alone, (3) On the Move, (4) Big Families, (5) Bonds That Tie, (6) Finding Your Place, (7) Hostile Homes, and (8) Stepping Up.

Rowing Machine & Exercise Task. An Aviron Tough Series Rower was utilized for all experimental trials. The Aviron Tough Series rower is a full-body exercise machine with dual air and magnetic resistance system and a 22-inch high-definition touchscreen. Resistance level is controlled on the touchscreen and ranges from 1 (no resistance) to 16 (max resistance). For this

study, resistance was set to 1 (no resistance) for all sessions and participants. The Aviron Tough Series rower has an aluminum frame that weighs 125 pounds and can hold 507 pounds.

A rowing task was selected because it is a full body aerobic exercise that does not put as much stress on joints, such as the knees, like running would. A rowing task involves the calves, hamstrings, glutes, quadriceps, abdominals, pectorals, biceps, triceps, deltoids, and latissimus dorsi muscles. To row, the participant pushes against the foot pads with the balls of their feet and fully extends their legs. After full extension of the legs, the participant will pull the oar bar just under their chest. The resistance the participant chooses to complete the task will be self-selected.

Procedure

Before the study began, Institutional Review Board (IRB) approval was confirmed. Prior to participation, participants were asked to review and sign the informed consent digitally. Then, the demographics questionnaire was administered along with a health history form to determine whether the participant was eligible to complete the research study. The MAAS was also administered to assess trait mindfulness if the participant was eligible. Participants were randomly assigned to either a digital mindfulness intervention condition or the control condition.

The digital mindfulness intervention consisted of watching one episode each visit of the Netflix docuseries, Headspace Guide to Meditation. The control condition watched one episode each visit of the Netflix series Wild Babies. Each video session took approximately twenty minutes to complete.

Participants completed the four-week study by coming into the lab two or three times a week to complete their assigned intervention (technology or control) for a total of ten visits. The first session took approximately forty-five minutes to complete, with the MAAS and PACES

questionnaires and the pre-assessment twenty-five-minute rowing task. Sessions two and three also took place during the first week, with at least 24 hours between sessions. Sessions four and five took place in the second week, with at least 24 hours between them. Sessions six and seven took place in the third week, with at least 24 hours between them. Sessions eight, nine, and ten took place in the fourth week, with session ten not having a mindfulness component, just the post-assessment exercise task, the MAAS and PACES questionnaires. All sessions for each participant were scheduled for the same time of day, either in the morning or afternoon

Participants were fitted with a heart rate monitor between the video and the exercise task on visits two through nine and before the exercise task on visits one and ten. On the first visit, standardized scripts explaining the RPE scale and the Attention scale were read to participants, allowing them the chance to ask questions and understand what the different values mean. Baseline RPE scale and the Attention Scale measurements were collected before the exercise task. During the first visit, participants watched the Rowing 101 video on the rowing machine, ensuring they understood proper form and technique for rowing. RPE and attention measurements were taken after the five-minute warm-up, at the 12.5-minute mark, before the cool-down at 20-minutes, and after the cooldown at the 25-minute time point, with heart rate recorded at these time points as well. During the exercise task, resistance was set to the lowest value for all participants. Post-exercise task, participants completed the PACES, the SMS-PA, and the MFPA to assess perceived enjoyment and state mindfulness following physical activity. Participants were debriefed at the conclusion of their tenth visit.

Data Analysis

After the 32 participants completed all assessments, data were analyzed using the Statistical Package for Social Sciences (SPSS) Version 29. Demographic information was

analyzed with descriptive statistics to calculate means and standard deviations, along with frequencies. The hypotheses were tested with the data collected for each participant, comparing the two conditions from the pre-assessment first visit to the post-assessment final tenth visit. A two-way (session by condition), within-between, repeated measures analysis of variance (RM-ANOVA) assessed the PACES, forecasted pleasure, remembered pleasure, MFPA, and MAAS. A three-way (session by time during session by condition), within-between, RM-ANOVA assessed the rating of perceived exertion, attentional allocation, and heart rate. A three-way (session by time during session by condition) factorial ANOVA assessed state mindfulness of the SMS-PA questionnaire to compare the individual subscales and total scores. A between-group ANOVA assessed the change scores for the PACES, remembered pleasure, and forecasted pleasure. When Mauchly's sphericity reached significance ($p < 0.05$) then the Greenhouse-Geisser (GG) epsilon correction coefficient was implemented. Bonferroni post-hoc analysis was utilized for significant results. Significance for all tested measures was set at $p < 0.05$.

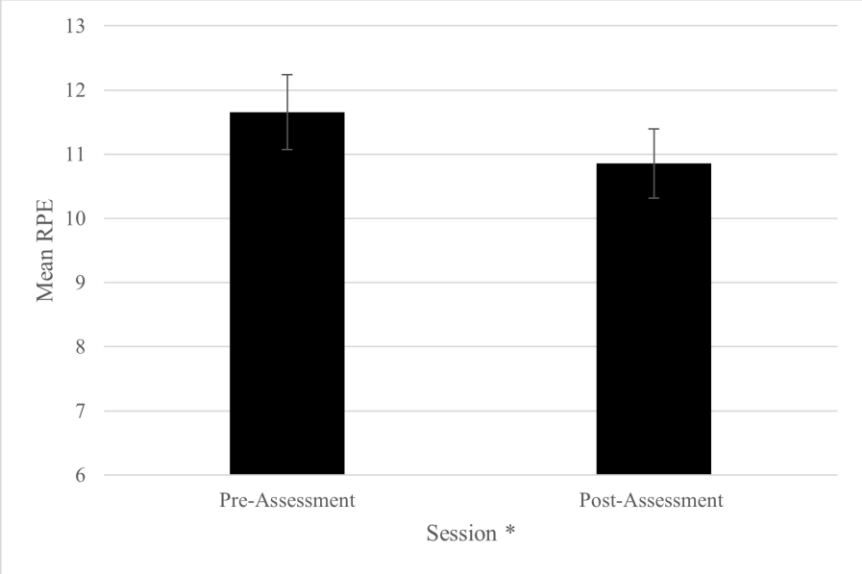
Chapter IV: Results

Rating of Perceived Exertion

A RM-ANOVA examined the differences in RPE scores between conditions from the pre-assessment to the post-assessment. There was a significant main effect for RPE between sessions, F (1, 30) = 7.054, p = 0.013, η_p^2 = 0.190 (see Figure 1). The mean RPE at the pre-assessment (M = 11.658, SD = 0.333) was significantly greater than the mean RPE at the post-assessment (M = 10.854, SD = 0.393). There was also a significant main effect for RPE across time, F (2, 41.611) = 124.249, p < 0.001, η_p^2 = 0.806 (see Figure 2). RPE significantly increased linearly across time during the rowing task, for both conditions. A non-significant session by group interaction was found, F (1, 30) = 2.417, p = 0.130, η_p^2 = 0.075. The intervention group experienced a decrease in RPE from the pre-assessment to the post-assessment, whereas the control group stayed relatively the same. A non-significant session by time by group interaction was found, F (1.387, 41.611) = 1.421, p = 0.249, η_p^2 = 0.045. From the pre-assessment to the post-assessment, the intervention group experienced a decrease in RPE at the 5-, 12.5-, and 20-minute time points, whereas the control group only experienced a decrease in RPE at the 5-minute time point from the pre-assessment to post-assessment.

Figure 1

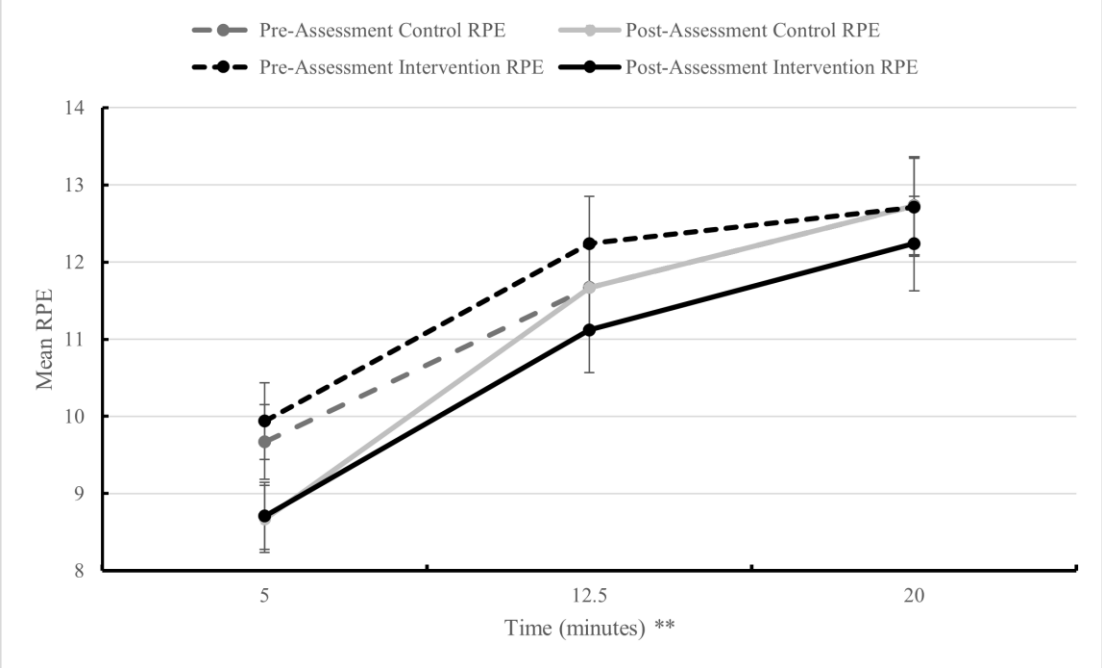
Mean ± 95% confidence intervals for RPE between sessions.



Note. Mean RPE scores decrease between pre-assessment and post-assessment (* = $p < 0.05$).

Figure 2

Mean ± 95% confidence intervals for RPE between conditions across time.



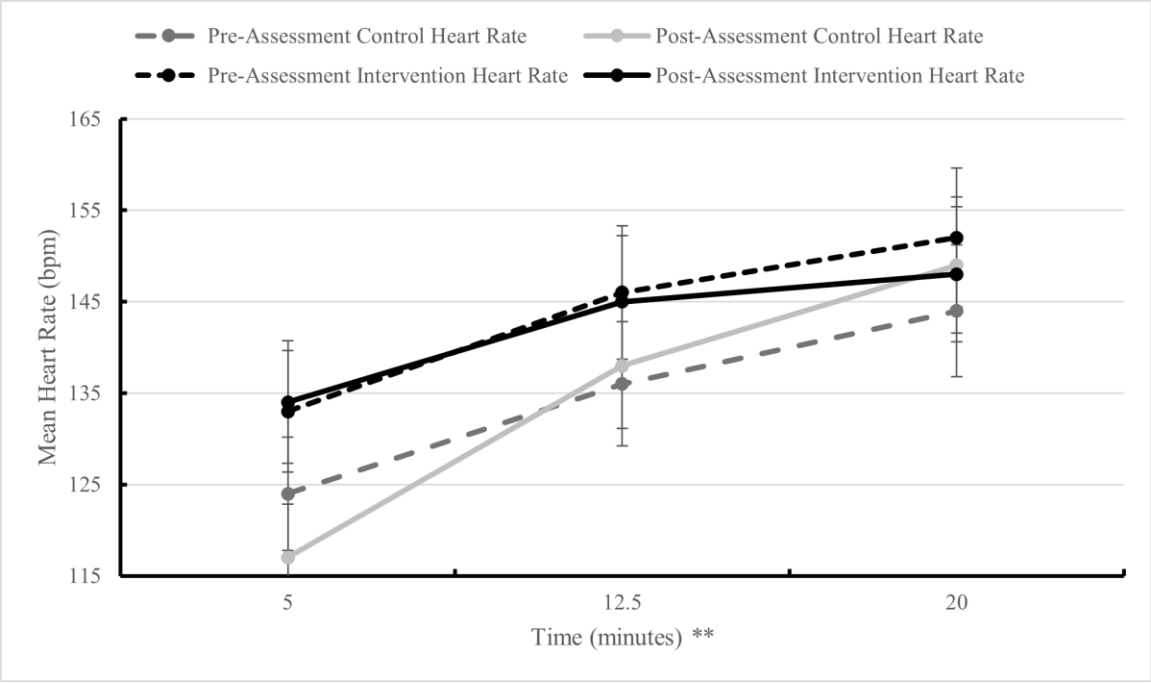
Note. Mean RPE scores significantly increase as time progresses (** = $p < 0.001$).

Heart Rate

A RM-ANOVA examined the differences in heart rate between conditions from the pre-assessment to the post-assessment. There was no significant main effect for heart rate between sessions, F (1, 30) = 0.024, p = 0.878, η_p^2 = 0.001. A significant main effect across time was found, F (2, 60) = 48.353, p < 0.001, η_p^2 = 0.617 (see Figure 3). As the session progressed, the participant's heart rate continued to increase linearly. A pairwise comparison indicated a significant difference at each time point (p < 0.001). There was a non-significant difference for the time x group interaction, F (2, 60) = 1.263, p = 0.283, η_p^2 = 0.040. At the 5-minute point, the intervention group's heart rate (M = 134, SD = 4.2) was higher than the control group (M = 120.7, SD = 4.5), indicating they came out of the warm-up period with a higher heart rate and sustained a higher heart rate throughout the rowing session.

Figure 3

Mean ± 95% confidence intervals for heart rate between conditions across time.



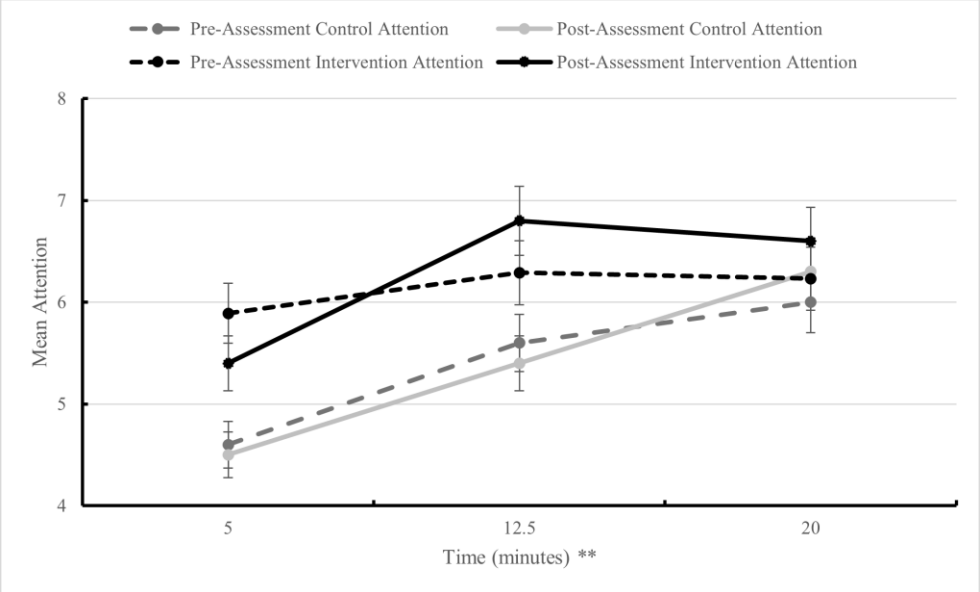
Note. Mean heart rate significantly increases as time progresses (** = p < 0.001).

Attention Allocation

A RM-ANOVA examined the differences in attentional allocation between conditions from the pre-assessment to the post-assessment. No significant main effect was found in attention between sessions, F (1,30) = 0.048, p = 0.828, η_p^2 = 0.002. There was a significant main effect for time, regardless of session or condition, F (1.405, 43.13) = 10.196, p < 0.001, η_p^2 = 0.254 (see Figure 4). As the rowing task progressed, attention scores significantly increased, indicating more associative attention, from 5- to 12.5-minutes, and from 5- to 20-minutes. A non-significant difference was found for the session by time by group interaction, F (1.438, 43.130) = 0.715, p = 0.451, η_p^2 = 0.023. Within this interaction, at the 12.5-minute timepoint during the post-assessment, the attention of the intervention group (M = 6.824, SD = 0.420) was considerably higher than the control group (M = 5.4, SD = 0.447). In the middle of the rowing task, the intervention group's attention score was more associative than the control group.

Figure 4

Mean ± 95% confidence intervals for attention allocation between conditions across time.



Note. Mean attention allocation significantly increases as time progresses (** = p < 0.001).

Exercise Enjoyment: PACES, Forecasted Pleasure, Remembered Pleasure

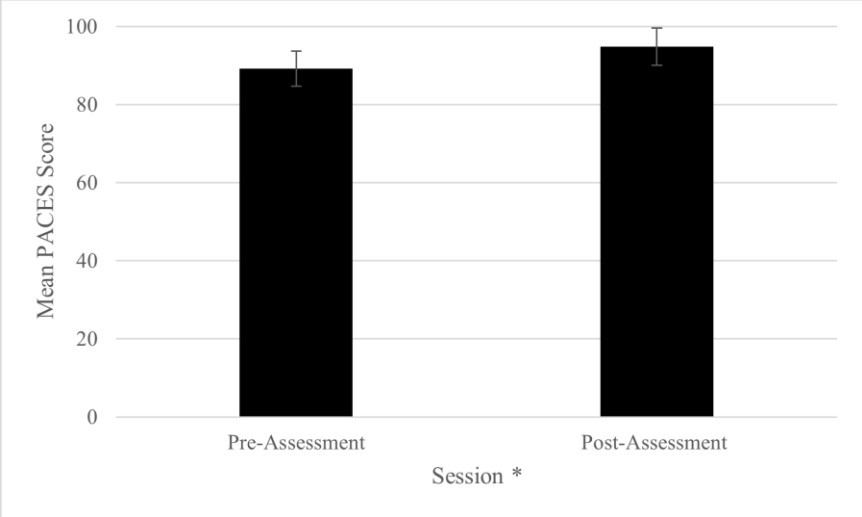
PACES

A RM-ANOVA examined the differences in the summed PACES scores between conditions from the pre-assessment to the post-assessment. A significant main effect was found between sessions, F (1, 30) = 4.666, p = 0.039, η_p^2 = 0.135 (see Figure 5). A pairwise comparison indicated that the post-assessment PACES score (M = 94.77, SD = 2.57) was significantly greater than the pre-assessment PACES score (M = 89. 22, SD = 2.50) (p = 0.039). A non-significant difference was noted for the session by group interaction, F (1, 30) = 4.122, p = 0.051, η_p^2 = 0.121. Participants in the intervention group experienced a greater improvement in their PACES scores from pre-assessment to post-assessment compared to the control group.

After a calculation of change scores, it was found that from the pre-assessment to post-assessment, the control group experienced Δ = -0.34, whereas the intervention group experienced Δ = +10.76 (see Figure 6). The intervention group experienced a greater change, and a positive change, compared to the control group's minimal, negative change in PACES scores. A between-group ANOVA examined the difference in change scores between the control and intervention group, and found a significant main effect between groups, F (1, 30) = 4.122, p = 0.05, η_p^2 = 0.121. The intervention group experienced a greater change in their PACES scores compared to the control group.

Figure 5

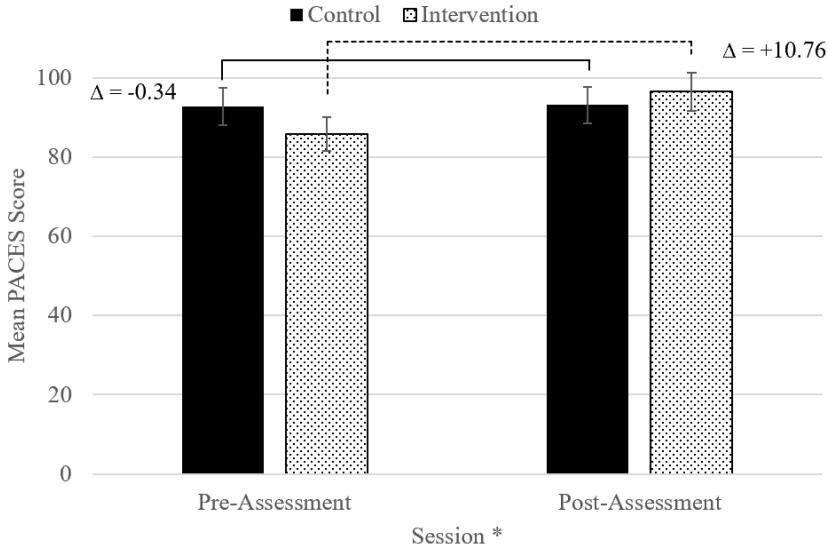
Mean ± 95% confidence intervals for PACES scores between sessions.



Note. Mean PACES scores significantly increase from pre-assessment to post-assessment (* = $p < 0.05$).

Figure 6

Mean ± 95% confidence intervals for PACES scores between sessions and groups.



Note. Greater positive change scores present for intervention group compared to the control group (* = $p < 0.05$).

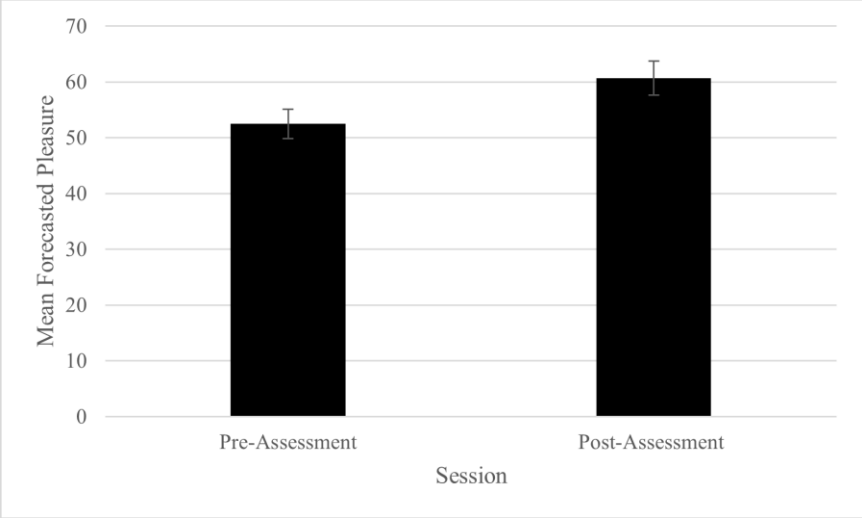
Forecasted Pleasure

A RM-ANOVA examined the differences in forecasted pleasure between conditions from the pre-assessment to the post-assessment. No significant main effect was found between sessions, F (1, 30) = 2.552, p = 0.121, η_p^2 = 0.78 (see Figure 7). No significant main effect was found between groups, F (1, 30) = 1.305, p = 0.262, η_p^2 = 0.042.

Change scores were calculated for pre-assessment to post-assessment, and the control group experienced a Δ = +0.08, whereas the intervention group Δ = +15.60 (see Figure 8). The intervention group experienced a greater positive change than the control group for scores of forecasted pleasure. A between-group ANOVA examined the difference in change scores between the control and intervention group, and found a non-significant main effect between groups, F (1, 30) = 2.08, p = 0.160, η_p^2 = 0.065. The intervention group experienced a greater change in their PACES scores compared to the control group.

Figure 7

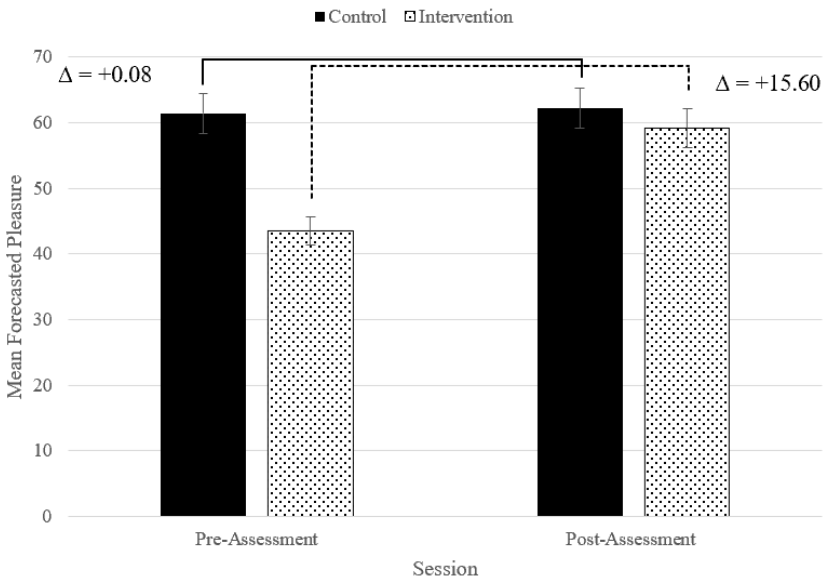
Mean ± 95% confidence intervals for forecasted pleasure between sessions.



Note. No significant differences between pre-assessment and post-assessment.

Figure 8

Mean ± 95% confidence intervals for forecasted pleasure between sessions and groups.



Note. Greater positive change scores present for intervention group compared to the control group.

Remembered Pleasure

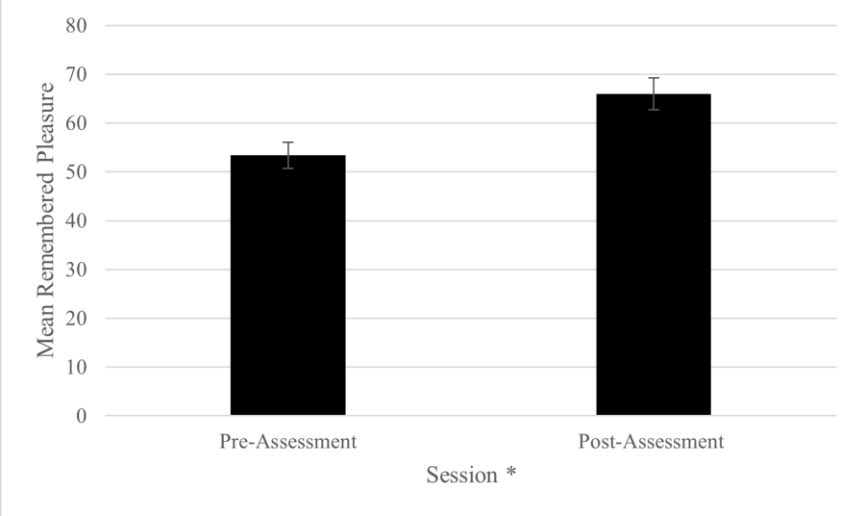
A RM-ANOVA examined the differences in remembered pleasure between conditions from the pre-assessment to the post-assessment. A significant main effect was found between sessions, F (1, 30) = 11.034, p = 0.002, η_p^2 = 0.269 (see Figure 9). The remembered pleasure after the pre-assessment (M = 53.37, SD = 3.52) was significantly lower than after the post-assessment (M = 65.96, SD = 3.83). A non-significant session by group interaction was found, F (1, 30) = 1.78, p = 0.192, η_p^2 = 0.056, where the participants in the intervention experienced greater remembered pleasure from the pre-assessment to the post-assessment compared to the control.

Change scores were calculated to analyze pre-assessment to post-assessment, and it was found that the control group Δ = +7.53, and the intervention group Δ = +17.65 (see Figure 10).

The intervention group experienced a greater positive change than the control group in their score of remembered pleasure. A between-group ANOVA examined the difference in change scores between the control and intervention group, and found a non-significant main effect between groups, F (1, 30) = 1.78, p = 0.192, η_p^2 = 0.056. The intervention group experienced a greater change in their remembered pleasure scores compared to the control group.

Figure 9

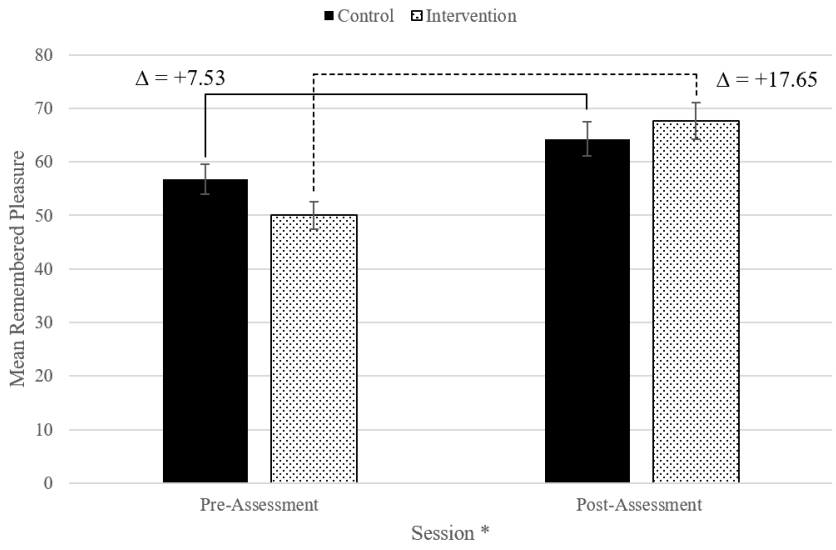
Mean ± 95% confidence intervals for remembered pleasure between sessions.



Note. Mean remembered pleasure significantly increases from pre-assessment to post-assessment (* = $p < 0.05$).

Figure 10

Mean ± 95% confidence intervals for remembered pleasure between sessions and group.



Note. Greater positive change scores present for intervention group compared to the control group (* = $p < 0.05$).

State Mindfulness: SMS-PA, MFPA

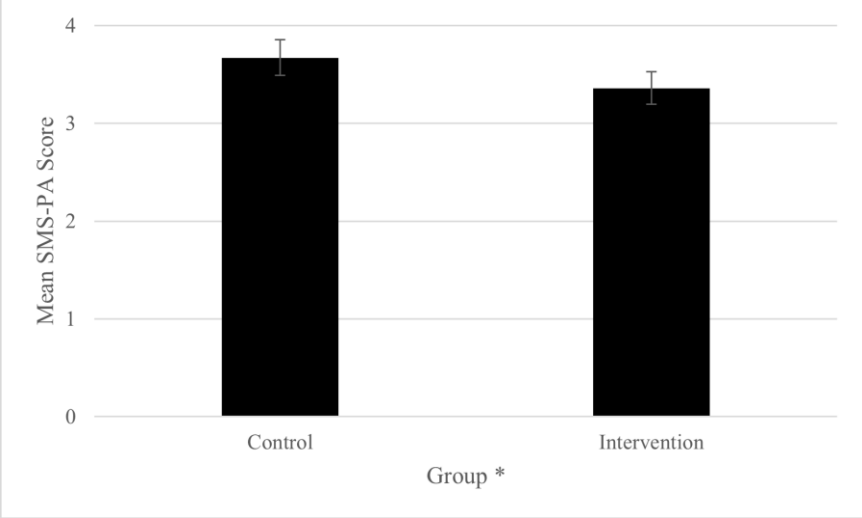
SMS-PA

A 2x2x2 Factorial ANOVA examined the differences in state mindfulness scores between conditions from the pre-assessment and post-assessment, along with any differences in the subscales from this assessment. A significant group main effect was present, F (1, 128) = 4.219, $p = 0.042$, $\eta_p^2 = 0.034$ (see Figure 11). A pairwise comparison was conducted to analyze this main effect, and it was found that the control group ($M = 3.67$, $SD = 0.90$) had significantly greater state mindfulness scores compared to the intervention group ($M = 3.36$, $SD = 0.91$). There was not a significant main effect for session, the mean SMS-PA score at the pre-assessment was not significantly different from the post-assessment. There was a significant main effect for subscale, F (1, 120) = 17.491, $p < 0.001$, $\eta_p^2 = 0.127$ (see Figure 12). Through

pairwise comparison, the mean score for Mindfulness of the Body (M = 3.83, SD = 0.76) was significantly greater than the mean score for Mindfulness of the Mind (M = 3.199, SD = 0.95). There was a non-significant group by session interaction, F (1, 120) = 1.547, p = 0.216, η_p^2 = 0.013, wherein at the pre-assessment, the control group state mindfulness score was greater than the intervention. There was a non-significant group by subscale interaction, F (1, 120) = 1.096, p = 0.297, η_p^2 = 0.009, wherein Mindfulness of the Mind scores were higher for the control group compared to the intervention group.

Figure 11

Mean ± 95% confidence intervals for SMS-PA scores between groups.



Note. The control group reports significantly greater scores of state mindfulness compared to the intervention group (* = $p < 0.05$).

Figure 12

Mean ± 95% confidence intervals for SMS-PA subscale scores.

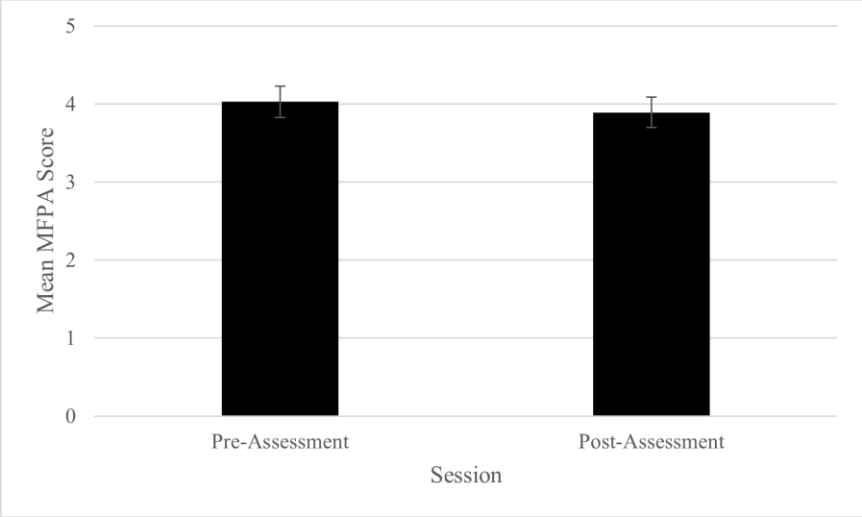
Note. Mean Mindfulness of the Body scores were significantly greater than scores of Mindfulness of the Mind (** = $p < 0.001$).

MFPA

A RM-ANOVA examined the differences in state mindfulness between conditions from the pre-assessment and post-assessment. No main effect was found between sessions, F (1,30) = 1.49, $p = 0.232$, $\eta_p^2 = 0.047$ (see Figure 13). A non-significant session by group interaction was found, F (1,30) = 3.093, $p = 0.089$, $\eta_p^2 = 0.089$, wherein the control group experienced a decrease in their MFPA score, yet the intervention group score remained constant.

Figure 13

Mean ± 95% confidence intervals for MFPA scores between sessions.



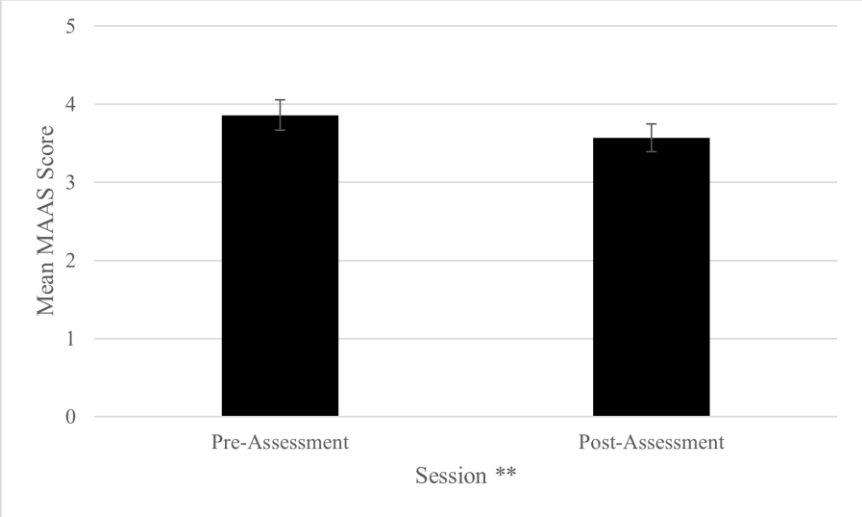
Note. No significant differences from pre-assessment to post-assessment.

Trait Mindfulness: MAAS

A RM-ANOVA examined the differences in trait mindfulness between conditions from the pre-assessment to the post-assessment. A main effect was found between sessions, F (1,30) = 12.322, p = 0.001, η_p^2 = 0.291 (see Figure 14). The mean MAAS score at the post-assessment (M = 3.568, SD = 0.123) was significantly lower than at the pre-assessment (M = 3.862, SD = 0.115). Through pairwise comparison, the control group experienced a significant decrease in MAAS scores (p = 0.003), and the intervention group experienced a decrease, albeit non-significant (p = 0.097) (see Figure 15). All other main effects and interactions were non-significant.

Figure 14

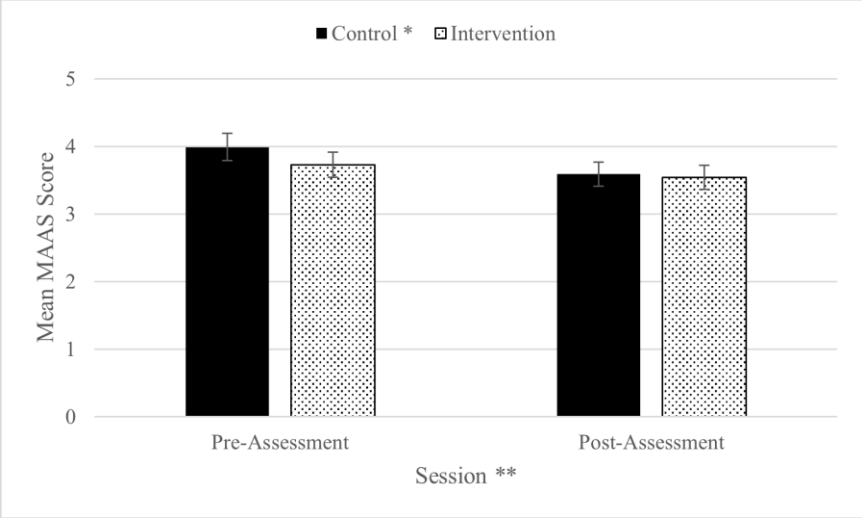
Mean ± 95% confidence intervals for MAAS scores between sessions.



Note. Mean MAAS scores significantly decreased from the pre-assessment to post-assessment (** = $p = 0.001$)

Figure 15

Mean ± 95% confidence intervals for MAAS scores between sessions and group.



Note. Mean MAAS scores for the control group significantly decreased from pre-assessment to post-assessment (* = $p < 0.05$; ** = $p = 0.001$).

Chapter V: Discussion

The purpose of this study was to examine how a low-dose, digital mindfulness intervention could impact RPE, heart rate, attention allocation, exercise enjoyment, remembered pleasure, forecasted pleasure, trait mindfulness, and state mindfulness. The results of the current study indicated that the mindfulness intervention did not provide significantly different outcomes for RPE, heart rate, attention, state mindfulness, or trait mindfulness, however the mindfulness intervention did result in greater change scores compared to the control group on the aforementioned variables of exercise enjoyment, remembered pleasure, and forecasted pleasure.

Based on the results from this study, there were no significant differences in perceived exertion between the two conditions. This finding is not consistent with research from Cox and colleagues (2018), who found that a mindfulness intervention group experienced lower RPE during an exercise task than a control group. It also contradicts Ivanova and colleagues (2015), who found decreases in RPE after a brief mindfulness intervention. This may have occurred because the control group was blinded to their condition assignment, they may have believed that watching Wild Babies on Netflix was a way to train and practice mindfulness, so they may have answered accordingly based on what they thought they were supposed to be doing. They could have been trying to be mindful and in the moment, but since they did not have the training and practice, and purposefully report a lower RPE than what they were actually experiencing.

Along with not telling participants if they were in the mindfulness or control condition, the participants were asked to complete the rowing task at whatever intensity felt good to them in that moment. Although non-significant, the intervention group's heart rate during the post-assessment was higher than the control group, and the intervention group demonstrated greater distance and power than the control group. To have reported the same perceived exertion, even

though their performance metrics were not the same, mindfulness training could have played a role in manipulating the participants' perception of how hard they were exercising. This is demonstrated through the post-assessment RPE scores being lower than the pre-assessment, with no significant changes in heart rate between the sessions. This can also be seen in how at the post-assessment, the intervention heart rate was the highest of all the conditions, yet their RPE was the lowest of all the conditions. This perception of exertion modification has been seen in previous research where mindful cycling resulted in accurate RPE prediction regarding their heart rate while cycling (Meggs & Chen, 2021). Similar findings have been reported, that when women were first taught mindfulness strategies, they reported a lower RPE and were able to tolerate exercise for longer periods of time (Ivanova et al., 2015). Previous research has shown that as exercise intensity increases, RPE will increase as well, which is corroborated with findings of this study where both heart rate and RPE significantly linearly increased across the three time points (Tenenbaum & Connolly, 2008).

Similarly to the findings for RPE, attention allocation results demonstrated no significant differences between the two conditions, but contrastingly, there was not a significant difference in attention scores from the pre-assessment to the post-assessment. The only significant finding within attention allocation was that attention scores increased and became more associative as more time passed during the rowing task, similarly to the increased heart rate as the sessions progressed. This finding has been found in prior research where lower intensity exercise is linked to dissociative attention, and higher intensity exercise tends to be more associative (Hutchinson & Tenenbaum, 2007; Masters & Ogles, 1998; Stanley et al., 2007; Tenenbaum & Connolly, 2008). Connolly and Janell (2003) investigated the performance metrics of two groups, one told to exercise with associative attention and the other with dissociative attention, it was found that

the group exhibiting associative attention rowed further and faster, which is in line with our findings that overall, the participants of this study used associative attention and had greater performance metrics than hypothesized. In agreement with our findings, with more associative attention, RPE is typically greater, indicating as intensity is greater, individuals are more in tune with how their body feels and their breathing (Masters & Ogles, 1998). As previously mentioned, mindfulness does not equate to associative attention, but they are typically linked to one another, which allows us to infer that since our participants had greater associative attention while completing the rowing task, they may have been utilizing mindfulness skills while rowing (Cox et al., 2018; Cox et al., 2020). Although non-significant, at the halfway point of the rowing task during the post-assessment, the intervention group had higher attention scores than the control group, indicating that they were more associative in their attention at the peak of the exercise task. The intervention group at the post-assessment also demonstrated sustained associative attention, with scores plateauing, whereas the control group continued to increase as the exercise progressed, as typically seen in the literature (Hutchinson & Tenenbaum, 2007; Masters & Ogles, 1998; Stanley et al., 2007; Tenenbaum & Connolly, 2008).

Contradictory research is found within enjoyment of exercise, with majority of research stating that an individual must dissociate from the exercise task to best enjoy it (Bird et al., 2019; Cox et al., 2020). By associating while completing this rowing task, no matter the group condition, enjoyment scores increased from the pre-assessment to the post-assessment. Cox and colleagues (2020) found that an exercise group that listened to music compared to listening to a mindfulness script experienced no differences in exercise enjoyment, although their attention styles did differ. It is noteworthy that previous research has suggested that to improve exercise enjoyment, an individual should dissociate from the task (Bird et al., 2019). However, findings

from the current study show that individuals who associated during the rowing task experienced an improvement in enjoyment over the four-week study period, so further research should investigate all ways of exercising, to find an individualized approach.

The PACES is a standard way for measuring post-exercise enjoyment, and it was used in this study to identify a significant increase in exercise enjoyment from the pre-assessment to the post-assessment (Murrock et al., 2016). This increase was primarily driven by the significant difference in change scores for the intervention group compared to the control, increasing their PACES score by 10.76 points. This finding can be found in previous research on mindfulness interventions with exercise, however, in previous research, the improvement in enjoyment was only visible for the mindfulness group, not in the control group (Cox et al., 2018; Ivanova et al., 2015). Since there was an overall improvement, it can be inferred that watching Wild Babies improved or maintained exercise enjoyment levels just as much as the mindfulness intervention, so neither group experienced a decrease in exercise enjoyment levels. Both strategies can be used to enhance enjoyment in individuals to build long-term exercise habits, the key will be to match the intervention to the individual wishing to begin exercising.

An interesting finding from this study was no significant differences in forecasted pleasure between groups or sessions. An increase in forecasted pleasure from pre-assessment to post-assessment was found, albeit not significant, largely driven by the non-significantly different intervention group change score of 15.6 points. The mindfulness intervention had an impact on forecasted pleasure, but not enough to elicit a significant difference. This contradicts previous research where a mindfulness condition had significantly greater forecasted affect when compared to a control condition (Cox et al., 2020). This could have been due to having an already active population, compared to sedentary populations used in previous research, that

already know they will exercise again and know what to expect when they take on an exercise task (Cox et al., 2020).

Based on the results of remembered pleasure, there was a significant increase between the pre-assessment and the post-assessment. Both the control and intervention groups experienced an increase in remembered pleasure, but the intervention group experienced a change of 17.65 points compared to the control group only increasing 7.53 points. This could have been caused by the pre-assessment being the first visit, with nine more rowing tasks ahead for the participants to complete, whereas, at the post-assessment, they were now done with the rowing tasks for the study and could think about their individual workout regimen instead. This contradicts previous research where the mindfulness condition experienced no significant difference in remembered pleasure compared to a control group of inactive individuals (Cox et al., 2020). As mentioned regarding forecasted pleasure, since the participants of our study were already consistent exercisers, they may have different feelings and experiences when it comes to these exercise tasks, meaning they had a greater enjoyment of what they had just completed and it did not seem as strenuous as compared to what an inactive individual may have experienced and perceived.

To analyze state mindfulness, two questionnaires were utilized. The SMS-PA, with the subscales of Mindfulness of the Mind and Mindfulness of the Body, reported results demonstrating how the control group reported significantly higher state mindfulness scores than the intervention group, and that Mindfulness of the Body scores were significantly greater than Mindfulness of the Mind scores. It is hypothesized that the control group reported higher mindfulness scores because they did not fully grasp what mindfulness is, whereas the intervention group, having been educated and having practiced mindfulness for four weeks, knew that they did not yet fully grasp the concept and did not follow how they should be

thinking. This finding contradicts previous research, where the control group experienced significantly less Mindfulness of the Mind and Mindfulness of the Body compared to the mindfulness intervention condition (Cox et al., 2020). With the subscale scores, it is believed that since the higher overall scores were driven by the control group, they were able to understand the concept of Mindfulness of the Body, without having to go through any mindfulness training. They could pay attention to their form and breathing without having to sit through a guided meditation before completing the rowing task. This concept may have been easier for the intervention group as well, who were trying diligently to understand Mindfulness of the Mind, and having a clear head, being present while exercising. This finding aligns with the research produced utilizing the SMS-PA where Mindfulness of the Body scores are significantly greater than Mindfulness of the Mind (Cox et al., 2016; Cox et al., 2020). High scores of Mindfulness of the Body have also been linked to increases in health or fitness reasons for exercising, rather than negative reasons such as self-objectification or body shame (Cox et al., 2016).

The other scale for state mindfulness, the MFPA, reported non-significant results for between session and group analysis. One finding is that the overall MFPA state mindfulness score decreased from the pre-assessment to the post-assessment, similarly to the SMS-PA, this change being driven by a greatly decrease from the control group and minimal change from the intervention group. Similarly to the SMS-PA, individuals may have been overenthusiastic to complete this study and thought they knew what mindfulness was on that first visit, but as the weeks went on, the control group lost their enthusiasm and reverted to dissociative techniques, and the mindfulness group might have focused on learning the practice and dedicating the time to do so. Since they could not master mindfulness in this low-dose intervention, the intervention group did not see improvements in state mindfulness after completing the rowing task. Perhaps a

longer, more intensive intervention could have shown those outcomes. The MFPA has been used in previous literature to find associations between satisfaction and trait mindfulness, where it was found to be significantly correlated both variables ($p < 0.001$) (Tsafou et al., 2016a; Tsafou et al., 2016b).

Lastly, trait mindfulness was measured with the MAAS, and showed that scores significantly lowered from the pre-assessment to the post-assessment. The control group experienced a greater change than the intervention group. This finding contradicts current research where a mindfulness intervention combined with exercise typically results in increases in dispositional mindfulness scores (Mothes et al., 2014). Other research has focused on the correlations between dispositional mindfulness and physical activity, and has found to be both significantly correlated (Tsafou et al., 2016a; Tsafou et al., 2016b) and not significantly correlated (Ruffault et al., 2016). Although not significant, there was a decrease in trait mindfulness from the pre-assessment to the post-assessment, driven by a decrease in the control group compared to the intervention group staying the same. They may have overestimated their mindfulness skills in that first visit, overenthusiastic to learn about mindfulness and complete the study, not knowing they would be watching nature documentary episodes each visit, thus limiting their creativity and motivation to try and exercise mindfully.

One would not expect a mindfulness intervention to reduce dispositional mindfulness, but as previously mentioned, it takes time and diligent effort to learn how to practice mindfulness, so this low-dose intervention was not enough for our participants to get to the point of mastery. They may have overestimated their mindfulness ability at the pre-assessment, and after the four weeks, the control group knew they were not being mindful, and the intervention group was on their way to grasping the mindfulness construct and how they can implement it in their lives,

specifically with exercise. Previous research about trait mindfulness, or dispositional mindfulness, has found that it is associated with increased exercise motivation, lower levels of externally controlled reasons to exercise, psychological distress, and exercise dependence (Lynn et al., 2022). With this information, the findings from this study should be compared to levels of motivation to see if there were any changes in motivation since participants did experience a decrease in trait mindfulness from the pre-assessment to the post-assessment.

Limitations and Future Research

Several limitations to the present study are worth mentioning. First, majority of the measures were taken via self-reporting, such as the questionnaires administered and the verbal responses of RPE and attention that were taken during the rowing task. This could have influenced the data because the perceptions of the exercisers may be different from the reality that they were experiencing. There may have been an inflated perception of what mindfulness is prior to completing the study, which could have skewed the pre-assessment scores of state and trait mindfulness. It is hard to capture true understanding and practice of mindfulness through Likert-scale questionnaires, so having a more in-depth response style could have helped to delineate if there were changes in mindfulness for these individuals.

The goal of the study was to have even numbers of females and males to make comparisons across sex on the dependent variables, however, there was a skewed ratio of females and males. With almost a four to one ratio of females to males in this study, those comparisons could not be made with any accuracy. Males also dropped out of the study at a higher rate than females, with five male drops to only two female drops, suggesting that they were not as inclined to receive the information from this study, or were less motivated to continue the study after starting. Since there were uneven numbers for the sexes, this impacts the

generalizability of the results, and future research should investigate how males are impacted by a mindfulness intervention, and if they are as invested in using this technique in exercise.

Another limitation of this study is that this mindfulness intervention was only delivered for four weeks, where most successful, traditional interventions last at least eight weeks (Demarzo et al., 2017; Carmody & Baer, 2009; Chiodelli et al., 2020). This intervention was also low dose, since the participants were only watching the videos twice a week for the four weeks, and they were not encouraged to practice mindfulness on their own outside of the study. Future research should increase the dosage of this intervention, using not only the episodes of Headspace Guide to Meditation, but also giving the participants use of the Headspace app to use outside of the research lab on a daily basis and log daily usage of the app.

It could not be guaranteed that participants paid attention to the episodes of whichever show they were assigned, but by having them leave all technology devices on silent in another room and making sure a member of the research team sat in the room with them all attempts were made to mitigate any distractions. But, having someone behind them could have possibly provided more of a distraction than an aid in not distracting, so this could be considered a limitation of not fully buying-in to the mindfulness meditation since they may have worried about how they were being perceived by the researcher. There is no way to know if they actually paid attention to the material and grasped the mindfulness concepts being taught in the Headspace episodes. Future research should implement some form of biofeedback attention tracking, to ensure that participants are giving the episodes their full attention, which may lead to improvements in mindfulness scores or testing the retention of the information presented.

This serves as an initial study, but future research should continue to collect as much data as possible on how mindfulness can be used to make exercise more enjoyable. More

interventions of doing so and making these interventions more accessible will continue to improve enjoyment of exercise which can serve to help individuals make and sustain long-lasting exercise habits.

Since the study was four weeks in duration, some attrition occurred. This aligns with research on intrinsic motivation and increased enjoyment of exercise because the participants who completed the entire duration of the study exhibited greater enjoyment of the exercise after completing the study (Cox et al., 2016; Kimiecik & Harris, 1996; Overstreet et al., 2017; Ruffault et al., 2015). Future research with an intervention of this duration should implement a measurement of the source of motivation to see if the participants who complete such a study do in fact exhibit higher levels of intrinsic motivation and lower levels of extrinsic motivation. The lack of attrition found within this study is not a novel concept, and it is something that mindfulness-based interventions struggle with, so future research needs to be conducted on ways to improve attrition for these studies, to better understand the effects of the interventions (Gavrilova & Zawadzki, 2023; Nam & Toneatto, 2016).

Lastly, this study only investigated active individuals who currently meet physical activity guidelines of 150 moderate or 75 vigorous minutes of exercise each week. Since these participants know their bodies well due to consistent exercise patterns, they may have been more inclined to integrate skills like Mindfulness of the Body and been able to accurately predict their rating of perceived exertion. Future research should investigate how this intervention would impact individuals who do not meet physical activity guidelines, who may be less familiar with how their body feels while exercising and may need guidance on how to shift their thought process to greater enjoy each exercise session they complete. By examining an inactive population, there can be further investigation on intrinsic motivation to exercise as well, because

there may be external forces at play such as risk for cardiovascular disease, Type II diabetes, or other health issues that a physician is prescribing exercise to try and reverse those effects. Also, participation was limited to individuals who do not currently practice mindfulness, as to not have any existing experience that could impact scores, but it could be worth investigating this population that was excluded because they may not have experience integrating mindfulness with exercise.

Practical Implications

Utilizing mindfulness while exercising can serve as a possible solution for clinicians and exercise professionals because it may increase enjoyment of exercise. Majority of Americans cite a lack of enjoyment for not wanting to exercise, which is why they do not meet current physical activity guidelines, leading to these individuals not obtaining both the psychological and physiological benefits of regular exercise (WHO, 2020). By exercising and building exercise habits that are sustainable and enjoyable for individuals, these negative outcomes can be mitigated (Kim, 2022; Sharma et al., 2006; Thayer et al., 1994). The current study's findings may be of relevance for practitioners who want to prescribe physical activity, but in a way that will be maintained by the individual for an extended period. An exercise prescription that uses a mindfulness intervention is easily accessible and can be utilized by any individual who wants to make the necessary changes to their lives. It is a cost-effective solution, and something that should be further investigated to find the best way to prescribe this intervention to individuals who may lack the intrinsic motivation to exercise on their own.

Conclusion

In conclusion, the aim of this study was to examine the effects of a low dose four-week digital mindfulness intervention during a rowing task on exercise enjoyment, RPE, heart rate,

attention allocation, state mindfulness and trait mindfulness. Results indicated the intervention and the control groups experienced an increase in exercise enjoyment, however, there were greater change scores for the group that underwent the mindfulness intervention. Similarly, RPE decreased over the course of the study for both groups, while heart rate remained the same, suggesting a manipulation of perception had taken place, with the mindfulness group exhibiting the lowest RPE at the post-assessment with the highest heart rate. As the rowing task progressed, attention scores trended more associative, suggesting that as the exercise became more intense, the focus of attention shifted inward rather than outward. The mindfulness group exhibited the highest attention scores at the post-assessment, where attention was maintained throughout the exercise, it plateaued. Scores of state and trait mindfulness decreased over the duration of the study, which could be attributed to an overestimation of mindfulness ability at the pre-assessment, or an overenthusiastic approach to participating in the study. To increase enjoyment of exercise, a digital intervention of any content may be a sufficient solution, however, to experience a greater change, a mindfulness intervention can be used to elicit these responses. Future research should expand upon the influence of digital mindfulness interventions by implementing a longer duration and investigating the role of intrinsic motivation on exercise enjoyment. Although this study has several limitations, it adds to the limited research on easily accessible mindfulness interventions and provides future research with a sufficient protocol for examining the effects of a digital mindfulness intervention on active exercisers during a rowing task.

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