

B. 2 Specific Aims

Nearly two thirds of the United States population does not get enough physical activity (PA) for good health¹ and rates of PA participation are particularly low for women aged 45 years or older². Among researchers in the health sciences, there is great interest in increasing PA rates among aging groups in part because PA is associated with numerous health outcomes. One PA related health outcome particularly relevant for middle-aged women is reduced risk for breast cancer. Between the ages 40-60, a women's risk for breast cancer increases eight-fold³. Behind cancers of the skin, breast cancer is the second leading cause of cancer-related death among women³ and it is estimated that one in eight women will be diagnosed with breast cancer at some point during their lifetimes³. Although breast cancer is highly heritable⁴, research has shown that women who regularly engage in moderate-intensity aerobic PA are between 15-80% less likely to develop breast cancer compared to physically inactive women⁵⁻⁸. For this reason, there is great public health incentive to increase PA rates among middle-aged women for the prevention of breast cancer.

Historically, intervention programs have been successful at encouraging individuals to initiate PA; however, maintenance of PA behavior has proven to be a more difficult task and an area of study in need of a more concrete theoretical framework⁹. Among individuals who adopt an exercise program, typically only half stay with it for more than six months^{10, 11}. In order to improve rates of PA participation among women on a broad scale and optimize breast cancer prevention efforts, interventions must strive to improve rates of long-term PA maintenance⁹. Reviews concerning the efficacy of behavioral interventions to increase PA behavior have consistently implicated self-monitoring, the purposeful observation and processing of information concerning internal and external states, as an effective strategy¹²⁻¹⁴. For example, in the context of a PA intervention, participants might be asked to self-monitor some internal (i.e., energy level) or external (i.e., number of miles ran) construct associated with a PA bout by logging scores in a journal.

In terms of what aspects of the PA experience might be most motivating, recent work by Segar and colleagues¹⁵ suggests that when targeting PA adherence among the middle-aged female demographic, it might be most useful to promote the *immediate benefits* PA holds for *everyday life* rather than the long-term benefits PA holds for physical health and weight management. Specifically, Segar and colleagues¹⁵ have shown that women who value PA for its health or weight management benefits exercise significantly less (between 15% and 34% less) than those who value PA for its quality of life (QoL) enhancing outcomes (e.g. "feeling good," and "happiness"). In sum, the literature suggests that interventions designed to increase PA behavior among middle-aged women might consider a focus on associated QoL benefits (e.g., improved affect) over a focus on associated health or weight management benefits.

In order to optimally encourage PA maintenance, the proposed study seeks to integrate the importance of self-monitoring with a test of the content of that monitoring using a design that includes a 1-month PA intervention and a follow-up period extending to 6-months post-baseline. Women aged 40-60 will be randomly assigned to one of three conditions. Common to all conditions, women will be asked to keep an online exercise journal and record type and duration of PA bouts for each day PA is performed. The conditions for the proposed study are: (1) record only the types of activities and durations of PA bouts (**CONTROL** condition); (2) self-monitor information that is physiological in nature and relevant to health and weight control benefits of the PA bout (**PHYSIO**, performance self-monitoring condition); or, (3) self-monitor information that is psychological in nature and relevant to aspects of QoL influenced by the PA bout (**AFFECT**, affective response to PA self-monitoring condition).

With this in mind, the specific aims of this research are to:

1. Test the main effect of self-monitoring on physical activity behavior at 1, 3, and 6 months.

Hypothesis 1: Participants who received the AFFECT or PHYSIO self-monitoring interventions will engage in more PA at 1, 3, and 6 months compared to those who received the CONTROL condition.

2. Test the main effect of self-monitoring content on physical activity behavior at 1, 3, and 6 months.

Hypothesis 2: Participants who received the AFFECT self-monitoring intervention will engage in more PA at 1, 3, and 6 months compared to those who received the PHYSIO self-monitoring condition.

3. Exploratory Aim: Examine the mechanisms by which the interventions influenced behavior change and maintenance through a mediational analysis utilizing constructs from a novel theoretical model of exercise, the theory of Physical Activity Maintenance (PAM)⁹.

B.3 Research Strategy

The public health significance of physical inactivity. The American College of Sports Medicine (ACSM) recommends a minimum of 30-minutes of moderate intensity aerobic physical activity (PA) five days a week¹⁶. Yet, the National Center for Health Statistics reports that in recent years, Americans have made “no substantial progress towards achieving recommended levels of PA¹⁷.” Nearly 2/3 of the United States population does not get enough PA for good health, and more than a 1/4 get none at all^{2,17}. There are also significant gender and age disparities in PA participation. Women engage in less PA than men of the same age² and rates of PA among women decrease significantly with age². In 2009, 19% of women aged 18-44 met the recommended guidelines for PA and among women aged 65 years old or older, only 9% of women meet these guidelines².

The benefits of aerobic PA. Aerobic PA is associated with numerous health benefits (e.g., enhanced wound healing, weight management, bone health etc.)¹⁸⁻²⁰, psychological health (e.g., affect improvement, lower perceived stress etc.)^{21,22}, mental health (e.g. antidepressant and anxiolytic effects)²³⁻²⁵, neurocognitive functioning (e.g. preserved executive functioning and working memory)²⁶⁻²⁸ and significantly fewer major medical problems (e.g., cardiovascular disease, type-two diabetes, and several forms of cancer)^{17, 20, 29-31}.

PA and cancer prevention. Numerous studies have implicated strong or probable evidence for reduced risk of colon, breast, and endometrial cancers when PA recommendations are followed³²⁻³⁵. A few of the likely mechanisms through which PA is believed to have an influence on cancer prevention include changes in circulating metabolic hormones and growth factors, as well as overall reduction in adiposity^{5,6,36}. Reduced adiposity may be an especially important factor as there is evidence to suggest that as many as 30% of total cancer-related deaths are associated with energy imbalance^{37,38}. On average, women are more likely than men to be obese^{39,40} and thus, regular PA may be particularly important for women’s cancer prevention efforts.

Cancers of the breast constitute the second leading cause of cancer-related death among women behind skin cancers⁴¹. Breast cancer occurs in both genders, but cases of male breast cancer constitute less than 1% of total annual diagnoses⁴²; thus, there is more incentive to develop breast cancer prevention interventions for women. In 2012, approximately 226,870 women will be diagnosed with breast cancer and approximately 39,510 women will die from breast cancer³. It is estimated that one in eight women, will be diagnosed with breast cancer at some point during their lifetimes³. Across racial groups, age-adjusted incidence rates are highest for White women (i.e., 127 per 100,000 women) and lowest for American Indian/Alaskan Native women (80 per 100,000). As women age, their relative risk for breast cancer increases significantly; between the ages 40-60, a women’s risk for breast cancer increases eight-fold³. Of women diagnosed between the years 2005-2009, nearly 50% were between the ages of 45 and 64 and the average age of diagnosis was 61 years old³. Thus, breast cancer prevention interventions may be especially critical for women ages of 40 to 60.

Evidence for an association between PA and reduced risk for breast cancer is considered convincing^{5,6,8,43}, with rates of reduced risk ranging from 15% to 80% depending on the contribution of other third variables such as family history of breast cancer, body mass index, and pre- or post-menopausal status^{5-8,43}. Despite this variability, the overall trend strongly suggests that PA is associated with a reduction in breast cancer risk. Importantly, even small increases in the total amount of PA accumulated per week may lead to meaningful differences in breast cancer risk. A systematic review of the literature found evidence for a 3-8% reduction in risk for breast cancer with every additional 60 minutes of PA per week⁷. Although this review found reduced risks for physically active women who were both pre- and post-menopausal, trend analyses revealed that the association was actually strongest for post-menopausal women⁷. This finding suggests that research focused on breast cancer prevention should not necessarily exclude female participants based on menopausal status. Beyond primary prevention, PA following a cancer diagnosis also holds important implications for mortality outcomes⁴⁴⁻⁴⁶. For example, a recent meta-analysis on PA and breast cancer survival found that post-diagnosis PA engagement reduced breast cancer deaths by 34%⁴⁵; thus, PA can be considered an effective breast-cancer intervention for both primary and secondary prevention of breast cancer.

Issues with PA maintenance. In order for PA to reduce women’s risk for breast cancer, women need to follow the recommended guidelines for frequency and intensity of PA (at the minimum); thus, it is imperative that researchers continue to search for ways to improve PA maintenance. Yet, how to effectively motivate long-term PA remains a quandary for researchers^{10,11}. Historically, research has shown that only around 50% of individuals who adopt a PA program stay with it for more than 6-months^{10,11}. Until recently, there have been no cogent theoretical frameworks regarding PA maintenance⁹. Recognizing this gap in the literature, Nigg and colleagues⁹ developed a model incorporating known mediators and moderators of PA behavior they call, the *Theory of Physical Activity Maintenance (PAM)*⁹. In this model, mediators of PA maintenance include goal setting, motivation, and self-efficacy; moderators include stressful life events (e.g., moving, having a baby, etc.) and environmental factors (e.g., the built environment). This theory predicts that to the extent an intervention

increases aspects of goal setting, motivation, and self-efficacy, PA levels will be maintained; conversely, co-occurring stressful life events and unfavorable environmental factors will likely decrease PA levels⁹. The authors argue that the majority of theories commonly applied to the study of PA behavior are missing the importance of external moderators. For instance, the *Theory of Planned Behavior* (TPB)⁴⁷ has been used extensively in exercise research but some have argued that the theory's "one size fits all nature" does not account for the role of external context in guiding behavior^{10,48}. Another common criticism is that most theories applied to the study of PA behavior are non-specific as they are also applied to the study of various other health behaviors ranging from condom use to teeth flossing¹⁰. By focusing specifically on empirically supported mediators and moderators of PA behavior, the PAM represents an improvement over more general models.

Aspects of effective PA interventions. The results of several recent reviews and meta-analyses have implicated self-monitoring (the purposeful observation and processing of information concerning internal and external states) as an effective strategy for maintaining PA behavior¹²⁻¹⁴. A meta-regression by Michie et al.,¹⁴ hypothesized that interventions implementing techniques from control theory⁴⁹ (e.g., setting goals, monitoring behavior, receiving feedback, and reviewing relevant goals in the light of feedback) would predict greater behavioral change than 22 other intervention techniques also under investigation. Results revealed that self-monitoring was the technique most strongly associated with sustained behavior changes. These findings dovetail nicely with the PAM's emphasis on goal setting and motivation, as these self-monitoring techniques are essentially the methods by which goal setting and motivation are believed to be enhanced and achieved.

Regarding what aspects of the PA experience might be most prudent to self-monitor, there is evidence to suggest that a focus on immediate benefits of PA (e.g., improved affect, increased energy) might be superior to a focus on long-term benefits of PA¹⁵ (e.g., reduced risk of cancer). Although PA is associated with a vast array of health benefits, attempts to increase PA levels by providing information about health benefits are generally ineffective¹³. Despite the good intentions of public health campaigns such as the ACSM's "exercise is medicine" initiative⁵⁰, recent work by Segar and colleagues¹⁵ suggests that when targeting PA maintenance among the middle-aged, female demographic, it might be more useful to instead promote the *immediate benefits* PA holds for *everyday life*. Specifically, Segar and colleagues¹⁵ have shown that women who value PA for its health or weight management benefits exercise significantly less (between 15% and 34% less) than those who value PA for its quality of life (QoL) enhancing outcomes (e.g. "feeling good," and "happiness"). In line with this perspective, positive affective responses to PA have been associated with greater intentions for PA⁵¹ and higher levels of subsequent PA behavior⁵¹⁻⁵³. Research further suggests that how one expects to feel after exercising, that is, his/her anticipated affective state, may be strongly related to the regularity of his/her general PA behavior⁵¹⁻⁵⁵. Based on the existing literature, there is reason to hypothesize that by self-monitoring the immediate benefits of PA (e.g. improved affect), these benefits may become more salient. In agreement with this point, one prominent PA and affect researcher has even recently suggested that, "self-monitoring and self-regulation may provide the keys to increasing PA adherence⁵⁶."

Innovation of the proposed research. There is considerable interest among behavioral scientists in the potential use of affective responses to encourage and reinforce regular PA participation^{22,51-53,56,57}. A crucial difficulty with such an approach is the inherent inability to study the affective response-behavioral outcome relationship using an experimental design. One cannot randomly assign a person to have a pre-specified affective response to PA⁵⁸. For this reason, research on this topic to date has been limited to passive observational designs looking at the association between experienced affect and PA motivation and behavior. The proposed project seeks to address this gap in the literature. Although it is not possible to randomly assign an individual to experience a pre-specified psychological response to PA, it is possible to randomly assign an individual to *attend* to a pre-specified aspect of the PA experience.

Study design. The proposed study is a 6-month long, three-group, randomized control trial conducted out of the University of Colorado Boulder (CU) Clinical Translational Research Center (CTRC). Although participants will be assigned to separate conditions, participation for all groups will involve a 1-month long aerobic PA intervention. A detailed outline of all study visits and assessments are provided in Tables 1 and 2.

Power analysis. Sample size was selected to permit analysis of Hypotheses 1 and 2 at a two-tailed alpha of .05 and a power level of .80⁵⁹. G*Power 3.0.3⁶⁰ was utilized to calculate these power calculations. Specific Aim 3 is exploratory, and thus, we do not have firm evidence upon which to base power calculations. Prior work by Segar et al.,¹⁵ compared PA participation among women valuing QoL goals versus women valuing current health or weight and appearance goals, and found moderate effect size values ($\Delta = .44 - .55$). Based on this work, we anticipate that the magnitude of our effect comparing QoL self-monitoring to performance based self-monitoring (or control) will also be moderate ($f^2 = .25$). Thus, for a three group comparison, over four time points (i.e., baseline, 1-, 3-, and 6-months follow-up), an expected moderate correlation ($\rho = .40$)

among the repeated measures, we will require a total sample size of 90 participants (i.e., 30 per group). Based on prior PA studies with inactive adult samples as well as the experience of the investigators^{61, 62} we estimate a 20% rate of attrition. Thus, to be fully powered at 6-months, we will recruit an initial sample of 120 participants.

Subject selection. A total of 120 female participants age 40-60 will be recruited from greater Boulder County. Consistent with the demography of the area and prior work by the sponsors, the ethnic distribution of the sample is expected to be 85% non-Hispanic/Latino and 15% Hispanic/Latino, and the racial distribution is expected to be 75% White, 15% Asian, 5% African American, and 5% American Indian/Alaska Native or Native Hawaiian/Pacific Islander. Age range was selected to be consistent with the age demographic studied by Segar et al.,¹⁵ and is further supported by the increased risk for breast cancer³ and decreased rates of PA participation² among that demographic. Note that because prior work suggests the relevance of aerobic PA for preventing not only first time cancer diagnosis, but also relapse⁴⁵, we will not exclude women who have been previously diagnosed with cancer of any type but who are currently in full remission. In an effort to balance generalizability and internal validity while also taking necessary precautions to ensure the safety of our participants and interpretability of our data, we have established exclusionary criteria on the basis of known contraindications for moderate intensity PA and known confounds associated with affective response to PA while purposefully keeping other aspects of inclusion criteria broad. To this end, our exclusionary criteria will include characteristics related to medical conditions that may put a person at higher risk for complications during PA (e.g., heavy smoker), as well as characteristics likely to introduce confounds to affective response to PA (e.g., obese BMI⁶³). Therefore, the specific criteria for inclusion are: (1) being female; (2) age 40-60; (3) sedentary (i.e., < 60 minutes per week of moderate PA in the past 6-months); (4) not obese (must have body mass index (BMI) < 31); (5) not a heavy smoker (i.e. smoking less than 4 days out of the week); (6) not diabetic; (7) not pregnant; (8) not currently undergoing treatment for cancer (any type); (9) not currently on psychotropic medications or under treatment for any psychiatric and/or neurological disorder; (10) not currently receiving treatment of any kind for alcohol or drug abuse; (11) no history of cardiac or respiratory disease; (12) physically capable of safely engaging in moderate-intensity PA (e.g., no injuries); (13) successful completion of VO₂max test without evidence of cardiac abnormalities or responses; (14) daily internet access; (15) remaining in the Boulder County area for the next month; (16) willing to accept random assignment.

Intervention procedures. Participants will be recruited through community advertisements targeting services, publications, and outlets frequented by middle-aged women. Recruitment materials will describe the opportunity to participate in a program designed to help women who do not currently exercise begin a PA program. The advertisements will also note the experimental nature of the program as well as the opportunity to earn \$50 in cash and \$50 in gift cards in exchange for participation in the research. A digital advertisement containing the same information will be posted on online forums such as Craigslist. A research assistant (RA) will question participants about the inclusion criteria outlined above to determine eligibility. All in-person study appointments will take place at the CTRC. The CTRC is a NIH funded resource for CU faculty and students who wish to incorporate biomedical aspects into their research.

Table 1. Schedule of 1-month Intervention Visits

Visit	Location	Duration	Includes
Visit 1. Orientation (ASAP after phone screen)	CTRC	2 hours	-Informed consent; Eligibility screening; Baseline survey; PAR Interview; VO ₂ max test; Assignment to condition, Description of PA prescription; Information on using the PA journal; Issue HR monitor; Compensate participants \$25.
Begin 1-Month Intervention	Personal choice	150 minutes per week	-PA journal entries (every day aerobic PA is completed).
Visit 2. HR monitor drop off/pick up (week 2)	CTRC	.5 hours	-Drop off HR with CTRC RA; Pick up new HR monitor from CTRC RA; CTRC RA will download data off of returned monitor; Compensate participant \$5 X 1 = \$5
Visit 3. HR monitor return and intervention exit survey	CTRC	1 hour	-Drop off HR with CTRC RA; study RA administered PAR interview; Qualtrics survey assessing PAM constructs; Compensate participant \$20.
Total time over 1 month		2.5 hours	Participants paid \$50 for 1-month

Visit 1: Orientation and initial assessments. At Visit 1, participants will come to the CTRC for an orientation session to learn about the study. After interested participants give informed consent, they will complete an eligibility medical screening form and be examined by a CTRC physician as a safeguard against any complications that could potentially arise from pre-existing conditions. In the 24-hours prior to this appointment, participants will be instructed to eat and drink normally, and to refrain from exercising and/or consuming alcohol or other recreational drugs. Participants deemed eligible will complete: (1) a baseline survey and structured interview about current PA participation; (2) a laboratory-based graded maximal oxygen capacity treadmill test (VO₂ max test); (3) an orientation meeting meant to provide instructions relevant to assessments (i.e., journal entries in Qualtrics), use of the equipment (i.e., heart rate (HR) monitors), and general study guidelines. The reasons for conducting VO₂ max assessments on all participants are twofold: (1) the VO₂ max test provides a metric for evaluating participant's baseline physical fitness; and (2) the results of

the VO₂ max test will provide an estimate of participant HR max – a value that will be used to calculate individualized aerobic PA prescriptions (i.e., 60-65% HR Max). At end of this appointment, all participants will be issued a water resistant Polar rs400 HR monitor (property of the CTRC) so that they make ensure that they stay within their prescribed HR range during their workouts. All participants will be compensated \$10.

1-month aerobic PA prescription. Immediately following the baseline visit, participants will be asked to begin the 1-month long aerobic PA intervention. The aerobic PA prescription for this 1-month period is based on national guidelines (i.e., ACSM) and past work by experts in the field^{10,57,63-67}. Prior work has shown that lower intensity PA bouts are associated with more positive core affective responses than are higher intensity PA bouts^{10,57}. Work by Ekkakakis colleagues have further demonstrated that the affective response to PA is most favorable if the intensity of the PA bout is self-selected^{10, 63}. In order to balance this potential confound of intensity while still encouraging participants to exercise at an intensity that meets ACSM recommendations, the PA prescription for this study will be the ACSM recommended guidelines for low-moderate intensity PA (i.e., 30-minutes, 5-days per week). Because all participants in this study will be physically inactive at baseline, the PA prescription will be made intentionally less demanding during the first week. Specifically, the prescription for the first week of the intervention will be to engage in at least 25-30 minutes of low-moderate intensity aerobic PA (55-60% of HR max) on at least 3-4 days. After a week of this schedule, participants will be asked (via phone call and email notification) to increase the intensity, duration, and frequency of their PA schedules to be at least 30-45 minutes of moderate intensity PA (60-65% of HR max) at least 5-days per week for the remaining 3-weeks of the intervention. This approach to training physically inactive older adults has been used successfully in numerous studies by the co-sponsor, Dr. Seals⁶⁴⁻⁶⁷. Participants will be instructed to do their best to meet these guidelines at the minimum; if they wish to participate in higher intensity PA, or if they wish to exercise more frequently, they will be encouraged to do so. Additionally, participants will be allowed to freely choose their PA modality, so long as the activity allows them to meet the conditions of the prescription.

Intervention conditions. Eligible participants will be assigned to one of three PA intervention conditions. Common to all conditions, participants will be asked to keep an online PA journal during the 1-month aerobic PA intervention period (at the end of the 1-month intervention, participants will no longer be asked to complete journal entries). Online journals will be created using Qualtrics software, a survey generating program free for all CU students and faculty. Online journals are preferable to paper and pencil journals because the online format will automatically time-stamp the journal entries, allowing the research team to know exactly when participants completed their entries. Participants will be asked to enter information only for days that they actually completed a bout of aerobic PA. The key difference between the three conditions is the information that is to be recorded in the PA journals and the explanation given for keeping such a record. In **condition 1 (CONTROL)** participants will be told, *“prior research shows that when people keep track of how often they exercise, they tend to exercise more frequently;”* they will be asked to simply record the PA that was completed and its duration (i.e., “jogged for 30 minutes”). Conditions 2 and 3 will ask participants to record information in addition to the activity completed and duration. In **condition 2 (PHYSIO)** participants will be told, *“prior research shows that when people keep track of physiological performance aspects of their workouts, they tend to exercise more frequently;”* they will be asked to record information that is physiological in nature and relevant to health and weight control benefits of the PA bout (average HR, total calories burned, and % of time spent in the prescribed HR range). All of this information will be recorded and stored by the HR monitors and participants will be shown how to access the information). In **condition 3 (AFFECT)** participants will be told, *“prior research shows that when people keep track of how they feel before, during, and after PA, they tend to exercise more frequently;”* they will be asked to record information that is psychological in nature and relevant to aspects of QoL influenced by the PA bout (energy/fatigue levels, core affect, and general affect).

Visits 2 & 3: Data backup and intervention check-ins. At Visit 2 (2-weeks into the 1-month intervention), participants will return to the CTRC with their HR monitors so that the HR data may be downloaded. A trained CTRC RA will complete this process and oversee the data analysis using a software program called "Polar ProTrainer 5" from Polar Electro Inc. The RA will then send a summary of the data back to the research team using the appropriate approved documentation. No assessments will be administered during this appointment; however, this in-person session will allow the research team to check-in with participants and troubleshoot any issues presented regarding study procedures. Participants will be compensated \$5 for completing this brief check-in appointment. At Visit 3 (the end of 1-month intervention period), participants will again return to the CTRC. At this point, the intervention portion of the study will conclude and participants will turn in their study-issued HR monitors. The data will again be downloaded using the same procedures described above. At this appointment, participants will be asked to complete the intervention exit survey and a structured interview about PA. Participants will be compensated \$20 for completing this appointment.

Follow-up procedures, Parts A & B (see Table 2). At the end of the 1-month intervention, participants will no longer be asked to engage in formal self-monitoring regarding their PA bouts.

Table 2. Follow-up Assessments

Assessment	Time point	Duration	Includes
Part A: Structured phone assessments (PAR)	3 & 6 mo.	15 min X 2 = .5 hours	-Study RA administered PAR interview at 3 and 6 months. Compensate participant \$15 gift card X 2 time points = \$30 in gift cards
Part B: Online follow-up surveys	3 & 6 mo.	20min X 2 = 40 min	-Online Qualtrics survey assessing PAM constructs Compensate participant \$10 gift card X 2 time points = \$20 in gift cards
Study completion raffle	Study end		Raffle to win latest Apple iPod (one winner).

Part A: Participants will be contacted by a study RA and asked to complete a 15-minute structured interview assessing PA engagement. As compensation for completing these interviews, participants will be mailed a \$15 gift card from a location of their choice (e.g., Starbucks, Target, Whole Foods, etc.). **Part B:** Participants will be asked to complete a brief online survey which will assess constructs relevant to the PAM⁹. Participants will be reminded to take the online surveys by the RA conducting their phone-assessment. As compensation for completing these surveys, participants will be mailed a \$10 gift card from a location of their choice. At the end of the study, participants who have completed all study appointments and follow-ups will be eligible for entry in a raffle for a chance to win the latest version of the Apple iPad.

Assessments and measures. All participants will complete a baseline survey assessing demographic information and constructs relevant to the PAM⁹. The constructs from the PAM will be asked again on the intervention exit, 3-, and 6-month follow-up surveys. The choice of measures listed below was based on specific recommendations from the PAM authors⁹. Figure 1 displays the mediators included in the PAM: (1) self-efficacy for PA, (2) PA goals, and (3) self-motivation for PA. *Self-efficacy for PA* will be measured using two scales, one pertaining to behavioral self-efficacy⁶⁸ and one pertaining to barrier self-efficacy⁶⁸. *PA goals* will be measured using the Reasons for Exercise Inventory (REI)⁶⁹ which assesses reasons for PA motivated by health and fitness goals, appearance and weight goals, or QoL goals. *Self-motivation for PA* will be measured using the Intrinsic Motivation Inventory (IMI)⁷⁰, and the Extrinsic Motivation Inventory (EMI)⁷¹. Pilot work was conducted using a sample of undergraduate CU students to determine the reliability of each of the PAM measures and all measures displayed adequate to good reliability:

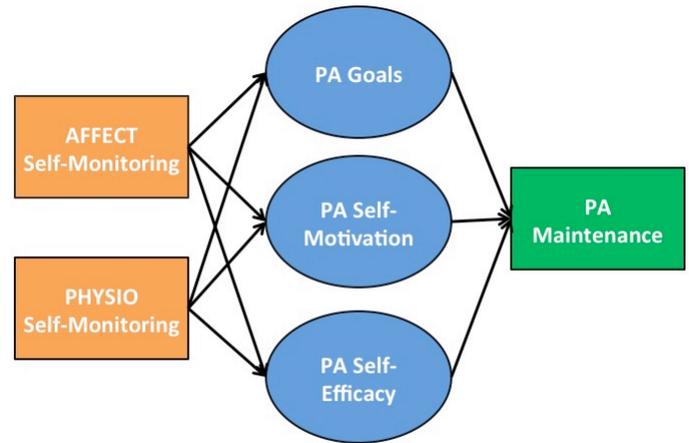


Figure 1: Exploratory Aim 3, Mediation Analysis of the PAM

REI, health & fitness subscale $\alpha = .88$, appearance & weight subscale $\alpha = .90$, QoL subscale $\alpha = .85$; **intrinsic motivation for PA**, $\alpha = .88$; **extrinsic motivation for PA**, $\alpha = .80$; **PA barrier self-efficacy**, $\alpha = .91$; **PA task self-efficacy**, $\alpha = .85$. Moderator constructs in the PAM are (1) life stress and (2) the physical environment. *Life stress* will be measured using the Recent Life Changes Questionnaire (RLCQ)⁷², a measure designed to assess stressful life events occurring within the last 6-months. *The physical environment* will be measured using the Neighborhood Environment Walkability Scale (NEWS)⁷³.

Measures specific to affect monitoring (AFFECT condition only) during the 1-month intervention. A growing body of literature suggests that affective valence measured during a PA bout may be a better predictor of future PA behavior compared to change in affective valence (measured before and after a bout of PA)^{10, 53, 56, 57}. Due to the nature of our study design, it will not be possible to collect measures of participant's PA related affect *during* PA bouts. It is important to note however, that the objective of collecting information on PA related affect in this study will be to see if the process of *reflecting on affective states* in response to PA will influence future PA. Thus, participants in the AFFECT condition (only) will be asked to provide ratings on affect variables regarding how they remember feeling immediately before beginning the PA bout, how they remember feeling during the PA bout, and how they remember feeling immediately after finishing the PA bout. To collect this information, we will use the following measures: (1) the Feeling Scale (FS)⁷⁴, a single item, 11-point measure corresponding with the valence component of a circumplex model of affect; (2) the Felt Arousal Scale (FAS)⁷⁵, a single item, 6-point measure used to measure physical arousal during PA; (3) the Physical Activity Affect Scale (PAAS)⁷⁶, a multi-dimensional 15-item measure with subscales that assess positive affect, negative affect, tranquility, and physical exhaustion in response to PA.

Measures of PA behavior. PA participation will be measured using both objective and self-report data. At baseline, 1-(exit survey timepoint), 3-, and 6-months, the Stanford 7-Day Physical Activity Recall assessment

(PAR)⁷⁷ and Godin Leisure-Time Exercise Questionnaire (GLTQ)⁷⁸ will be used to assess *self-reported PA minutes accumulated over the prior week*. During the 1-month intervention period, HR monitors will be distributed and all participants will be instructed to use the HR monitor every time that they engage in a purposeful bout of aerobic PA. This information will provide the research team with an *objective measurement of PA participation* to compare against the *self-reported PA participation* reported in their daily PA journals.

Measure of PA maintenance. In treatment studies, it is common for researchers to conceptualize symptom remission across conditions as the proportion of participants exhibiting sub-threshold or no symptoms at discrete time intervals (e.g., 1-, 3-, 6-, or 12-months)⁷⁹. The proposed study will use a design inspired by this work to assess enduring change in PA influenced by condition. Specifically, participants who have achieved the prescribed 150-minutes of PA per week at the end of the 1-month aerobic PA intervention will be examined in the context of the mediational PAM model (i.e., **exploratory Aim 3**). The outcome variable will be the summation of a categorical assessment of whether the participant is achieving 150-minutes or more per week (yes=1, no=0) at 1-, 3-, and 6-months follow-up for a possible range of 0-3 for the maintenance variable.

Measure of baseline aerobic fitness: VO₂max. In order to measure graded maximal oxygen capacity (VO₂max) – a marker of aerobic fitness, CTCRC physiologists uses a modified Balke protocol. To complete the test, participants run on a treadmill at a constant speed but the incline of the belt increases 2% every 2 minutes. Treadmill speed is determined using participant HR and ratings of perceived exertion (RPE) and can vary greatly between subjects (1.5-10+ mph). A speed that elicits 70% of age-predicted HR max and an RPE rating of around 13 (“somewhat hard”) will be used to begin the test. Staying within these parameters generally yields an 8-12 minute test; the recommended target for VO₂ max testing⁸⁰. The determination of when a participant has reached VO₂ max is not without controversy⁸¹ and ultimately the participant chooses the point at which she can no longer continue. This study will determine a valid VO₂ max using both the primary criterion of having achieved a plateau in VO₂ as well as secondary criteria outlined by Pimentel and colleagues⁸² including respiratory exchange ratio (RER) max ≥ 1.1, RPE max ≥ 18, and age predicted HR max ±10bpm. VO₂ max will serve as the basis for generating accurate PA prescriptions for moderate intensity PA.

Statistical analysis plan. In **Specific Aim 1**, we will test the hypothesis that participants who received either the AFFECT or PHYSIO self-monitoring interventions will report more PA participation than those who received the CONTROL intervention at 1-(time of exit survey), 3-, and 6-months. In **Specific Aim 2**, we will test the hypothesis that participants who received the AFFECT self-monitoring intervention will report more PA participation than those who received the PHYSIO self-monitoring intervention at 1-, 3-, and 6-months. In order to test these aims, we will use a between groups, repeated measures analysis of variance (ANOVA) with planned contrasts. Scores on the PAR and GLTQ will serve as the primary repeated measures outcome variables. Because up to 20% attrition is anticipated, all analyses for specific aims 1 and 2 will be repeated utilizing random coefficient regression (RCR)⁸³ models in SAS Proc Mixed. Proc Mixed uses full-information maximum likelihood estimation of missing data⁸⁴ and accounts for the clustering of longitudinal observations over time within subjects. **Specific aim 3** is an exploratory aim that proposes to examine the mechanisms by which the interventions influenced PA maintenance using a mediational analysis utilizing constructs from the PAM. We will estimate this mediational model via structural equation modeling (SEM). In this model, there are two exogenous variables representing the contrast codes for (1) comparing the AFFECT and PHYSIO conditions (both coded 1) versus CONTROL (coded 0), and (2) comparing the AFFECT (coded 1) versus the PHYSIO (coded 0) conditions. The endogenous mediators are latent variables characterizing PA goals, self-motivation for PA, and PA self-efficacy; each of these variables is expected to covary with the other. The sole outcome variable is PA maintenance (coded 0 to 3 as described above). This model will be estimated and both the fit of the model and the significance of the path coefficients will be examined. If paths from intervention condition to the mediators are significant, and paths from the mediators to outcomes are significant, then mediation is suggested. A test for completeness of mediation is employed through a series of one degree of freedom χ^2 tests where a path directly from intervention to outcome (e.g., PA maintenance) is added to the model. A nonsignificant direct path and a nonsignificant change in χ^2 suggest that intervention effects on the outcome were mediated through the theoretical mediational constructs. A secondary test of mediation will utilize bootstrap methods to test the significance of, and confidence limits around, the mediated effect^{85, 86}. The applicant has had formal training in SEM and mediational analyses of this type have been widely and successfully used by the primary sponsor, Dr. Bryan^{48, 87, 88}. The moderating influence of life stress and the physical environment will be assessed in ancillary analyses that include conditionXmoderator interactions in the model, or that compute the mediational model using cross-groups analysis techniques for comparing model parameters in, for example, groups with high versus low life stress during the intervention period⁸⁹⁻⁹¹.