A Pilot Study of the Impact of a Brief Values-Based Exercise Promotion Intervention on College Student Exercise Levels

by

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Background: Many individuals do not meet recommendations for adequate amounts of exercise, despite well-documented health benefits. While many studies have been designed to promote exercise, there is still a dearth of effective interventions for increasing exercise. Recently, exercise promotion interventions which aim to increase autonomous motivation using a values-based approach to behavior change have found promising results. However, they are often lengthy and multi-faceted, and it is unclear whether a simplified brief intervention could effectively promote exercise.

Purpose: The purpose of the current study was to develop and test a brief exercise promotion intervention focused on integrating exercise with values among college students.

Methods: 78 students were recruited from a large, Southeastern university, and 50 completed the study. Completers attended four group sessions over four weeks. Participants were randomly assigned to intervention or control groups at a 1.5:1 ratio. The intervention group focused on integrating exercise into key value areas, while the control group received education about benefits of exercise. A mobile app was used to monitor daily self-reported exercise. Participants completed the Behavioral Regulations in Exercise Questionnaire-2 to assess motivation for exercise and a self-report measure of congruence between exercise and values.

Results: ANCOVAs were used to examine whether participation in the intervention was associated with greater exercise, controlling for baseline exercise. Students in the intervention group did not engage in more exercise compared to the control group ($p=.55$). The intervention group appeared to help participants engage in more values-consistent exercise ($p=.021$), and those in the intervention group who reported engaging in more values-based exercise reported greater exercise ($p=.044$). Participants who reported more intrinsic motivation for exercise engaged in more vigorous-intensity exercise ($p=.018$) and average METs/week ($p=.018$).

Discussion: The brief values-focused intervention was not associated with greater exercise. However, the intervention was successful at promoting value-consistent exercise, and those most successful at integrating exercise with their values did engage in more exercise. Greater intrinsic motivation was associated with more exercise, particularly vigorous-intensity. Future studies should examine how combining exercise and values may be used to promote health behaviors and how to best implement and dose interventions for various populations.

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Doctorate of Philosophy in Health Psychology

by

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TABLE OF CONTENTS

LIST OF TABLES:

LIST OF FIGURES:

Chapter 1: Literature Review

Exercise Benefits and Prevalence

As the medical field has progressed and the lethality of acute diseases has decreased, the leading causes of death in recent years have largely shifted to chronic diseases with modifiable, preventable behavioral factors. For example, a recent review estimated that overweight/obesity status and physical inactivity were responsible for nearly one in ten deaths in the US (Danaei et al., 2009). Another large review conducted by the Center for Disease Control (CDC) suggests that since 2005, the rate of premature deaths has remained relatively constant (Johnson, Hayes, Brown, Hoo, & Ethier, 2014). In this review, which spans from 2005-2013, many behavioral risk factors (e.g., tobacco smoking, obesity, physical inactivity, uncontrolled hypertension and hyperlipidemia) have seen little to no improvement over the past decade. For physical inactivity in particular, large cohort studies suggest that engaging in even low levels of PA may result in a significant reduction in all-cause mortality risk (Ekelund et al., 2015). It is quite apparent, therefore, that improving these essential health behaviors is a critical public health concern and would have an immense impact on reducing the impact of various chronic diseases.

Given that physical inactivity is so highly associated with preventable causes of death, it stands to reason that engaging in active behaviors is extremely advantageous. According to the American Heart Association (AHA), aerobic exercise has been associated with many physiological benefits. For example, Fletcher and colleagues (1996) noted that exercise was associated with a reduction in the risk of coronary artery disease, as well as decreased oxygen demand in the heart in both healthy individuals and those who already have cardiovascular disease. Additional benefits of aerobic exercise include blood lipid control, improved lipid and carbohydrate metabolism, and reductions in diabetes, obesity, and hypertension (Fletcher et al.,

1996). Even resistance training, such as lifting weights, has been shown to have positive effects on the body by improving strength and flexibility, especially among the elderly (Fletcher et al., 1996).

Recent research has corroborated the beneficial effects of exercise in numerous different studies. A large meta-analysis of over 288,000 participants in longitudinal studies assessing physical activity suggested that increases in physical activity were associated with decreased obesity, less occurrence of coronary artery diseases and type 2 diabetes, and even some decreases in dementia and Alzheimer's disease prevalence (Reiner, Niermann, Jekauc, & Woll, 2013). These associations have been found in children as well, with sedentary behavior being directly linked to increases in obesity in a longitudinal study of children ages 9 to 15 (Mitchell, Pate, Beets, & Nader, 2013). Another large meta-analysis focusing on cardiac functioning, specifically left ventricular ejection fraction, suggested that the heart recovered more fully and was able to eject more blood following a myocardial infarction when exercise programs were initiated soon after the event (Haykowsky et al., 2011). While research on college students' exercise and health outcomes is relatively sparse, there is evidence which suggests that there are observable physiological benefits (e.g. improvements in skeletal muscle mass, flexibility, balance, and muscle strength) when young, sedentary women begin to engage in a low-intensity exercise program (Tolnai, Szabó, Köteles, & Szabo, 2016). Additionally, research supports the idea that engaging in exercise in adolescence and young adulthood is associated with more exercise behaviors in adulthood, as well as potential protective effects on key health areas like bone health and some cancers (Hallal, Victora, Azevedo, & Wells, 2006).

Above and beyond physiological benefits, exercise has also been associated with a plethora of psychological benefits. For example, the AHA notes that exercise has been associated with improved cognitive functioning and lower levels of stress and anxiety (Fletcher et al., 1996). Another recent systematic review of 30 studies demonstrated that exercise was

associated with improved self-esteem and social interactions, as well as decreases in depressive symptoms in children and adolescents (Eime, Young, Harvey, Charity, & Payne, 2013). In both older adults and young adults, exercise has been associated with increases in positive affect, suggesting that exercise behaviors may result in similar psychological benefits regardless of age (Hogan, Mata, & Carstensen, 2013). While the literature is somewhat mixed with regards to the benefit of exercise on cognitive functioning, some studies have found improvements in various components of cognitive functioning after engaging in an exercise program (Stroth, Hille, Spitzer, & Reinhardt, 2009). Neurological changes have been found among college-aged females after engaging in aerobic exercise, providing further support for possible cognitive improvements related to exercise (Li et al., 2014). Additionally, in multiple studies which examined individuals' motivations for engaging in exercise, improvements in psychological outlook or psychological benefits were cited as key reasons for engaging in exercise (Lovell, El Ansari, & Parker, 2010; Resnick et al., 2008).

In order to obtain the optimal health benefits associated with exercise, various standard-setting organizations in the US have described recommendations for how much exercise individuals should engage in. According to the US Department of Health and Human Services (HHS), adults should engage in at least 150 to 300 minutes of moderate aerobic activity (such as brisk walking or playing tennis) or 75 to 150 minutes of vigorous aerobic activity (such as running or fast swimming) per week (US Department of Health and Human Services, 2008). The American College of Sports Medicine (ACSM) and American Heart Association (AHA) suggest similar, albeit slightly different, recommendations. These organizations recommend that all healthy adults, aged 18 to 65 years, should engage in moderate-intensity aerobic activity for a minimum of 30 minutes on five days per week, or vigorous-intensity activity for 20 minutes three days per week (Haskell et al., 2007). In general, moderate-intensity activity is

conceptualized as activities which increase heart rate, while vigorous-intensity activity results in rapid breathing and a substantial increase in heart rate (Haskell et al., 2007).

While the benefits of exercise have been clearly defined by the literature and recommendations have been set by various health organizations, the prevalence of adequate exercise is still suboptimal. Kohl and colleagues (2012) examined literature from many different countries and found that approximately 31% of the global population does not meet minimum daily requirements for exercise; for this study, physical inactivity was defined as not meeting the ACSM guidelines. This number appears even higher in the US. According to the CDC, only around 21% of US adults meet these same recommendations for exercise (Johnson et al., 2014). In studies which examine sedentary behaviors (e.g. behaviors which involve sitting and limited movement, like watching television), approximately 55% of individuals in the Americas spend four or more hours per day sitting (Hallal et al., 2012). Another study in the US of over 6,000 participants across the lifespan who wore an activity monitor for up to 7 days found that participants spent 54.9% of their waking time, or approximately 7.7 hours/day, engaged in sedentary behaviors (Matthews et al., 2008). Notably, the two groups which were found to engage in the most sedentary behaviors included adults aged 60 or greater and older adolescents (e.g. college students), with each group spending about 60% of their waking time engaged in sedentary behaviors. Physical inactivity has also been associated with older individuals, females, and individuals in high-income countries (Hallal et al., 2012). While there is some evidence that exercise levels are improving somewhat in recent years in the US (Dwyer-Lindgren et al., 2013), there is still a severe lack of adequate exercise which contributes to poor health outcomes.

In college students, physical inactivity appears to be a problem as well. One meta-analysis found that about 40-50% of college students are physically inactive, which was defined as not meeting ACSM recommendations for exercise (Keating, Guan, Piñero, & Bridges, 2005).

Another meta-analysis of over 35,000 students from 27 countries estimated that over 50% of college students do not meet the ACSM guidelines to obtain optimal health benefits from engaging in exercise (Irwin, 2004). Interestingly, knowledge about the benefits of exercise may be significantly lacking within this population as well, as one study of over 19,000 students from 23 countries found that 40-60% of students were unaware that sedentary behavior was a risk factor for heart disease (Haase, Steptoe, Sallis, & Wardle, 2004). Among college students, women (especially African-American women) and students who live on-campus have been found to engage in less exercise than men or off-campus students (Irwin, 2004; Buckworth & Nigg, 2004).

Exercise Promotion Attempts

Considering how valuable exercise is for physical and psychological health and how prevalent sedentary behavior is, it is not surprising that a myriad of attempts has been made to try and improve individuals' level of exercise. Many of the studies which originally attempted to increase exercise behaviors were based on social-cognitive theories, which had already been applied to other health behaviors. For example, Godin (1993) reviewed research which examined the use of the theory of reasoned action and theory of planned behavior on exercise promotion. The theory of reasoned action (TRA) suggests that an individual's personal attitude towards a certain behavior, as well as social norms and beliefs about the behavior, are the key contributors to the intention to engage in a behavior; subsequently, behavioral intentions lead to behavior (Madden, Ellen, & Ajzen, 1992). The theory of planned behavior (TPB) added to this model by suggesting that perceived control over the behavior is also associated with forming an intent to act, considering that many behaviors may be perceived as out of the individual's control (Madden, Ellen, & Ajzen, 1992). Godin (1993) suggested that studies which utilized these social-cognitive theories and examined individuals' attitudes towards exercise and perceived control over starting an exercise regimen showed promising results for exercise promotion.

However, more recent reviews offer more mixed results. A systematic review of 30 papers using TPB-based behavior change interventions suggested that only half of the interventions were successful at changing intentions, with generally small effect sizes; at the same time, many of the proposed mechanisms of effects were not measured, so conclusions about the effectiveness of TPB were unable to be assessed (Hardeman et al., 2002). Given that the TPB is a theory, and not a behavior change intervention itself, the studies examined in this review were often heterogenous aside from the focus on measuring intentions to engage in exercise behaviors. Some of the components found in various interventions based on the TPB include educational components, exercise classes to model behavior, graded behavior change and goal setting, social encouragement, etc. Therefore, this systematic review appears to suggest that even a major proposed TPB mechanism, intent to engage in exercise, was not altered in many of these diverse interventions. Further, some studies of exercise promotion in adolescents demonstrate increased intention to exercise but no corresponding improvements in exercise participation (Chatzisarantis & Hagger, 2005). This finding casts considerable doubt on the use of TPB as a theory to guide exercise promotion attempts, given that the key mechanism of this theory involves increasing intent to act. If increased intentions to engage in a behavior do not necessarily lead to increased engagement in that behavior, this theory is likely not very useful for trying to increase exercise behaviors. One recent review went so far as to suggest that the TPB should be retired at this point, describing several key criticisms of the model with regards to measurement of mechanisms, validity, and utility (Sniehotta, Presseau, & Araújo-Soares, 2014).

Other researchers have utilized different theoretical frameworks to attempt to increase exercise levels as well. For example, Adams and White (2003) examined 26 papers which used exercise promotion programs based on Prochaska and DiClemente's (1982) transtheoretical model (TTM). In the TTM, behavior change is seen as a process with five potential stages:

precontemplation, contemplation, preparation, action, and maintenance. According to Adams and White (2003), however, interventions which attempted to aid participants in moving to a higher stage of change to improve exercise only showed short-term (six months or less) benefit; most participants did not maintain improvements in exercise in long-term follow-ups (longer than six months). Because the TTM views change as a process, and not a single event, interventions may include different components for individuals at different stages of change. For example, individuals in the pre-contemplation stage may be provided with information (e.g. consciousness-raising) about the importance of engaging in adequate exercise. However, someone already in the action phase may receive more focus on building social support for exercise or stimulus control strategies to move to the maintenance phase. While this individualization of treatment to an individual's stage of change seems potentially advantageous for behavior change, Adams and White (2003) note that these interventions are often very heterogeneous depending on how the TTM is interpreted when designing an intervention.

Additionally, the health belief model (HBM) has been applied to exercise promotion. The HBM posits that various perceptions about a health behavior (e.g. perceived susceptibility, perceived threat), social cues about the behavior, perceived barriers, and individual differences may also contribute to affect the likelihood of a behavior (Hochbaum, Rosenstock, & Kegels, 1952). For example, among a sample of 161 college students, self-reported self-efficacy and perceived barriers to exercise were significantly associated with exercise behaviors (Von Ah, Ebert, Ngamvitroj, Park, & Kang, 2004). In another recent study examining exercise behaviors and HBM mechanisms, researchers did find that self-reported perceived benefits and exercise cues were associated with increased exercise behaviors, while perceived barriers were associated with decreases in exercise (King, Vidourek, English, & Merianos, 2013). A recent systematic review of general health behavior change interventions based on the HBM found that approximately 78% of interventions reported improvements in adherence to health behaviors

(Jones, Smith, & Llewellyn, 2014). However, many of the same criticisms of other social cognitive theories have been applied to interventions based on the HBM. For instance, Jones, Smith, and Llewellyn (2014) noted that only 33% of interventions used all components of the HBM, and that significant improvements in adherence were often unrelated to any specific HBM construct. Additionally, these researchers note that interventions based on the HBM are often heterogeneous; techniques used to change behavior included providing information, using prompts to elicit changes in behavior, social support, teaching new behaviors, etc.

Overall, there appears to be some evidence which suggests that various social-cognitive theories are effective models for promoting exercise; however, there are notable limitations to this literature. In a recent meta-analysis of randomized controlled trials of theory-based interventions (TTM, TPB, Social Cognitive Theory, etc.) for exercise promotion, 82 trials resulted in an overall small to moderate effect size (d = 0.31) (Gourlan et al., 2016). However, as mentioned in Adams and White (2003), long-term benefits of many exercise promotion programs are still questioned. The AHA reported similar concerns, noting that around 50% of those who begin an exercise program have discontinued it by six months (Fletcher et al., 1996). If these attempts at improving exercise behaviors do not have long-term effects, the usefulness of these programs would be seriously questioned. Additionally, many of the RCTs reviewed by Gourlan and colleagues (2016) were found to have poor methodological quality; many of the studies were based on certain theories, but did not measure the mechanisms by which those theories suggested behavior change occurs or did not fully incorporate them into their intervention. Based on this limitation, it is likely not possible to definitively know what the key components are when examining exercise promotion. Likewise, many of the interventions based on various theories utilize the same key techniques to try and promote behavior change while interpreting them through the lens of whichever theory the intervention is based upon. Almost all interventions described above include a significant educational component;

depending on the theory, education may serve to increase participant intent to exercise (TPB), move a participant from the pre-contemplation to contemplation stage (TTM), or improve participant perception of benefits and barriers to engaging in exercise (HBM). Therefore, it is still quite unclear as to exactly what underlying mechanisms may be most effective for improving exercise behaviors.

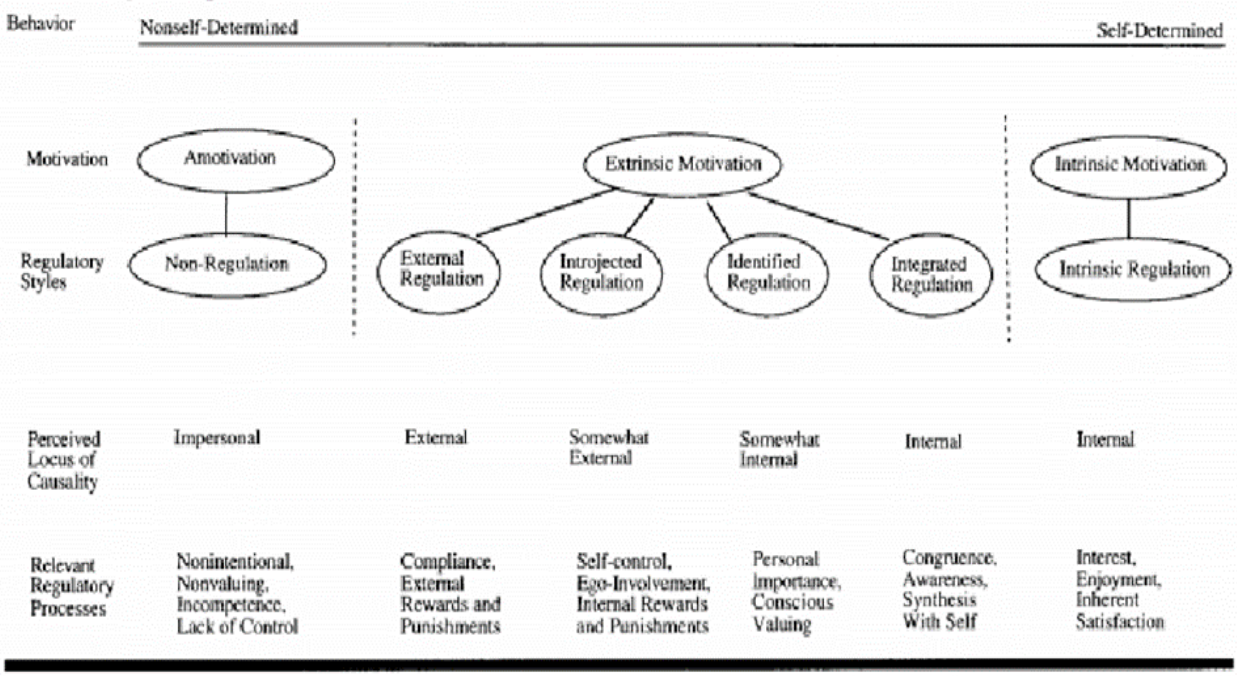
Ultimately, the results from these different theory-based exercise promotion interventions suggest that more research is needed to better understand the mechanisms of exercise promotion. A recent review of twenty-three studies utilizing a variety of social cognitive theories for exercise promotion (including TPB, TTM, and HBM) noted that many of these interventions improve participant intention to engage in exercise, but are much less effective at actually improving exercise behavior (Plotnikoff, Costigan, Karunamuni, & Lubans, 2013). Given that long-term exercise adherence is still a significant weakness of many of these interventions as well, it is possible that other models of behavior change may be more useful to identify the key driving mechanisms behind long-term exercise behavior.

Exercise Promotion Using Self-Determination Theory

One of the more recent social-cognitive theories which has received attention in the exercise promotion literature is self-determination theory (SDT), described by Ryan and Deci (2000). According to this theory, motivation to engage in a behavior exists on a continuum ranging from controlled to autonomous motivation, where more autonomous forms of motivation result in more sustained behavior. Within this framework, SDT describes extrinsic forms of motivation (e.g. engaging in a behavior to obtain some external reward) and intrinsic motivation (e.g. engaging in a behavior because the behavior itself is its own inherent reward), with intrinsic motivation being more autonomous than extrinsic (Ryan & Deci, 2000). However, SDT does not suggest that all types of extrinsic motivation are inherently non-autonomous. Rather, a sub-

theory of SDT called organismic integration theory (OIT) expands upon extrinsic motivation and denotes several types of extrinsic motivation. The least internalized, autonomous motivation is externally regulated motivation, where a behavior is done simply to meet an external demand or reward. Introjected regulation would involve behaviors performed to obtain positive psychological states (e.g. pride) or avoid negative states (e.g. guilt); this is still seen as extrinsic motivation because these behaviors are not performed for their inherent satisfaction. Identified regulation occurs when a behavior is accepted as important, whereas the most autonomous form of extrinsic motivation is integrated regulation, which "occurs when identified regulations are fully assimilated to the self, which means they have been evaluated and brought into congruence with one's other values and needs" (Ryan & Deci, 2000). As an example, a teacher who dislikes teaching but only does so for his or her paycheck may be said to be externally motivated. If this teacher only prepares his or her lesson plan to avoid feeling guilty, he or she likely has introjected motivation. A teacher who may not enjoy teaching itself but identifies being a teacher as a key part of his or her self-view and values would have integrated regulation. Finally, a teacher who genuinely finds teaching enjoyable in itself is intrinsically motivated. Overall, therefore, the key distinction in motivation according to SDT is between controlled motivation and internalized, autonomous motivation. See Figure 1 (taken from Ryan and Deci, (2000)) for a visual representation of this continuum.

Figure 1
The Self-Determination Continuum Showing Types of Motivation With Their Regulatory Styles, Loci of Causality, and Corresponding Processes



In interventions based on SDT, when a behavior helps an individual meet some of their basic psychological needs, such as autonomy, competence, or relatedness, a behavior is more likely to become more self-determined (e.g. intrinsically motivating) and then more likely to be maintained. In this way, even behaviors which are extrinsically motivating may become more intrinsically motivating if the behavior satisfies one of these underlying psychological needs. Therefore, many interventions utilizing SDT as a framework attempt to facilitate the transition of extrinsic motivators to internalized, autonomous motivation to engage in a behavior (Fortier, Duda, Guerin, & Teixeria, 2012). SDT has been successfully applied to a variety of health behavior changes (Fortier et al., 2012).

Research on the SDT and exercise has been mainly promising to date. For example, one recent study demonstrated that changes in goals from extrinsic to intrinsic predicted greater

autonomous motivation (Gunnell, Crocker, Mack, Wilson, & Zumbo, 2014). In the same study, increased autonomous motivation was associated with increases in psychological need satisfaction (e.g. autonomy, competence) and increased exercise behavior, as would be predicted by SDT (Gunnell et al., 2014). However, this study used data at two times six months apart and conducted a structural path analysis to examine these associations; therefore, it is unclear how these mechanisms changed over time and not possible to draw causal conclusions about the exact sequence in which these different components change. A smaller qualitative study over ten months suggested that constructs related to SDT, such as more intrinsic, self-determined motivation for walking behavior, was essential to maintenance of exercise; additionally, these principles were key for re-adoption of exercise after stopping for some time (Kinnafick, Thøgersen-Ntoumani, & Duda, 2014). While this study benefited from a longitudinal design to better assess change over time, it involved a very small sample size (n=15) and did not measure specific mechanisms associated with SDT, limiting its ability to draw stronger conclusions about SDT and exercise promotion.

Several large reviews of the literature involving SDT and exercise promotion lend even more evidence to their effectiveness. For instance, three large randomized controlled trials utilizing SDT to increase exercise were reviewed by Fortier and colleagues (2012). Each of the RCTs demonstrated positive effects on exercise levels, with one of the studies even showing significant results at a two-year follow-up. A larger systematic review of 66 studies showed "consistent support" for the association of intrinsic motivation and exercise (Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Interestingly, the authors also noted a trend towards intrinsic motivation being associated with long-term adherence to exercise regimens, which was a significant weakness of previous interventions. Overall, it appears as if interventions based on SDT have promise for being effective means to help sedentary individuals adopt and maintain better exercise routines.

The Promotion of Health and Exercise in Obesity (PESO) trial is a good example of an SDT-based exercise promotion intervention (Silva et al., 2010). This study was an RCT for 239 overweight or obese women, consisting of a 1-year intervention and 2-year follow-up with no intervention components. The intervention was based on SDT and promoting autonomous, intrinsic motivation for exercise and eating habits. Over the course of 30 weekly or bi-weekly 120-minute sessions, participants engaged in a variety of informational modules and activities designed to promote autonomy and competence over their behavior. Specifically, the intervention included components such as education and knowledge building, providing exercise options and encouraging choice to promote an internal locus of causality, encouraging participants to exercise in congruence with their values, providing positive feedback, setting goals, exercise monitoring, safety discussions, problem solving of barriers to exercise, structured dance classes and an activity challenge program, and others. The control group in this study was an education-only group, consisting of 29 sessions covering topics like healthy nutrition, stress management, self-care, and effective communication skills; no specific goals were set and minimal feedback was provided. Overall, individuals in the intervention group showed significantly higher levels of moderate-intensity and vigorous-intensity exercise at intervention end (30 weeks) compared to the control group, as well as at the year 2 follow-up. Measurements of autonomous motivation for exercise also were significantly improved within the intervention group compared to the control group, though both groups increased in autonomous motivation (d= 0.80 for control, d= 0.96 for intervention). This finding suggests that the development of more autonomous motivation for exercise may be a key mechanism in this sustained increase in exercise.

Many of the studies previously cited, while promising in their findings, acknowledge some notable limitations to the use of SDT for exercise promotion. For example, the studies reviewed in Fortier and colleagues (2012) recruited homogenous populations; namely, middle-

aged, overweight or obese women. More research is needed among other populations to determine if these findings are consistent among other ages, races, and ethnicities. Additionally, the interventions designed via SDT are often bulky and contain a plethora of components. The three RCTs analyzed by Fortier and colleagues (2012) involved interventions with many components, including techniques like values interviews, problem solving, goal clarification, failure normalization, risk/benefit analysis of exercise, promoting internal loci of causality, focusing on safety, and relapse discussions, among many others. Given that the PESO trial described previously involved 30 group sessions of 120 minutes each, it is likely that these interventions may not be feasible or cost-effective in settings where exercise promotion may be needed, like primary healthcare or among sedentary college students (Silva et al., 2010; Fortier et al., 2012). Therefore, one of the primary calls for future research in this area involves dismantling the components of these studies to determine the "active ingredient" for how participant benefits are achieved.

The Use of Values in Behavior Change

One of the key components which is often used in SDT-based exercise promotion interventions is a values exploration. Given that a primary goal of SDT is to create intrinsic motivation for a given behavior, leveraging existing expectations of reinforcement using values may be a particularly important part of these interventions. Values are also used in many of the newer, third-wave cognitive-behavioral therapies like Behavioral Activation Treatment for Depression (BATD) and Acceptance and Commitment Therapy (ACT). From a behavioral viewpoint, values may be defined as "freely chosen, verbally constructed consequences of ongoing, dynamic, evolving patterns of activity, which establish predominant reinforcers for that activity that are intrinsic in engagement in the valued behavioral pattern itself" (Wilson, 2009). In other words, values arise based on an individual's previous experiences and help establish what types of activities will be more intrinsically rewarding and reinforcing. Therefore, in

interventions like BATD and ACT, pre-established values are utilized to guide behavior change, rather than attempting to create new values and intrinsic motivation around certain behaviors. It seems possible, therefore, that focusing on an individual's values and aiding them in including PA in their existing set of values may be an efficacious method to promote behavior change, and much more efficient than multicomponent interventions that seek to establish new patterns of reinforcement.

There are numerous studies which have examined the association between an individual's values and behavior change. For example, an online intervention combining goal setting and values training resulted in significantly greater improvements in college students' GPA compared to goal-setting alone (Chase et al., 2013). Several studies have explored the association between values-based behavior change principles and improved health behaviors as well. One recent study found a significant association between valued activity restriction, depressive symptoms, and smoking behavior in a sample of patients with acute coronary syndrome (ACS) (Busch, Srour, Arrighi, Kahler, & Borrelli, 2015). At the same time, the replacement of restricted activities with other valued behaviors was associated with fewer depressive symptoms and abstinence from tobacco use. For exercise specifically, some studies have also suggested that individual goals and values are associated with increased exercise. Segar, Eccles, and Richardson (2008) demonstrated that women's goals for engaging in exercise were significantly associated with their level of exercise; exercising for stress relief and well-being was associated with high levels of exercise, for example. Therefore, it seems possible that individualizing exercise promotion interventions using participants' values could be highly effective.

Based on the principles of value-driven behavior change, various interventions have been conducted to attempt to improve various health behaviors. MacPherson and colleagues (2010) conducted an RCT of 68 adult smokers, primarily African-American with mild depressive

symptoms. In the intervention group, which consisted of eight sixty-minute group sessions and nicotine replacement therapy, BA principles were used to encourage participants to engage in a variety of reinforcing and value-driven behaviors consistent with a nonsmoking lifestyle; daily behavioral monitoring and discussions about quit-related activities were also used. When compared to a control group (which included nicotine replacement therapy and education about smoking cessation, relaxation techniques, coping with triggers, social support, and relapse prevention), individuals in the intervention group reported greater tobacco abstinence and lower depressive symptoms. Another study which used values-based behavior change principles from BATD examined exercise promotion among a sample of depressed women with type 2 diabetes (Schneider et al., 2016). In this study, individuals participated in thirty-eight, ninety-minute group exercise classes over twenty-four weeks, which included an exercise and BA component. In the BA component, participants completed daily behavior monitoring, behavioral contracts to enlist social support for exercise, and were encouraged to generate a list of values to find ways to incorporate exercise to their values. While this pilot study suffered from recruitment difficulties and did not find significant differences in exercise levels compared to control, participants reported greater exercise enjoyment and lower avoidance of exercise behaviors over time compared to the treatment as usual control group.

Several similar values-based behavior change interventions have been conducted using an ACT framework, which emphasizes committed action to valued behavior. For instance, the principle of psychological flexibility, which is defined as an individual's ability to persist in engaging in value-driven behavior, despite distress or negative emotions, has been associated with increased exercise behaviors in individuals with chronic pain conditions (McCracken, 2013). A recent pilot study using an ACT-based mobile app found that diet and exercise behaviors improved significantly among individuals who used the app, further supporting the potential efficacy of this framework for improving exercise behaviors (Levin, Pierce, &

Schoendorff, 2017). One pilot study was found using ACT principles to promote exercise, which demonstrated significant increases in exercise compared to education (Butryn, Forman, Hoffman, Shaw, & Juarascio, 2011). In this study, thirty-five young adult females participated in two two-hour group sessions over the course of two weeks. In the ACT condition, participants learned activities to defuse from distressing thoughts about exercise, practice mindfulness, reduce experiential avoidance of aversive internal states associated with exercise, and identify their values associated with exercise. Despite these promising results, this study had several limitations. Exercise outcomes were measured as number of visits to the campus rec center, which is not inclusive of all types of exercise which participants may have been engaging in. Additionally, results were not significant at the one-month follow-up mark, indicating a possible problem with long-term behavior change.

Many of these studies utilizing values-based behavior change seem to expand upon some of the potential limitations of SDT-based interventions. For example, many of these studies can be done in significantly shorter timeframes with many fewer components; rather than thirty two-hour sessions over the course of a year (Silva et al., 2010), significant increases in exercise behaviors were found using ACT-based principles in two two-hour sessions over two weeks (Butryn et al, 2011). Additionally, by limiting the number of components in these studies, it seems likely that values are a key mechanism associated with sustained behavior change. However, no studies were found which utilized values-based components alone to determine the effectiveness of this particular component of exercise promotion. It is possible that even the additional components in the ACT-based interventions (e.g. defusion techniques, mindfulness) are not necessary for exercise promotion if individuals are able to incorporate exercise into their pre-existing values. Therefore, future research is warranted into the effectiveness of using a values-based exercise promotion intervention on its own.

Limitations in Exercise Assessment

In addition to limitations in the existing exercise promotion interventions, there is also significant debate about the most accurate method to assess exercise. A review of forty-four studies which assessed exercise behavior found that approximately 73% of studies utilized self-report measures of exercise, which may not have adequate reliability or validity and may suffer from recall errors and self-report biases (Falck, McDonald, Beets, Brazendale, & Liu-Ambrose, 2015). The authors suggest that future research may benefit from more objective measures of exercise behavior, like the use of accelerometers or other technology. While some studies have suggested that self-reported exercise is significantly greater than exercise measured via accelerometer (Slootmaker, Schuit, Chinapaw, Seidell, & van Mechelen, 2009), a systematic review comparing self-reported exercise and accelerometer data found low to moderate correlations in both directions, indicating a lack of congruence between these assessments and the need for more valid and reliable exercise assessments (Prince et al., 2008). One recent meta-analysis of studies examining the validity of accelerometer use found promising results, although it was noted that various models of accelerometers have variability in their output and validity (Plasqui, Bonomi, & Westerterp, 2013). Additionally, accelerometers may not adequately measure all types of exercise and often suffer from significant missing data due to participant non-use (Dunton, Liao, Intille, Spruijt-Metz, & Pentz, 2011).

Ecological Momentary Assessment (EMA) is an assessment technique which allows researchers to collect data in a real-time natural environment and help reduce the effects of recall bias (Stone & Shiffman, 1994). The feasibility of using EMA to assess exercise has been demonstrated in several different populations, including adolescents (Dunton, Dzubur, & Intille, 2016) and young adults (Bedard et al., 2017); given that this method may help reduce recall bias for exercise behavior, it is likely that using EMA to assess exercise would circumvent some of the flaws of self-report measures noted as limitations in previous studies. Additionally, the

validity of using EMA for exercise assessment has been shown in several populations. For example, Dunton, Whalen, Jamner, Henker, & Floro (2005) found that EMA self-report was consistent with heart rate and accelerometer data in a sample of adolescents. Other studies have also suggested that the use of mobile phone apps may be a valid method to assess exercise (Bexelius et al., 2010). Ultimately, while there still appear to be some important limitations to consider when assessing exercise levels, EMA appears to be a promising and feasible method to obtain information about exercise behaviors.

The Current Study

The primary goal of the current study is to design a brief values-based intervention for exercise promotion and determine its effectiveness compared to an education-only control group. Many exercise promotion interventions have been long and time-intensive, limiting their feasibility for many individuals; this has led to calls for deconstructing the interventions to determine which parts may be most necessary for behavior change (Fortier et al., 2012). Considering that values-based interventions like BATD and ACT are also effective at promoting health behaviors, it seems possible that integrating exercise behaviors and existing values is a more efficient and direct way to promote behavior change. As described previously, short-term improvements in exercise behavior have been found in as little as two sessions in an ACT-based intervention (Butryn et al., 2011). Some studies even suggest that BATD may be effective for depression in as little as one session; a study utilizing BATD demonstrated significant reductions in depressive symptoms among college students after only one ninety-minute intervention (Gawrysiak, Nicholas, & Hopko, 2009).

Additionally, the current study seeks to overcome several other key limitations noted in the previous exercise promotion literature. For example, given that many interventions have targeted a homogenous population of overweight or obese women, utilizing college students will

provide unique information about exercise change in a distinct group. Given that at least 40-50% of college students are considered physically inactive (Keating et al., 2005) and the importance of exercise on future health outcomes, this is a population which needs more research and effective exercise promotion interventions. Additionally, the accurate measurement of exercise has been a notorious problem in the literature. Since studies among college students suggest that many students over-estimate their level of exercise on self-report measures (Downs, Van Hoomissen, Lafrenz, & Julka, 2014), the current study will utilize EMA to reduce the potential for recall bias and obtain more accurate reports of exercise compared to traditional self-report measures. A recent meta-analysis supports the effectiveness of using mobile phone interventions to promote exercise and weight loss, which further supports the use of EMA as part of the intervention (Stephens & Allen, 2013).

In the current study, the effects of a brief values-based exercise promotion intervention based on BATD will be tested among a college student population. A values exploration will be conducted, and participants will be encouraged to find ways to engage in exercise which is consistent with their values. Exercise will be measured via self-report on EMA.

Aims and Hypotheses

There are several aims and hypotheses for this study. The primary aim of this study is to determine if a brief exercise promotion intervention, based on principles from BATD and values-based behavior change, can significantly improve exercise levels. The **first hypothesis** is that individuals who are randomly assigned to the intervention group, in which they receive a values exploration and are encouraged to exercise in accordance with their values, will increase their level of exercise to a significantly greater degree than an education-only control group. Within this aim, we will also seek to explore how exercise behavior differs from baseline after

each of the two intervention sessions and to examine how exercise changes over three weeks in response to the intervention.

The second aim of the study is to determine whether individuals who exercise in accordance with their values engage in higher levels of exercise than those who do not. First, congruence between values and exercise behavior will be examined between the intervention and control group to determine whether the intervention successfully aided individuals in exercising in ways that are more consistent with their values. Then, within the intervention group, EMA questions and a measure of values-exercise congruence will be used to have participants rate the congruence of their exercise behaviors to their values; within-group analyses will be conducted to explore whether greater congruence between values and behavior was related to greater amounts of exercise. Finally, as some of the participants in the control group may already exercise in values-consistent ways, all participants (regardless of group) will be included in analyses to determine whether greater congruence between values and exercise is associated with more exercise. The **second hypothesis** is that individuals who exercise more consistently with their values will demonstrate greater improvements in exercise than those who do not exercise in a values-congruent manner.

Given that the promotion of autonomous motivation is a key proposed mechanism for sustained behavior change according to SDT, the third aim of the study is to test whether a values exploration is sufficient to promote more autonomous motivation for exercise. If autonomous motivation significantly increases based on a brief values-based intervention, it is possible that this component of SDT interventions may be one of the primary "active ingredients" for increasing exercise. A measure of motivation for exercise will be given to participants before and after the intervention to examine change in motivation towards exercise. Additionally, as intrinsic motivation is thought to be a key component of sustained behavior change, the association between intrinsic motivation and exercise levels will also be examined.

The **third hypothesis** for the study is that individuals who are assigned to the intervention group will be more likely to view exercise as intrinsically motivating at the conclusion of the study compared to the control group, and that intrinsic motivation will be associated with more exercise behavior.

Finally, an exploratory aim of the study will seek to examine if a brief values-based exercise promotion intervention will have any additional physiological or psychological benefits for college students, such as improvements in other outcomes possibly related to exercise (e.g., weight and depressive symptoms). The **fourth hypothesis** is that individuals who receive the brief values-based intervention will also demonstrate small but significant improvements in weight and depressive symptom.

Chapter 2: Methods

Participants

Participants were recruited through an online undergraduate research pool in introductory psychology classes. Students participated as part of their research requirement for introductory psychology, and were compensated with course credit for each hour of research they participate in. The sample included undergraduates ages eighteen and above, with both males and females included. For the initial online screening part of this study, all research pool users were eligible.

Eligible participants were selected from those who complete the screening survey through the online research pool. For the first several weeks of the study, only individuals who endorsed engaging in less than thirty minutes of moderate-intensity or vigorous-intensity exercise two days per week (less than sixty minutes total per week) were invited to participate in the in-lab portion of the study; therefore, those who are already regular exercisers would be excluded from this part of the study. However, this criterion was removed after approximately one month due to identifying few eligible participants and experiencing very low enrollment. For the majority of the study, the in-person portion of the study was open to individuals with any amount of baseline exercise. Other exclusion criteria included inability to read or speak English, not owning a smartphone or device to use the EMA, and the presence of medical conditions which would preclude an individual from being able to safely exercise. One participant completed the study but was excluded during analyses because he was on the university football team and already exercising several hours each day, which was not representative of the intended sample for the study. No exclusionary criteria were set for gender, age, or race. According to the power analysis (See Appendix A), the goal was to recruit 134 participants to achieve adequate power. This power analysis was based on the results of Butryn and

colleagues (2011), who designed a similar short-term exercise promotion intervention for college students based on ACT principles. According to their results, the effect size of the difference between intervention and control groups was a η^2 of 0.15, which is a moderate effect; therefore, a moderate effect size was used in this analysis. An a priori analysis for F-tests was used with three covariates (gender, race, and baseline exercise levels), with α set at 0.05 and power set at 0.80. Additionally, the intervention to control ratio was set at 1.5:1, to provide more power for the within-group analyses only among the intervention group. By the end of the study, seventy-eight participants were enrolled and fifty fully completed the study (twenty-nine in the intervention group, twenty-one in the control group).

Measures

International Physical Activity Questionnaire (IPAQ) Short Form (Craig et al., 2003): The IPAQ is a brief, four-item questionnaire assessing an individual's level of physical activity during the past week. Individuals are asked to estimate how many days and for how long on each day they engaged in vigorous and moderate physical activity, walking, and sitting/sedentary behaviors. The IPAQ has been shown to have acceptable reliability and validity for measuring physical activity in adults aged 18-65 years, in a variety of countries (Craig et al., 2003). In the current study, which focused on exercise behaviors, only the items for moderate-intensity and vigorous intensity physical activity were utilized as measures of exercise.

Behavioral Regulations in Exercise Questionnaire (BREQ-2) (Markland & Tobin, 2004): The BREQ-2 is a nineteen-item questionnaire designed to assess motivation specific to exercise. The measure has five subscales: Amotivation, External, Introjected, Identified, and Intrinsic Motivation. Participants are asked to rate each item on a five-point Likert scale. The BREQ-2 was developed based on the original BREQ (Mullan, Markland, & Ingledew, 1997) and

added the amotivation items to more fully assess exercise motivation. The BREQ-2 was shown to have acceptable reliability and the subscales were confirmed by confirmatory factor analysis (Markland & Tobin, 2004).

Patient Health Questionnaire-9 (PHQ-9) (Kroenke, Spitzer, & Williams, 2001). The PHQ-9 is a common nine-item self-report measure of depressive symptoms. The internal reliability and test-retest reliability have been shown to be excellent (α=0.84-0.89) and criterion validity has been well-supported (Kroenke, Spitzer, & Williams, 2001).

Modified Valued Living Questionnaire (VLQ). The VLQ, as described in Wilson, Sandoz, Kitchens, & Roberts (2010), contains ten items consistent with commonly valued areas (e.g. family relations, employment, recreation, etc.). Participants are asked to rate, on a scale of 1-10, how important each value is and how consistent behaviors have been with each value in the past week. As a part of their study, Segar, Eccles, & Richardson (2008) found eighteen main reasons people cite for engaging in exercise; a cluster analysis was then used to classify these reasons in five clusters (health benefits, weight loss, weight maintenance/toning, sense of well-being, and stress reduction). From one of our previous studies, currently unpublished, the VLQ was modified to include these areas as possible values, and the life area of parenting was removed given the population of college students being studied. Additionally, in order to assess how exercise behaviors in particular are consistent with values, one to three behaviors for each value were created, and participants rate how often they engage in that type of behavior on a scale of seven-point Likert scale. See Appendix B for the specific questions in this measure.

Procedure

Online screening. This study involved two parts, an online screening survey for all research pool users and an in-lab, interventional component. In the online screening section of the study, participants accessed a Qualtrics study and read through an informed consent

document for the study before beginning the survey. Originally, the main purpose of the online section was to identify individuals who do not meet ACSM recommendations for exercise, which was assessed with an online version of the IPAQ. Additionally, participants completed the modified VLQ (as described in the Measures section) as a baseline measure of values and exercise congruence. Embedded validity questions were utilized to eliminate responses which may suggest a lack of participant effort. Given that it was estimated that this portion of the study would take no more than 15-30 minutes, participants were provided 0.5 research credits towards the research component of their Introductory Psychology class for completing this survey.

Baseline group. Baseline slots open to ten to fifteen participants were posted on Experimentrak, the online Psychology research pool, at various days and times throughout the week. These groups averaged four to five participants per group and took approximately forty minutes. Informed consent for the intervention was provided to the participants at this time. Baseline measures were then obtained during this first session, including measures of exercise motivation (BREQ-2), depression (PHQ-9), and physical measurements of height and weight. Then, time was spent informing participants of how to use the EMA monitoring system for exercise and providing information about the difference between moderate and vigorous exercise. Each participant downloaded the EMA app and questions were answered at this time. Participants were asked to monitor daily exercise each day for one week, without changing their normal exercise behaviors, to obtain a baseline measure of exercise. Participants were compensated with 1.0 research credits for this part of the study.

At the conclusion of this session, participants were randomly assigned at a 1.5:1 ratio to the intervention group or an education-only control group; they were not informed of the difference between groups at this time, to avoid contamination between groups.

Intervention group. One week following the baseline session, participants in the intervention group attended the first session, which lasted approximately sixty minutes and involved no more than six participants (average group size = two participants). Participants engaged with a trained experimenter to cover values-based behavior change principles during the first session. In particular, values were defined and examples were provided, a values exploration was conducted, and participants were encouraged to come up with values for their life within different key areas (e.g. family, social relationships, health, education, etc.). After this exercise, the experimenter and participants brainstormed possible ways to incorporate physical activity into their values, including providing participants with a list of resources on campus and in the immediate community to help them come up with more options for exercise. Examples of ideas which were discussed during these sessions included exercising to dance videos online for a participant who valued music and creativity, doing more strength training to prepare for basic training for a participant who valued his future career in the military, and going to the gym with friends or romantic partners for social values. Goals were set individually by each participant to begin trying to implement values-consistent exercise. Participants received 1.0 research credits for participation and were asked to schedule a follow-up meeting with a group in approximately one week.

At the follow-up group session, approximately two weeks after baseline, participants spent approximately thirty minutes with the experimenter (average group size = two participants). The primary focus of this session was to review the concept of values and reiterate the concept of integrating exercise into existing values. As needed, the group spent time discussing barriers which arose over the previous week, brainstormed additional ways to incorporate exercise into their values, and set additional goals for engaging in values-consistent exercise. Participants received 0.5 research credits for participating in this group. The length and size of groups were recorded to ensure treatment fidelity across time and groups.

Control group. Participants in the control group also met with the experimenter for approximately sixty minutes one week after the baseline session (average group size = two participants). During the one-hour group, general education about the benefits of exercise were provided to the participant, including the ACSM recommendations for exercise. Information was also provided about safely engaging in exercise, including education about preventing injury, appropriate nutrition for exercise, and exercise attire and footwear. Participants were encouraged to try a variety of types of exercise, but no specific mention of values was used. The control group was also provided with a list of resources on campus and in the immediate community to provide ideas for how to exercise, and goals were also individually set for participants to begin attempting to increase their exercise. These participants also received 1.0 research credits for participation.

At the follow-up group session, approximately two weeks after baseline, participants spent approximately thirty minutes with the experimenter (average group size = two participants). The primary focus of this session was to review the physical and psychological health benefits of exercise and reflect on progress so far. Additional education about exercise benefits and safely engaging in exercise was provided at this time, and goals were discussed again for the last two weeks of the study. Participants received 0.5 research credits for participating in this group. The length and size of groups were recorded to ensure treatment fidelity across time and groups.

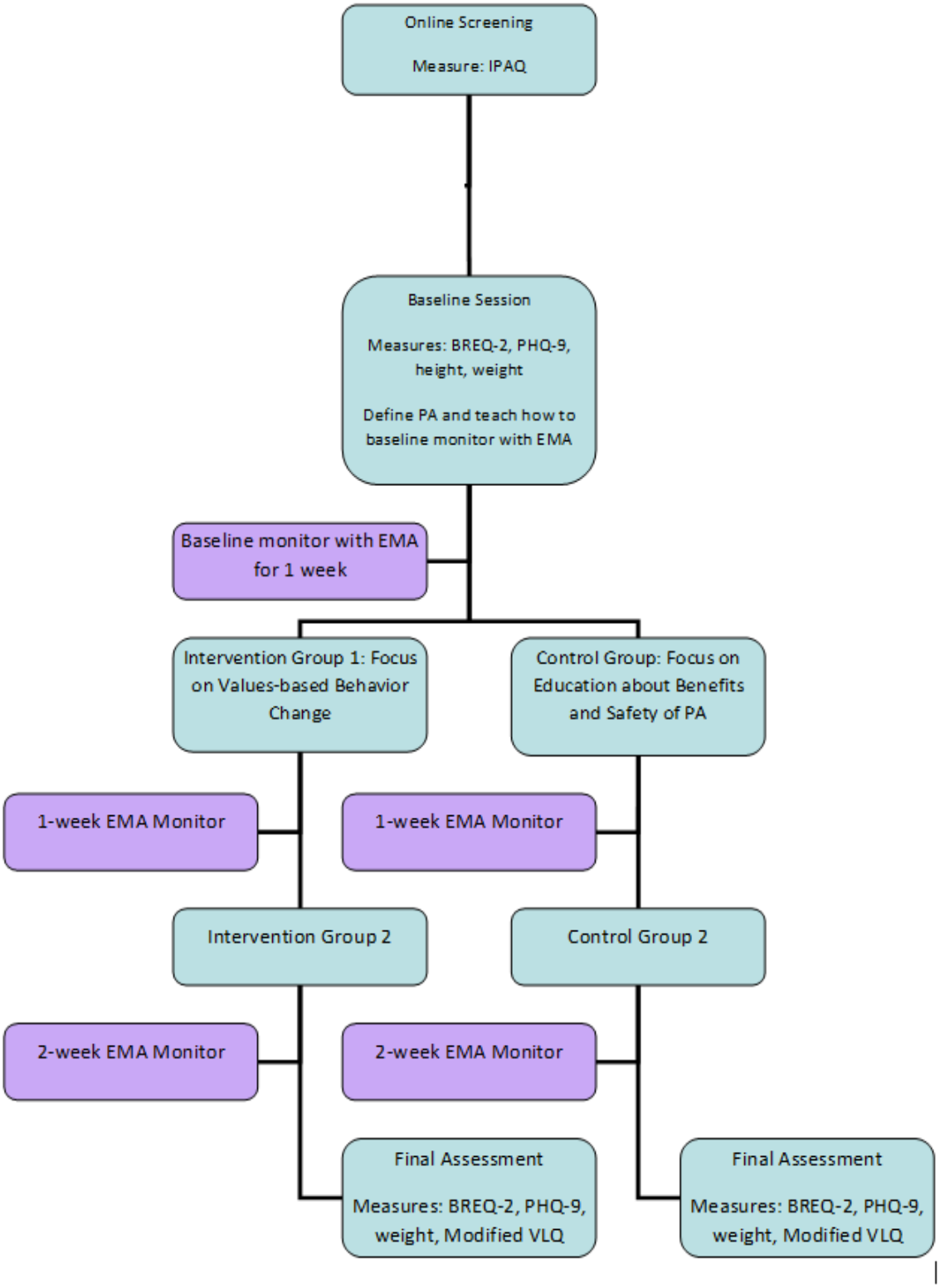
EMA Outcome Monitoring. Throughout the one-week baseline and three-week intervention, participants were asked to record their daily level of moderate and vigorous exercise. A mobile phone app (PACO) was utilized for this purpose, and participants were trained on how to use it during their baseline visit. Specifically, participants were asked each day to answer the moderate and vigorous exercise questions from the IPAQ short form, reporting the type of exercise and length of time they spent engaging in those behaviors during

the day. During the baseline session, education was provided to participants about the difference between moderate- and vigorous-intensity exercise, including examples of when not to monitor basic physical activity as exercise (e.g. a slow walk to class). Time spent engaging in each type of exercise was averaged across each week, and also converted to average Metabolic Equivalent of Tasks (METs) to get a combined measure of exercise. METs is a measure of how intense an activity is above an average individual's resting metabolic rate. To calculate these values, the IPAQ suggests that moderate exercise is equivalent to 4.0 METs and vigorous exercise is equivalent to 8.0 METs; therefore, average minutes per week of moderate exercise were multiplied by four and average minutes per week of vigorous exercise were multiplied by eight to get a total average of exercise across the week. Additionally, participants were asked to report what behaviors they engaged in for each type of exercise and several mood ratings, based on the Positive and Negative Affect Scale (Watson, Clark, & Tellegen, 1988); participants rated how happy, sad, and stressed they were during the previous day, rated on a 1-5 scale. Participants in the intervention group were also asked to rate their perception of how well their exercise behaviors that day were in congruence with their values. All of these questions were only asked of participants once per day, in the evening at a time chosen by the participant to encompass the whole preceding day's exercise. Given that most participants reported that it did not take more than two minutes to fill out these questions each day for thirty days, participants were informed that they will receive 1.0 research credits at the end of the study if they monitor as consistently as possible throughout all stages of the study.

Final Assessment. Two weeks after the second intervention appointment, participants in both groups were asked to schedule a final follow-up appointment. During this session, the same baseline measures were repeated and a brief questionnaire was given to ask about their perceptions of the group material and use of EMA to monitor exercise. Additionally, to assess whether engaging in values-consistent behaviors was a key mechanism for increases in

exercise, participants from both groups were asked to complete the modified Valued Living Questionnaire (same measure from the screening). At this session, participants were debriefed as to the purpose of the study and they were asked if they knew about the purpose of the study, as a manipulation check; altogether, this session took approximately thirty minutes. Participants received 1.0 research credits and a $5 gift card for compensation for fully completing the study.

Figure 2: Study Outline



Data Analysis

All analyses were conducted using SPSS 25.0 and α was set at 0.05. To analyze exercise outcomes, average minutes of moderate and vigorous exercise per week were calculated using data from the EMA monitoring. Then, each type of exercise was converted to METs (as described above) and summed to provide an overall measure of exercise. Each analysis using exercise as an outcome was completed with both METs/week and separate types of exercise (average moderate- and vigorous-intensity exercise per week) as outcomes.

The first analyses conducted examined whether the randomization was successful and that the two groups were equivalent regarding several demographics (sex and race) and BMI. Chi-square analyses were used to compare the differences between the two groups on gender and race. Then, t-tests were used for race and sex to determine whether demographics were significantly associated with the outcomes of moderate or vigorous-intensity exercise at study end. Variables that significantly differ between groups were used as control variables for future analyses.

To assess the difference between the intervention and control group on the main outcome of increases in exercise (Hypothesis #1), nine ANCOVAs were utilized to compare overall exercise, moderate-intensity, and vigorous-intensity exercise levels between the two groups, controlling for baseline exercise. Statistically significant covariates were utilized as control variables. The first two analyses examined whether the groups differed after the first week of the intervention. The second two analyses examined whether the groups differed after the follow-up period (weeks two and three of the intervention). Finally, the last two ANCOVAs examined whether the groups differed across the whole three-week intervention. Given the potential for outliers with self-reported exercise time, the PACO data was examined and, per

IPAQ scoring guidelines for self-reported exercise, exercise of more than 180 minutes was recoded to 180 minutes.

To determine whether engaging in values-consistent exercise behaviors may be associated with increased exercise (Hypothesis #2), several analyses were conducted. First, to determine whether the intervention group actually achieved its goal of increasing participants' values-consistent exercise, an ANCOVA was used to compare the modified VLQ scores from the final assessment session between the intervention and control group, controlling for baseline VLQ scores. Congruence scores were calculated by dividing the scores between each of the twelve value areas and consistent types of exercise, then averaging the twelve scores together for an overall congruence score. Scores ranged from 0.00 to 1.00, with higher scores indicating greater congruence between values and exercise behavior.

Then, three bivariate correlations were utilized to examine whether participants who reported greater congruence on the modified VLQ engaged in greater levels of exercise, regardless of group. Third, among individuals within the intervention group only, three bivariate correlations were utilized to assess whether greater values-exercise congruence was associated with more exercise as measured by the VLQ measure. Finally, three bivariate correlations were utilized to determine whether congruence (as measured by the average score of the values question on their daily EMA monitoring) was associated with higher amounts of exercise across the three-week intervention (using the intervention group only, which is the only group which received this question on the app).

To analyze whether the intervention succeeded in changing participant motivation to exercise (Hypothesis #3), scores from the BREQ-2 subscales were used. An ANCOVA was used to compare each of the five subscales between the intervention and control group at the study end, controlling for baseline scores on this measure. Given that SDT suggests that higher

autonomous motivation for exercise is more likely to lead to sustained exercise, three additional bivariate correlations were used to examine whether scores on the BREQ-2 Intrinsic Motivation scale at study end were associated with exercise across the three-week intervention.

Finally, to examine changes in other outcomes like weight or depressive symptoms (Hypothesis #4), two ANCOVAs were utilized. The first ANCOVA examined whether participant weight differed between groups at study end, controlling for baseline weight. The second ANCOVA examined whether participant PHQ-9 scores at study end differed between groups, controlling for baseline PHQ-9 score.

Chapter 3: Results

Retention and Demographics of the Sample

The sample for this study consisted of seventy-eight participants. Of these participants, fifty attended all four sessions and completed the study (64% completion rate). Among the completers, there were thirty-one (62%) females and nineteen males (38%). The completers were heterogenous in race, with twenty-six white (52%) and twenty-four non-white (48%) participants. The average BMI of completers at the start of the study was 25.11 ± 5.75, which is just in the overweight range.

Of the twenty-eight participants who did not fully complete the study, twenty were male (71.4%) and eight were female (28.6%), while fourteen were white (50.0%) and fourteen were non-white (50.0%); the average BMI of non-completers at the start of the study was 25.26. Of the non-completers, fourteen came to the baseline session but did not return for session one, twelve completed session one but not session two, and two were lost after session two. The first fourteen who dropped out of the study did so prior to randomization. Of the fourteen who dropped out after session one (after randomization), seven dropped out of the intervention group and seven dropped out of the control group. Six of the fourteen were non-white participants (43%), while eleven of the fourteen who dropped out after randomization were men (79%). The rest of the analyses for the study were conducted for only the completers, as the primary aims of the study were to primarily understand the efficacy of the intervention among those who were fully exposed to it. Additionally, since many of the non-completers did not monitor any (or very little) exercise on the EMA app and did not complete post-intervention measures, inclusion of non-completers in the analyses is unlikely to be useful. Demographics for the sample is presented in Table 1, which contrasts demographic information between the intervention and control groups.

Table 1: Demographics of Completers in Intervention and Control Group

Demographics	Intervention (N=29)	Control (N=21)	All Completers (N=50)	Non-Completers (N=28)
Sex				
Male	11 (37.9%)	8 (38.1%)	19 (38.0%)	20 (71.4%)
Female	18 (62.1%)	13 (61.9%)	31 (62.0%)	8 (28.6%)
Race				
White	14 (48.3%)	12 (54.5%)	26 (52.0%)	14 (50.0%)
Non-White	15 (51.7%)	9 (40.9%)	24 (48.0%)	14 (50.0%)
BMI				
BMI	25.23 ± 5.66	24.81 ± 6.04	25.11 ± 5.75	25.26 ± 4.32

T-tests were used to examine whether exercise differed by sex or race. Male participants reported engaging in significantly more vigorous-intensity exercise (29.21 ± 22.19 minutes/day) over the course of the intervention compared to females (15.57 ± 20.79 minutes/day), $t(1,48)= -2.20$, $p=.033$ $d= -.63$, 95% CI [-1.22, -.05], but not moderate-intensity exercise (males reported 17.60 ± 17.78 minutes/day, females reported 13.94 ± 15.50 minutes/day), $t(1,48)= -0.77$, $p=.45$, $d=-.22$, 95% CI [-.79, .35]. White participants reported engaging in 25.74 ± 25.75 minutes/day of vigorous-intensity exercise and 13.87 ± 15.39 minutes/day of moderate intensity exercise; this was not significantly different from non-white participants, who reported 15.36 ± 16.27 minutes/day of vigorous-intensity exercise, $t(1,48)=1.69$, $p=.10$, $d= .47$, 95% CI [-.09, 1.04], and 16.91 ± 17.48 minutes/day of moderate-intensity exercise, $t(1,48)=-0.66$, $p=.52$, $d= -.18$, 95% CI [-.74, .37].

Analyses were also conducted to confirm randomization was successful and that the two groups did not differ on key demographic characteristics. Chi-square analyses were utilized for

sex, χ^2=0.000, *p*=.99, and race, χ^2=0.384, *p*=.54, which showed that the groups did not differ significantly on these demographics. A *t*-test was conducted to confirm BMI did not differ between groups, and results indicated that there was no significant difference between groups on BMI, *t*(1,48)=0.25, *p*=.80, *d*=.07, 95% CI [-.49, .63]. Because the two groups did not significantly differ on race, gender, or BMI, these variables were not used as covariates for future analyses.

Results for Hypothesis #1:

Prior to analyzing differences between the two groups with regards to exercise, several descriptive statistics were calculated to examine overall characteristics of the sample's exercise patterns. During the baseline week of EMA recording, participants reported averaging 17.52 ± 18.61 minutes per day of moderate-intensity exercise and 21.94 ± 24.61minutes per day of vigorous-intensity exercise. IPAQ data from the online screening questionnaire was also examined to compare participant ratings on the IPAQ to their EMA self-report. On the IPAQ, these same participants (the completers) reported averaging 38.26 ± 46.62 minutes per day of moderate-intensity exercise and 47.40 ± 44.31 minutes per day of vigorous-intensity exercise. Several correlations were conducted to examine whether participants' reports on the IPAQ correlate with their self-report during the baseline week with the EMA app. While there was not a significant association between the moderate-exercise items, *r*= .14, *p*= .34, the IPAQ and EMA vigorous-intensity items were significantly correlated, *r*= .41, *p*= .004.

To compare differences between the intervention and control group on the main outcome of changes in exercise, nine separate ANCOVAs were utilized. For the first two analyses, participants' average minutes per day of moderate-intensity and vigorous-intensity exercise were examined over the first period of the intervention (between session one and two), controlling for average minutes per day of moderate-intensity and vigorous-intensity exercise

during the baseline period (between baseline session and session one). Inclusion in the intervention group was not significantly associated with increases or decreases in moderate-intensity, $F(1,47)=0.870$, $p=.36$, $\eta_p^2= .018$, or vigorous-intensity, $F(1,47)=.024$, $p=.88$, $\eta_p^2= .001$, exercise over the first period of the intervention. When exercise was converted to total METs (moderate and vigorous-intensity exercise combined), an ANCOVA was used controlling for baseline METs. Inclusion in the intervention group was not significantly associated with greater METs/week, $F(1,47)=.15$, $p=.70$, $\eta_p^2= .003$.

The next three analyses were identical to the first three analyses, except that participants' exercise was examined over the second period of the intervention (between session two and the final assessment session), while controlling for baseline exercise. Similarly, inclusion in the intervention group was not significantly associated with increases or decreases in moderate-intensity, $F(1,47)=.060$, $p=.81$, $\eta_p^2= .001$, or vigorous-intensity, $F(1,47)=1.95$, $p=.17$, $\eta_p^2= .040$, exercise, or METs/week, $F(1,47)=1.45$, $p=.24$, $\eta_p^2= .030$, over the second period of the intervention.

Finally, the last three ANCOVAs examined whether participants in the intervention group differed significantly from the control group across all three weeks of the intervention combined (between session one and final assessment session), controlling for baseline exercise (between baseline session and session one). Inclusion in the intervention group was not significantly associated with increases or decreases in moderate-intensity, $F(1,47)=.413$, $p=.52$, $\eta_p^2= .009$, or vigorous-intensity exercise, $F(1,47)=.929$, $p=.34$, $\eta_p^2= .019$, or METs/week, $F(1,47)=.369$, $p=.55$, $\eta_p^2= .008$, over the full three-week period of the study. Average minutes per day of exercise for each group is presented in Table 2.

Table 2: Average Minutes/Day of Exercise among Completers in Intervention and Control Groups

Average Exercise (minutes/day)	Intervention (N=29)	Control (N=21)	Combined (N=50)
Moderate-Intensity			
Baseline	15.68 ± 17.80	20.08 ± 19.84	17.52 ± 18.61
First Period (between sessions one and two)	16.85 ± 19.58	16.55 ± 18.21	16.73 ± 18.83
Second Period (between session two and final assessment)	14.15 ± 14.55	16.19 ± 18.54	15.01 ± 16.20
Combined (between session one and final assessment)	14.91 ± 15.58	15.91 ± 17.68	15.33 ± 16.33
Vigorous-Intensity	18.39 ± 13.78	27.86 ± 28.41	22.48 ± 21.63
Baseline	16.11 ± 19.99	29.97 ± 28.42	21.94 ± 24.61
First Period (between sessions one and two)	18.39 ± 13.78	26.01 ± 27.71	21.59 ± 20.89
Second Period (between session two and final assessment)	13.85 ± 15.28	32.09 ± 35.01	21.51 ± 26.77
Combined (between session one and final assessment)	15.03 ± 14.05	28.66 ± 28.48	20.76 ± 22.14

Results for Hypothesis #2:

To determine whether the intervention group was successful in promoting increases in values-exercise congruence compared to the control group, an ANCOVA was conducted to compare VLQ score at study end, controlling for baseline VLQ scores. The intervention group

reported significantly greater levels of congruence between their values and exercise behaviors (*M*=.71, *SD*=.09), *F*(1,46)= 5.69, *p*=.021, compared to the control group (*M*=.64, *SD*=.11).

Three bivariate correlations were utilized to assess whether greater congruence between values and exercise behaviors (as reported on the modified VLQ at study end) was associated with greater levels of exercise averaged across the full three-week period of the intervention, regardless of group. Greater congruence was not significantly associated with either moderate-exercise, *r*=.18, *p*=.21, vigorous-exercise, *r*=.06, *p*=.67, or combined METs/week, *r*=.01, *p*=.96. This remained true for just the intervention group (which primarily focused on promoting exercise consistent with values) as well, with neither moderate-intensity, *r*=.17, *p*=.38, vigorous-intensity exercise, *r*=.05, *p*=.79, nor combined METs/week, *r*=.12, *p*=.52, being significantly associated with values-exercise congruence.

Because participants in the intervention group were also asked to rate how congruent their exercise and values were each day on the EMA app, a follow-up analysis was conducted to determine whether participants in the intervention group who rated their daily exercise as more congruent with their values using the EMA app question was associated with greater levels of exercise. Three additional bivariate correlations were utilized to assess whether greater self-reported daily congruence between exercise and values was related to greater levels of exercise across the three weeks of the intervention. There was no significant association between reported congruence between values and moderate-intensity exercise, *r*=.15, *p*=.45, nor vigorous-intensity exercise, *r*=.36, *p*=.052. Interestingly, when exercise was combined to average METs/week across all three weeks, greater self-reported congruence between exercise and values on the EMA app was significantly associated with more exercise, *r*=.38, *p*=.044.

Table 3: Exercise and Values Congruence Measures Scores

Exercise/Values Congruence	Intervention (N=27)	Control (N=20)
Modified VLQ*		
Baseline	0.69 ± 0.09	0.67 ± 0.09
Final Assessment	0.71 ± 0.09	0.64 ± 0.11
EMA app Question**		
Baseline Period	3.08 ± 0.70	
First Period (between sessions one and two)	3.23 ± 0.96	
Second Period (between session two and final assessment)	3.10 ± 0.89	
Combined (between session one and final assessment)	3.12 ± 0.84	

*Scores from 0.00-1.00, with higher scores indicating greater congruence between values and exercise
** Scores from 1-5, with higher scores indicating greater congruence between values and exercise

Results for Hypothesis #3:

To examine whether the intervention was able to successfully alter participant motivation for exercise, scores from the BREQ-2 were used. The BREQ-2 has five subscales (Amotivation, External, Introjected, Identified, and Intrinsic motivation) and an ANCOVA was used for each subscale to determine whether the two groups differed at study end in motivation for exercise, controlling for baseline scores on the measure. The groups did not significantly differ on any of the five subscales: Amotivation, $F(1,43)=1.42$, $p=.24$, $\eta_p^2= .032$, External, $F(1,43)=.183$, $p=.67$, $\eta_p^2= .004$, Introjected, $F(1,43)=1.50$, $p=.23$, $\eta_p^2= .034$, Identified, $F(1,43)=.020$, $p=.89$, $\eta_p^2= .000$, and Intrinsic, $F(1,43)=.000$, $p=.99$, $\eta_p^2= .000$. Average scores for each BREQ-2 subscale are shown for each group in Table 3.

Three additional bivariate correlations were utilized to examine whether participants with higher scores on the BREQ-2 Intrinsic subscale at study end was associated with more exercise over the three-week intervention, regardless of group. While scores on the Intrinsic subscale were not predictive of moderate-intensity exercise, r=.03, p=.86, it was significantly associated with both vigorous-intensity exercise, r=.35, p=.018, and combined METs/week, r=.35, p=.018.

Table 4: BREQ-2 Scores

BREQ-2 Scores	Intervention (N=27)	Control (N=19)
Baseline		
Amotivation	0.21 ± 0.41	0.16 ± 0.40
External	0.99 ± 0.72	0.55 ± 0.61
Introjected	1.52 ± 0.85	1.47 ± 1.05
Identified	2.77 ± 0.76	2.93 ± 0.83
Intrinsic	2.83 ± 0.94	2.98 ± 0.94
Final Assessment		
Amotivation	0.21 ± 0.40	0.09 ± 0.23
External	1.01 ± 0.91	0.63 ± 0.74
Introjected	1.89 ± 0.96	1.58 ± 1.04
Identified	2.97 ± 0.68	3.03 ± 0.65
Intrinsic	3.06 ± 0.92	3.09 ± 0.81

Results for Hypothesis #4:

For the exploratory aim of determining whether the intervention had significant effects on outcomes potentially related to exercise, like weight and depression scores, two additional ANCOVAs were conducted. The first analysis examined whether participant weight at study

end differed between groups, controlling for baseline weight. Inclusion in the intervention group was not significantly associated with increases or decreases in weight compared to the control group, $F(1,47)=.063$, $p=.80$, $\eta_p^2= .001$. Then, the second analysis examined whether participant PHQ-9 scores at study end differed between groups, controlling for baseline PHQ-9 scores. Inclusion in the intervention group was not significantly associated with changes in depression scores compared to the control group, $F(1,47)=.341$, $p=.56$, $\eta_p^2= .007$. Additional information about participant weight and depression scores can be found in Table 4.

Table 5: Participant Average Weight and Depression Scores (PHQ-9)

Weight and Depression Score	Intervention (N=30)	Control (N=22)
Baseline		
Weight (lbs)	159.69 ± 31.72	161.58± 53.34
Depression Score (average PHQ-9 score)	5.33 ± 4.92	5.29 ± 4.58
Final Assessment		
Weight (lbs)	159.83 ± 31.65	161.49 ± 52.38
Depression Score (average PHQ-9 score)	4.66 ± 4.08	4.24 ± 3.75

Chapter 4: Discussion

Overall, the results of this study do not support the primary hypothesis. Participation in the brief values-based intervention was not associated with greater engagement in exercise compared to the education-only control group. There are several possible explanations for these results. First, it is possible that promoting values-consistent exercise is not sufficient by itself to result in significant increases in exercise. Many previous studies utilizing either SDT or ACT for exercise promotion have included numerous other treatment components, which may be necessary to change a behavior like exercise. For instance, the brief ACT-based study by Butryn and colleagues (2011) included values exploration around exercise, as well as mindfulness skills, defusion techniques, and education on experiential avoidance. Many other exercise promotion interventions have been comprised of numerous components, so it is possible that values exploration alone may not be sufficient for increasing exercise. Similarly, it is possible that the dose of the intervention was too low and that more exposure to and practice with values-based exercise would promote more exercise. One of the goals of this study was to design a brief intervention, but many exercise promotion interventions include many sessions spanning multiple months. While some studies have had success increasing exercise with as few as two sessions (Butryn et al., 2011), it is possible that a higher dose of a focused intervention like this would be needed to effectively help individuals integrate exercise with their values. Even depression treatments which focus on increasing value-driven behavior, like BATD, often last multiple weeks of consistent sessions and weekly goal setting.

Another possible explanation of the results is that the intervention was unsuccessful at increasing value-driven exercise, or that both the intervention and control groups increased at a similar rate. If the intervention was not successful, then it is likely that the main hypothesis would not be supported. However, when examining the results from the modified VLQ measure from the second hypothesis, it does appear as though the intervention group demonstrated

more values-exercise congruence than the control group by the end of the study; therefore, it is unlikely that this would be a plausible explanation for the results. Similarly, the results do not support the idea that both groups engaged in more exercise at equivalent rates; in fact, based on the overall results in Table 2, neither group appeared to increase exercise throughout the course of the study.

One of the primary advantages of exercise promotion interventions based on SDT or third-wave cognitive-behavioral therapies is the preliminary evidence which suggests they may be effective for promoting long-term, maintained exercise change. Even some of the older interventions, which struggled to promote sustainable increases in exercise, found short-term increases in exercise. Therefore, it is possible that the results from this study also may be affected by the lack of long-term follow-up. While both groups may not have changed their exercise levels significantly in the three-week period of the intervention, it is possible that individuals who received the values information would be more likely to maintain their exercise long-term because they have better integrated it into important areas of their life. Given that the intervention group increased in congruence between their exercise and values more than the control group, perhaps there would be a difference between the intervention and control groups' exercise after several months or years.

One additional contributing factor to the results of this study is the recruitment difficulties which were encountered. While the power analysis suggested a sample size of 134 participants was needed to achieve a power of 0.80, seventy-eight participants were recruited, and only fifty participants (64% completion rate) fully completed the study after nearly two semesters of data collection. It does not appear as though there was differential drop-out between conditions but having less power than anticipated likely was a major factor in being unable to detect some significant effects.

Throughout the study, many available time slots went unfilled. Initially, when the study was targeting less active undergraduates, emails were sent to potential participants to inform them of the study. Once it became clear that recruitment would be much too slow with this strategy, the inclusion criteria were expanded, and more recruitment efforts were made. For example, the principal investigator personally visited as many PSYC 1000 classes as possible to tell students about the study and answer questions; if the timing did not work out, the instructors of those PSYC 1000 classes were sent a brief presentation to show at the beginning of their classes with information about the study. Despite these efforts, recruitment still remained slower than expected.

Several factors likely played a role in these difficulties, including the length and timing of the intervention. Because the study involved multiple meetings over four weeks, participants were compensated with 4.5 credits total for their participation. As the research requirement for the semester is only five credits, students who participated in any other research study prior to this one may have decided that they did not need to participate in a longer study like this. Additionally, because the whole intervention lasted four weeks, enrollment in baseline groups was stopped four weeks before the semesters ended. The final weeks of the semesters are often ideal times to collect data, as students seek to fulfill their research requirements before the semester ends. Because of the length of this study, however, those students were not able to participate. It is possible, therefore, that a small sample size and inadequate power also contributed to the results.

Finally, another consequence of the recruitment difficulties which could have affected results was the change in inclusion criteria. The study was originally designed to target relatively inactive undergraduates who were exercising less than sixty minutes per week. These individuals had significant room for improvement and may be more amenable to trying new types of exercise. However, after several weeks of attempted recruiting, it became apparent

that reaching these individuals would be difficult; very few undergraduates reported exercising less than sixty minutes per week, and of those who were contacted by email, very few responded to recruitment efforts. Therefore, it was decided to begin recruiting any undergraduate who was interested in increasing their exercise. This new recruitment method could have created a possible ceiling effect, with students participating who already had established exercise routines. In fact, there were several participants in this study who expressed that they had always been athletes and had regular workouts they did each week, which limited their motivation or ability to increase significantly. For example, the control group reported engaging in more vigorous-intensity exercise across all three time periods (see Table 2); upon evaluation of the data, this group included several active students, including one who did daily boxing workouts and a student on an ultimate frisbee club team.

At baseline, participants overall averaged eighteen minutes of moderate-intensity and twenty-two minutes of vigorous-intensity per day (or 126 minutes of moderate-intensity and 154 minutes of vigorous-intensity exercise/week), which is somewhat greater than the ACSM recommendations of 150 minutes of moderate-intensity and 60 minutes of vigorous-intensity exercise per week. While this sample appears to be more active than the general population, once again it would have been beneficial to have a long-term follow-up to examine whether these students were able to maintain their exercise. Assessing maintenance of exercise could reduce the impact of a ceiling effect; it is possible that the students who engaged in more values-consistent exercise were better able to maintain exercise, regardless of how much or little they were doing initially. Ultimately, however, due to these recruitment challenges, it is possible that the sample in this study was not ideal for trying to increase values-consistent exercise, and it is unclear whether these results would generalize to other populations (e.g. sedentary undergraduates). A sample which included more sedentary undergraduates, or fewer students who had well-established baseline exercise routines, may have altered the results.

The results are also mostly unsupportive of the second hypothesis, which examined whether more congruence between values and exercise behaviors was associated with greater exercise levels. When all participants were included in analyses, there was no significant association between values-exercise congruence and more exercise. However, it appears the intervention itself did effectively increase self-reported congruence between values and exercise, as participants in the intervention group had higher modified VLQ scores at study end than those in the control group. Within the intervention group, participants who rated their exercise as more congruent on the EMA questions did engage in significantly more overall exercise (as measured by METs); this is likely mostly driven by more vigorous-intensity exercise, as participants who reported more congruence trended towards engaging in significantly more vigorous-intensity exercise than those who rated their exercise as less congruent. While the finding with vigorous-intensity exercise was non-significant, as noted previously, recruitment difficulties led to lower power than expected. Therefore, it is possible that with increased recruitment this finding may also be significant and suggest that individuals who were better able to integrate their exercise and values would be more likely to engage in greater levels of vigorous-intensity exercise. On the other hand, there was no significant difference for moderate-intensity exercise, and these findings were not supported by the modified VLQ outcomes. These findings suggest that values-exercise congruence may be associated with greater levels of vigorous-intensity exercise, but it is still unclear due to the mixed findings and methodological difficulties of the study.

There are several possible explanations for why these results appear to be discrepant with regards to the association between vigorous-intensity exercise and values-exercise congruence. First, it is possible that this association does not exist and the finding is a type 1 error. However, given the success of previous interventions which utilize values explorations (e.g. Butryn et al, 2011), this does not seem like the most likely reason. It is also possible that

the effect was too small to detect given the smaller sample size. Additional groups and modifying the timeline of groups may be necessary to achieve an adequate "dose" of the intervention.

Based on the results from the second hypothesis, several additional questions can be raised. Trying to understand why some participants in the intervention group seemed to be better able to integrate their exercise and values may be useful for designing future similar studies. It is possible that some individuals would need additional time, information, or practice with exercising in values-congruent ways; alternatively, perhaps group discussions and goal setting was not the best way for some participants to learn and they struggled to actually engage in exercise outside of the groups. Additionally, it is interesting that the results from the EMA question about congruence and the outcomes from the modified VLQ measure do not fully support each other when examining the intervention group specifically. On the EMA question, individuals who rated their exercise as more congruent trended towards engaging in more vigorous-intensity exercise; however, individuals who rated their exercise as more consistent with their values on the modified VLQ did not engage in more vigorous-intensity exercise. These findings raise the question of how to best measure the construct of exercise-values congruence. Because neither the EMA question nor the modified VLQ are validated measures, it is unclear which measure is a more valid method of assessing exercise-values congruence. There is no validated measure for this construct in the literature, however, so these methods appear to be the best options at this time. Therefore, continuing to learn what the best way to measure exercise-values congruence would be another question that would improve future studies.

The results of this study partially support the third hypothesis, which assessed participant motivation for exercise. Using scores from the BREQ-2, five different types of motivation for exercise were compared between groups. While it was expected that individuals

in the intervention group would demonstrate greater intrinsic motivation compared to the control group, the results suggested that the groups did not differ on any of the five types of motivation. This is an interesting finding when combined with the fact that the intervention group reported more congruence between their values and exercise behaviors. Many previous studies based on SDT have utilized values explorations as a key mechanism to try and increase autonomous motivation (e.g. intrinsic motivation); however, these results would seem to suggest that discussions about exercise and values integration may not be enough alone to increase intrinsic motivation for exercise.

Additional analyses examined whether intrinsic motivation was associated with more exercise, regardless of group. Interestingly, higher reported intrinsic motivation was significantly associated with greater vigorous-intensity exercise, but not moderate-intensity exercise. This finding at least partially supports one of the key mechanisms of interventions based on SDT, suggesting that more autonomous forms of motivation, like intrinsic motivation, are related to behavior change. If increasing intrinsic motivation is a key factor associated with promoting exercise, it is notable that this brief intervention did not increase intrinsic motivation greater than the control group; future studies may benefit from trying to use values explorations or other methods to more specifically promote autonomous forms of motivation. It is also possible that the way participants interpreted the EMA questions could have affected these outcomes. If participants monitored light physical activity, like walking to and from class, as moderate exercise, it would make more sense that intrinsic motivation for exercise may not be associated with this type of exercise. While participants were instructed not to measure these types of activities as moderate-intensity exercise, it is possible that self-reporting light physical activity as moderate exercise could also contribute to this finding.

Finally, the results from the exploratory analyses for the fourth hypothesis were not supported either. Participants in the intervention group did not lose more weight nor decrease

PHQ-9 scores to a greater extent than the control group. While weight remained very similar across the four-week period for both groups, scores on the PHQ-9 decreased by approximately one point for each group (-0.67 for intervention, -1.05 for control). With average baseline PHQ-9 scores in the mild ranges, most participants did not report significant depressive symptoms, so this decrease is not likely clinically relevant. Both weight and depression are multi-factorial, complex issues which often take more than four weeks to significantly change; therefore, expecting large changes during the intervention was unlikely. Neither weight nor depression was specifically targeted or discussed during the study, either. It is interesting that depression scores decreased over the course of the study, however, which could support the benefit of exercise in general on improving mood and decreasing depression (Hogan, Mata, & Carstensen, 2013). Given that the short period of time involved in this study may have played a large role in not seeing outcomes in these areas, a longer intervention with more time to focus on improving value-driven exercise behavior still may have the potential to affect weight loss or depression scores.

One of the key limitations in the literature which this study attempted to address involved the best way to measure exercise. There have been many studies which suggest that self-reported exercise has many flaws, including recall errors or self-report biases (Falck et al., 2015). While the use of objective exercise monitoring using accelerometers may be ideal, it was not a feasible option for the purposes of this study, and there were some concerns that it may not fully account for all types of exercise which undergraduates may be engaged in (Dunton et al., 2011). Therefore, a daily EMA monitoring was used to try and eliminate some of the recall biases which are prevalent with self-report. Anecdotally, participants seemed to like the use of the app to monitor exercise; they noted that it was a very small burden, and typically took them less than one or two minutes to complete each day. One of the biggest questions about the use of this technique was whether or not the daily EMA monitoring would be a better,

feasible way to measure exercise than weekly recall on the IPAQ. By comparing the IPAQ data from the screening questionnaire and the baseline average from the EMA monitoring, it does appear as though the use of daily monitoring may have reduced some over-reporting. On the IPAQ, participants reported engaging in an average of 38.26 minutes per day of moderate-intensity exercise and 47.40 minutes per day of vigorous-intensity exercise. The baseline monitoring on the EMA app was significantly lower, however; participants averaged 17.52 minutes of moderate-intensity and 21.94 minutes of vigorous-intensity exercise per day. It seems likely that these results are indicative of less over-reporting on the EMA app, though there are even potential reasons why the EMA monitoring may have been a less accurate method of measurement, like participants growing tired of daily monitoring and being less accurate in their reports as the study continues. Ultimately, the use of the daily self-monitoring via EMA app cannot be confirmed to be more accurate without other objective measures of exercise to compare these measures to.

There are several limitations to the current study which should be considered when evaluating the results of this study. As mentioned previously, due to recruitment difficulties, the achieved sample size was lower than what was needed to achieve adequate power. Due to the lower sample size, the possible effects of sampling error are also increased. The sample in this study may have suffered from several other limitations. Given the relatively high baseline exercise of the participants, it is possible that a ceiling effect occurred, as many participants may have already been exercising regularly and did not want to increase exercise very much. The sample was also a self-selected convenience sample. While randomizing between groups seemed to help reduce variation based on key demographics, the overall sample may have some characteristics that differ from the general population of undergraduate students. For example, participants who were more interested in exercise may have been more likely to sign up for a research study talking about exercise, and the study may not have reached many

students who were more ambivalent about exercise. The sample was also a self-selected sample of undergraduates who participated as part of a course requirement, which may have affected their motivation to engage with the intervention. Given that many previous exercise promotion interventions have targeted potential participants who were motivated to engage in more exercise, undergraduates who participated for class credit may be a very different population than other studies have targeted. It is unclear whether these results would generalize to other populations, therefore. Finally, participant age was not collected so it is unclear what effect age may play on the results. Given that previous research in this lab with this population has demonstrated very little variability in undergraduate age, it is unlikely that age would have been a significant covariate in these analyses. However, not being able to examine age in these analyses is a limitation of the current study.

The intervention itself may have suffered from several limitations which should also be acknowledged. While the study was designed to be administered in group formats, many of the groups were very small, with a few sessions being only one participant. Participants who participated in groups which were significantly smaller may have been at a disadvantage, as hearing others' values and how they integrate exercise into their values could have been a key component that was lacking for some. Similarly, as the intervention spanned two semesters, timing effects likely played a role as well. For example, some participants were actively enrolled in the study during a Thanksgiving break in the fall semester, or over spring break in the spring semester. It is likely that their exercise may have been altered during these periods, which had nothing to do with the intervention itself.

As with many interventions, the current study also suffered from some attrition over time. Of the seventy-eight participants who attended the baseline session, only fifty fully completed the study (64% completion rate). There did not appear to be differential drop-out between groups, as half of the participants dropped out prior to randomization and after randomization,

seven participants from each group did not fully complete the study. It appears males were more likely to drop out of the study than females, given that 71.4% of the non-completers were males; in particular, males seemed more likely to drop out of the study after the baseline session (79% of those who dropped out after baseline were males). It is unclear why this may have occurred, but it suggests that the study may not have been as appealing to males as females. Considering that many of the participants who dropped out of the study were lost early in the intervention, there is not enough data to know whether individuals who dropped out differed in their engagement in exercise compared to those who completed the study. Therefore, the retention rate is another limitation which likely affects the generalizability of the study and should be acknowledged.

One of the main criticisms of many exercise promotion interventions is a lack of long-term benefit. The use of values-based interventions is one novel way to try and improve maintainability of exercise, but this study was unable to have a long-term follow-up due to feasibility and timing concerns. As the current study was only a pilot study, it is important to understand whether the intervention promotes short-term exercise before expanding and studying its long-term effects; however, the lack of a follow-up after several weeks or months could also be a limitation.

Finally, the assessment tools which were utilized have limitations which should be considered as well. While the EMA daily monitoring was possibly a more accurate way to record exercise levels, it is still self-report data and could potentially be biased. Participants may have overestimated their daily exercise to avoid having to report not doing exercise or counted minor activities (e.g. walking to class) as exercise when they were not actually exerting themselves (and were instructed not to count this activity as "exercise"). While this type of data collection was probably the most feasible and accurate way of monitoring exercise for this study, the lack of objective data to verify self-report is a limitation to acknowledge.

There are several possibilities for future research based on the results from this study. Considering the null results for the main aims of the study, some changes should likely be made for similar values-based interventions. First, increasing the dose of the intervention may be beneficial, as participants may not have had enough time and exposure to values exploration activities to learn and implement them well. As there were only two sessions of content in this intervention totaling ninety minutes, there is plenty of room for increasing the dose of the intervention while still being brief. Additionally, adding a long-term follow-up to the study design would be a very interesting next step for this research. It seems possible that both the intervention and control groups may increase their exercise initially, but one of the main benefits of the values-based framework is the possibility for promoting sustained exercise. Therefore, even if there are not immediate differences between groups, perhaps exercise levels would be different after a longer time.

Another essential consideration for future studies in this area is designing a study that is better able to reach desired populations. Due to the timing and compensation challenges described above, the sample for this study was likely not representative of many inactive undergraduates on college campuses. These students did not seem to be motivated to sign up for an exercise study, even with research credit compensation offered, so designing a study that is more likely to attract these participants would be important. Perhaps recruiting outside of the psychology department research pool would be more effective, through the use of flyers or presentations to other classes on campus. Collaborating with other departments on campus, like student affairs or the student recreational center, may also be used to increase the reach of the intervention to other populations. Providing more options for participating, like individual versus group settings, may also appeal to a larger potential sample.

There are also other inactive populations who would likely benefit from a brief exercise promotion intervention, like individuals seeking to lose weight or primary care patients with

chronic health issues. Given the large association between sedentary behavior and many chronic diseases, primary care or other healthcare settings may be ideal for recruiting and implementing a future intervention like this one. In fact, a systematic review of primary care providers demonstrated that while most physicians found providing counseling on physical activity to be important, there were many barriers to effectively doing so. Some of the top barriers included uncertainty about effectiveness, lack of knowledge about providing detailed recommendations, and a lack of time, training, and reimbursement (Hébert, Caughy, & Shuval, 2012). Therefore, there is a definite need for better ways to engage primary care patients in exercise, and designing a brief, effective intervention that can be led by a psychologist may be a great way to overcome some of the main barriers identified. In medical settings, patients may also be more interested to participate if they perceive more immediate benefits (e.g. improvements in health) and are being recommended by a trusted authority figure, like their physician. Therefore, recruiting these populations may be another future step in this research.

Finally, future studies should consider using objective measures for exercise. If the resources were available, the use of accelerometers would likely strengthen the validity of the data collected. At the very least, providing a random sample of participants with accelerometers to determine the accuracy of the objective data versus EMA self-report would provide valuable information about the extent of over-reporting which may be occurring using EMA self-report. As described previously, accelerometers alone may not be ideal either, as they would likely record non-exercise physical activity (e.g. walking to class) and would not be able to distinguish well between moderate and vigorous-intensity exercise. Possibly using a combination of accelerometers and daily self-report would be effective for future studies.

This study also had some notable strengths which should be acknowledged. The groups seemed to have been successful and well-designed from an implementation standpoint. The content of the sessions was evidence-based and utilized well-researched information

directly from the ACSM or evidence-based treatments (e.g. BATD). While formal qualitative analyses were not completed, participants also provided feedback at the end of the study on what they liked and did not like about the groups they participated in. Overwhelmingly, the feedback was positive, with people enjoying the conversations, material, and use of the app to help them stay focused on exercise during the week. There were few criticisms, and the most common criticisms were things that would likely be changed in future studies, like small group sizes. The intervention group also seems to have been effective at accomplishing what it intended to, as that group reported greater increases in values-exercise congruence than the control group. Anecdotally, participants in the intervention group often commented about how they had not viewed exercise from a values framework before, and many seemed to enjoy exploring their values. Several students were able to come up with unique ideas for how to exercise in accordance with their values; for instance, one student decided to watch YouTube videos and dance in her room, while another student began doing more strength training because he ultimately wanted to join the military. Within the control group, some participants noted that information about the benefits of exercise was not new, and that they had heard this information before. Still, they primarily expressed that hearing the information again and spending time each week specifically thinking about their exercise routine was helpful.

While the sample in this study had some significant limitations, as noted previously, there were also some strengths about the sample. The diversity among the sample is certainly a strength, as there were nearly even numbers of males/females and white/non-white students. Whereas many exercise promotion interventions include homogenous populations, the fact that this study included a variety of undergraduates is a major strength.

Finally, a key strength of this study was its attempt to address several key limitations in the existing literature. The design of the intervention attempted to discover a much briefer way to promote exercise, as a major limitation of previous studies is their length and lack of

feasibility. Additionally, attempting to dismantle large interventions to discover the main contributors to the effectiveness are very necessary; while this study did not find significant results for the main outcomes, future studies should continue attempting to dismantle large exercise promotion interventions. Finally, the use of EMA for reporting exercise rather than self-report measures like the IPAQ is a strength of this study. By reducing some of the recall bias associated with those assessment measures, this study also attempted to overcome another major limitation in the literature.

Taken altogether, participation in a brief intervention design to increase values-consistent exercise was not associated with greater levels of exercise. Despite notable recruitment difficulties, the intervention appeared to be successful and well-accepted, and there was some evidence that individuals who reported more congruence between values and exercise engaged in more vigorous-intensity exercise. Individuals who reported more intrinsic motivation for exercise also evidenced greater levels of vigorous-intensity exercise. Future studies would benefit from trying to recruit more sedentary individuals who are motivated to increase exercise and examining long-term maintenance.

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Appendix A: IRB Approval

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board
4N-64 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** ·
www.ecu.edu/ORIC/irb

Notification of Initial Approval: Expedited

From: Social/Behavioral IRB
To: John Freeman
CC: Matthew Whited
Date: 10/2/2017
Re: UMCIRB 17-001912
Values-Based Exercise Promotion in College Students

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 10/1/2017 to 9/30/2018. The research study is eligible for review under expedited category #4, 7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

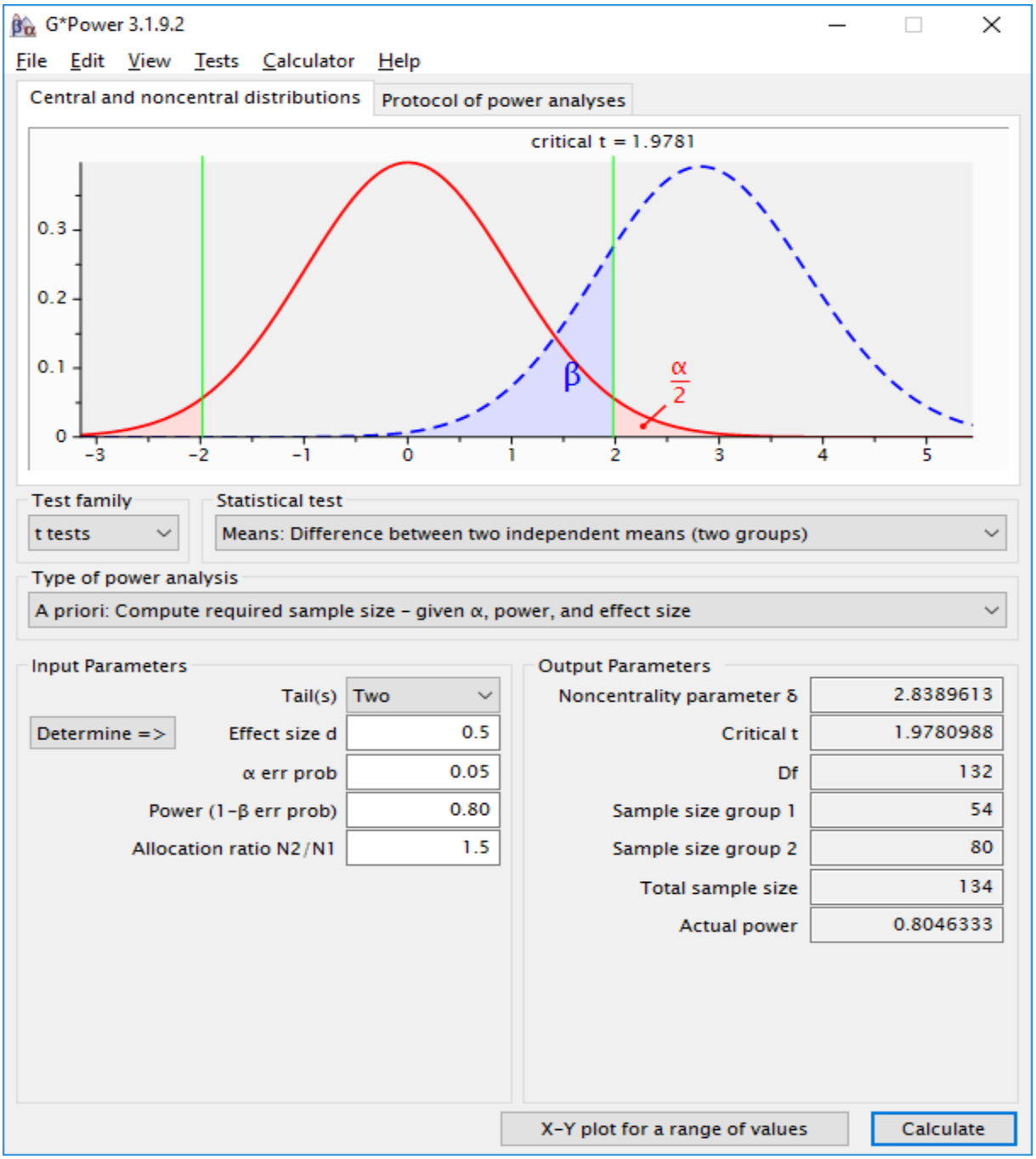
Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Name	Description
BREQ-2.pdf	Surveys and Questionnaires
ECU Referrals.docx	Surveys and Questionnaires
EMA Questions Dissertation.docx	Surveys and Questionnaires
Freeman Dissertation Debriefing Forms.docx	Additional Items
Freeman Dissertation Informed Consent Online.doc	Consent Forms
Freeman Dissertation Informed Consent.doc	Consent Forms
Freeman Dissertation Proposal Draft Final.docx	Study Protocol or Grant Application
Freeman Dissertation SONA announcement.docx	Recruitment Documents/Scripts
IPAQ Short Form.pdf	Surveys and Questionnaires
Modified VLQ for Dissertation.docx	Surveys and Questionnaires
PHQ-9.pdf	Surveys and Questionnaires

The Chairperson (or designee) does not have a potential for conflict of interest on this study.

APPENDIX B: Power Analysis



APPENDIX C: Modified VLQ for Exercise Behaviors

Below are areas of life that are valued by some people. Please rate how much you agree with each statement. Not everyone will value all of these areas, or value all areas the same. Rate each statement according to your own personal views.

Please rate how much you agree with each statement.

	Completely Disagree	Disagree	Disagree Somewhat	Neither Agree nor Disagree	Agree Somewhat	Agree	Completely Agree
I value having good relationships with my family							
I value having good social relationships with my friends							
I value having a fulfilling romantic relationship with my spouse/partner							
I value being a well-educated or well-trained person							
I value having a successful career or job							
I value being a person who has fun and enjoys recreation time							
I value being involved in volunteer activities, charity, or political organizations							
I value being a highly spiritual or religious person							
I value being able to get daily chores and responsibilities done efficiently							

I value feeling good, happy, and stress-free							
I value having an attractive appearance and controlling my weight							
I value being a healthy individual							

Below are statements about how some people might feel or act with regard to exercise. For these questions, exercise refers to either moderate or vigorous activities that you engage in for at least 10 minutes at a time (activities that take moderate or hard physical effort and make you breathe somewhat or much harder than normal). Please rate how much you agree with each statement. Rate each statement according to your own personal views.

Please rate how much you agree with each statement.

	Completely Disagree	Disagree	Disagree Somewhat	Neither Agree nor Disagree	Agree Somewhat	Agree	Completely Agree
I often exercise with family members (in person, on the phone, etc.)							
I exercise to set a good example for my family							
I exercise in group settings or with my friends							
Exercise is a good way for me to meet new people							
I often exercise with my romantic partner/spouse							
I exercise because it makes my partner/spouse happy							
I study or read for school while I exercise							
Exercise is a great way to							

take a break from studying so I can study more efficiently later							
Exercise is a key part of my job							
I exercise so that I will be able to be a better employee at my job							
I exercise because it is fun							
I enjoy exercise							
Many of my hobbies involve exercising (e.g. sports)							
I get exercise through my involvement in volunteer, charity, or political events							
I exercise while praying							
I often read a religious text or listen to religious music while I exercise							
Exercise helps me feel more connected to the world or nature							
I exercise by working around my house or apartment (e.g. cleaning, raking leaves, etc.)							
I exercise because it makes me feel good and happy							
Exercise is great because it helps me reduce stress							
When I exercise, I am usually trying to control my weight							
I exercise because it helps							

me look more attractive (more muscular, thinner, etc.)							
I exercise to be healthy							
I exercise because it reduces my risk of developing some diseases							