Use of in-home stationary cycling equipment among parents in a family-based randomized trial intervention

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Abstract

Objectives: The purpose of this study was to examine the use of home exercise equipment in the form of exergame cycling compared to a stationary recumbent bicycle ergometer in front of TV in the home over 3 months among parents of an intervention with their inactive children. The primary outcome was bike use (total weekly duration). Predictors of bike use in the form of theory of planned behavior and self-determination theory were also examined. Design: Randomized controlled trial. Method: Sixty eight parents of children aged 10-14 were randomized to either the exergame condition (n = 36) or the standard bike condition (n = 32). Weekly bike use was recorded in a log-book. Results: The exergame bike and a standard bike in front of a TV had similar use across three months ($p = .13$, $\eta_p^2 = .02$), which declined over time ($p < .01$, $\eta_p^2 = .14$). Parents who were active at baseline and had the intention to use the bikes were more likely to use the bikes ($p < .05$). Furthermore, those who reported higher perceived control, intrinsic motivation, and affective attitude were more likely to use the bikes ($p < .05$). Conclusions: The findings suggested that irrespective of modality, use of exercise equipment declined considerably for parents over three-months. Parents may also benefit from family physical activity interventions, but it depends on their physical activity status, how much they would enjoy using the equipment, and their overall perceived control over being physically active.

Trial Registration: clinicaltrials.gov #NCT01373762. Registered 1 June 2011.

Key Words: Intrinsic motivation, intention, attitude, exergame

Introduction

The health benefits of regular physical activity (PA) are well-established[1], yet many adults fail to meet the 150 weekly minutes of moderate or greater intensity recommended in public health guidelines[2]. One group that is particularly at risk for physical inactivity is parents with dependent children in the family home[3], yet applications of home-based interventions are limited[4].

One area of home-based PA that has seen recent attention is exergames[5]. Exergames are games where players interact physically (using leg, arm, or whole-body movement) in response to some on-screen virtual activity. These games have extensive reach into the family home. For example, the Wii has sold over 101.63 million units since its introduction and has contributed to a 73% increase in net Nintendo sales[6]. Most of the focus of exergaming research has been on children[7], but it is also possible that parents themselves could derive PA from game play. Adult exergame trials have had very limited research and with mixed results[8-10]. Thus, it is unclear whether there is any spill-over of game use by parents when the intended audience was their children.

Relatedly, the introduction of fitness equipment into the family home may be useful to facilitate PA. The Sport and Fitness Industry Association reports that exercise equipment sales is a $5+ billion business, with home fitness equipment exceeding 35% of that revenue[11]. Thus, whether home equipment can help promote PA is a practical research question for consumers, but this has received almost no research attention[12].

Thus, the purpose of this study was to examine the use of exergame cycling compared to a stationary recumbent bicycle ergometer in front of the TV in the home over 3 months among parents. A secondary aim was to examine predictors of bike use. A prior publication of this randomized controlled trial focused on children aged 10-14[13], and showed the exergame group reported higher use, though both conditions declined in bike use over time. Here we explore parental use of the bikes, as parents were also invited to use the bikes during the trial. We hypothesized that the exergame condition may show higher use due to the interactive play capabilities of the equipment, but both conditions would decline over time.

We also sought to explore the predictors of equipment use in both conditions. We first sought to explore whether parental sex and PA status could explain differences in bike use. Next, we used self-determination theory (SDT)[14] and the theory of planned behavior (TPB)[15] to predict bike use and explore whether these psychological models could explain any covariance between condition (standard bike, exergame) and use. Both models have shown predictive capability when explaining PA[16,17]. Based on this prior research, we expected that bike users would be more intrinsically motivated (SDT) and have stronger intentions (TPB) than non-users.

Methods

We followed the consolidated standards of reporting trials statement for this study[18]. A two-arm parallel design single blinded randomized controlled trial was conducted where participants were randomized using simple computer randomization procedures and allocated to one of two groups 1) exergame bike; or 2) stationary bike in front of TV- condition for three months duration at a 1:1 allocation ratio. Participants were aware of their group allocation, but assessors and initial recruiters were blinded to treatment allocation as this was concealed by a study coordinator (who performed the randomization) via opaque envelopes.

Participants were recruited via advertisements placed through recreation/health centres, schools and online interest sites. Participants were parents (where at least 1 parent reported <150 min of moderate or vigorous PA per week) of inactive children (i.e., reporting less than 60 min of moderate or vigorous PA per day) aged 10-14 years from single or dual parent families who completed the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+)[19]. In the case of dual-parent households, one parent designated themselves as the primary participant in the study. Participants were recruited in either Victoria, British Columbia or Halifax, Nova Scotia regions.

The Exergame bike group received a Hoggan Health® interactive video gaming system linked to a Sony Playstation3® and a television monitor. The Hoggan Health®interactive video gaming system reads the participant's speed (measured by cycling cadence) and steering, which in combination with a

full function handlebar-mounted game controller that allows each participant the opportunity to play a variety of Sony Playstation3® video games. Participants received five of these video games (including Smuggler's run, ATV Offroad Fury, Gran Turismo 3, Nascar Heat, and Need for Speed) and were asked to select among these during bike use.

The standard bike group received the Hoggan Health stationary bike without the videogame component and was instructed to exercise during each training session while watching TV.

The recommended exercise training regimen for both conditions was moderate intensity exercise (i.e., 60 to 75% of heart rate reserve), 3 d/wk for 30 min/d[20]. Participants were provided written and verbal instructions on the ratings of perceived exertion (RPE) associated with the recommended training intensity and received heart rate monitors to support participant fidelity to the target intensity.

The primary outcome of the trial was minutes of exercise equipment usage tracked in a log and recorded by the date, time and duration of usage. This log was based on the prior study by Mark and Rhodes[8], who demonstrated that the log was sensitive to changes in use over time.

Predictor variables of bike use included self-reported sex, PA measured by the Godin Leisure-Time Questionnaire[21], constructs from the TPB[15] and motivational regulations from SDT[14]. TPB and SDT questions were framed as expectations of bike use 3 days per week of 30 min over the next six weeks. Measures of affective attitude (3 items, time 1 $\alpha = 0.79$; time 2 $\alpha = 0.84$), instrumental attitude (3 items, time 1 $\alpha = 0.77$; time 2 $\alpha = 0.92$), subjective norm (3 items, time 1 $\alpha = 0.69$; time 2 $\alpha = 0.66$), perceived behavioral control (3 items, time 1 $\alpha = 0.69$; time 2 $\alpha = 0.77$) and intention (2 items, time 1 $\alpha = 0.87$; time 2 $\alpha = 0.91$) all showed adequate internal consistency. Assessments of motivational regulations in SDT were measured using adapted questions from the Behavioral Regulation in Exercise Questionnaire 2 BREQ-2; [22]. The aggregate scores for amotivation (time 1 $\alpha = 0.78$; time 2 $\alpha = 0.85$), and external regulation (time 1 $\alpha = 0.89$; time 2 $\alpha = 0.82$), introjected regulation (time 1 $\alpha = 0.81$; time 2 $\alpha = 0.84$), identified regulation (time 1 $\alpha = 0.81$; time 2 $\alpha = 0.86$), intrinsic motivation (time 1 $\alpha = 0.89$; time 2 $\alpha = 0.93$) all had acceptable scale reliabilities.

The study was approved by the University of Victoria Human Research Ethics Board. After interested parents contacted the researcher and were determined to be eligible to participate in the study, a researcher visited the respective families' homes and asked parents and children to complete informed consent and parents were asked to complete a questionnaire on demographics, and PA.

On completion of baseline assessment, participants were randomized to one of the two conditions. Following randomization, the researcher scheduled an orientation session with the family. At the orientation session, the equipment was brought to the home and set-up, and all family members were given the opportunity to use the equipment. The usage log was given to the family with specific sections for each member (usage tracking occurred after the first orientation session). A discussion of intensity and perceived exertion using the Borg scale/heart-rate monitors[23] followed. At this time, participants were asked to complete a brief measure of expected motivation to use the bike with instrumentation from the TPB and SDT. These measures were administered immediately after the initial practice session use of the bike[9]. The same instrumentation was administered to parents at the six-week point of the trial.

At three months, parents were asked to participate in a brief end-of-trial interview to evaluate the impact of the intervention delivered by a research assistant.

Data were analysed in SPSS 20 (SPSS Inc., Chicago, IL, USA). Missingness was inspected to determine the appropriate imputation procedures[24]. Descriptives and bivariate correlations of all variables were then computed.

The primary research question was investigated using a repeated measures analysis of variance with two between subject conditions (standard bike, exergame bike) and 13 within-participant estimates of weekly bike use. Power analysis (.80) with 13 repeated assessments, an estimated medium effect size ($f = .25$) based on our pilot study with adults and exergame bikes[9], with an alpha of .05 suggested that a sample size of 70 was required to detect a between-group difference in bike usage[25]. Exploratory follow-up analyses (i.e., not powered a priori) were employed using parent sex and baseline PA as fixed factor moderators of bike use.

Prediction of bike use with the TPB and SDT concepts included the weeks 1-6 and 7-13 epochs of bike use. Ordinary least squares regression analyses with path analysis were used to predict bike use. The PROCESS macro for SPSS[26] was used (5000 bootstrapped samples) to investigate any mediation effects of the theoretical constructs between condition (standard, exergame) and bike use.

All end of study interviews (September, 2012 to March, 2014) were transcribed verbatim. First order themes were created based on categorizing coded data using Ajzen's[15] TPB as a framework. This approach was chosen because the interview questions about benefits and barriers fit the overall thematic representation of TPB belief elicitation. Total frequency of the themes and the percentage of endorsement were calculated as an estimate of commonality across interviews.

Results

Study flow is provided in Supplementary Figure 1. The 68 parents who met the study inclusion criteria were randomly assigned to one of the two conditions (32 standard bike and 36 exergame bike) and rolling recruitment began in May 2012 and continued until December 2013. There were no study drop-outs. All parents cited time conflicts for their reasons for declining to participate. No participants cited harms associated with the study.

Baseline characteristics of the participants can be found in Supplementary Table 1. Parents were typically in their early 40s, with close to an equal representation of mothers and fathers as the designate parent (58% mothers), mainly white, university educated, and employed. Approximately one third of the sample were meeting recommended PA guidelines. No significant group differences on these variables were present by group allocation.

All bike data had a moderate positive skew and thus we used a square root transformation procedure. Only one participant had missing bike data (weeks 8-10) so we used a simple last entry carried forward procedure to impute. By contrast, 17% of the sample was missing data on the TPB/SDT constructs at the second assessment. These data were found missing completely at random [Little's test

(9) = 6.66; p = .67], and an imputation approach was conducted using the expectation-maximization algorithm[24].

Mean bike use was 36.06 (*SD* = 58.08) min in week 1 and only 8.81 (*SD* = 35.27) min at week 13. Repeated measures ANOVA indicated that Mauchly's test for sphericity had been violated ($\chi^2(77) = 303.24$, $p < .01$); therefore, degrees of freedom were corrected using Huynh-Feldt estimates of sphericity ($\varepsilon = .70$). As shown in Figure 1, mean weekly play duration declined significantly across time [$F(8.37, 86.59) = 10.90$, $p < .01$, $\eta_p^2 = .14$]. There was no significant difference in bike use across time between the standard bike and exergame conditions [$F(8.37, 12.37) = 1.56$, $p = .13$, $\eta_p^2 = .02$].

The inclusion of parent sex as an exploratory moderator showed no significant differences in bike use [$F(8.23, 9.55) = 1.18$, $p = .31$, $\eta_p^2 = .02$]. By contrast, meeting baseline PA guidelines was significantly related to bike use [$F(8.29, 21.24) = 2.65$, $p < .01$, $\eta_p^2 = .05$]. Those who met guidelines for PA (150 min of moderate-to-vigorous intensity) at baseline were more likely to use the bikes compared to those who were not active in relation to this guideline.

Descriptive statistics and bivariate correlations among the TPB and SDT constructs with bike use can be found in Supplementary Tables 2 and 3, respectively. Condition was associated with both affective ($\beta = .29$; $p < .05$) and instrumental ($\beta = .28$; $p < .05$) attitude but not subjective norm or perceived behavioral control ($p > .05$) following the initiation session (see Figure 2a). However, neither attitude construct was associated with intention ($p > .05$), and mediation tests showed no meaningful covariance between the attitude constructs, condition, and intention (all 95% confidence interval estimates passed through zero). Instead, only perceived behavioral control predicted intention to use the bikes ($\beta = .39$; $p < .05$). Intention, in turn, predicted bike use over the first six weeks ($\beta = .32$; $p < .05$). Mediation analyses showed that perceived behavioral control had a small effect on bike use (standardized mediation coefficient = 0.14; 95% CI = 0.04 to 0.29) through its effect on intention.

Intention to use the bikes over the second half of the trial (i.e., TPB measured at six weeks) predicted bike use ($\beta = .25$; $p < .05$) during the 7-13 weeks (see Figure 2b). No other TPB construct, or

condition, had an independent significant effect on bike use ($p > .05$). Affective attitude ($\beta = .47$; $p < .05$) and perceived behavioral control ($\beta = .34$; $p < .05$) significantly predicted intention, but did not have an indirect effect on behavior through intention (95% confidence interval estimates passed through zero).

No construct measured after the initiation session predicted bike use over the first six weeks and condition was not associated with SDT (see Figure 3a). Intrinsic motivation measured at six weeks ($\beta = .51$; $p < .05$) predicted bike use over the second six weeks of the trial (See Figure 3b). Condition was associated with higher values of intrinsic motivation ($\beta = .25$; $p < .05$) and accounted for the covariance between condition and bike use (standardized mediation coefficient = 0.14; 95% CI = 0.02 to 0.37).

Results of the end-of-trial interviews are summarized in Supplementary Table 4. For the exergame condition, 46.4% of parents reported that the exergame was enjoyable or fun while 22.6% of participants reported that the bike felt was not enjoyable to use. Many parents also suggested that the bike was a good way to get their exercise (46.4%), an opportunity to get active (25%) and improve health and fitness (17.9%). Still, 50% of participants reported bike related barriers such as a lack of comfort or frustrations over gameplay (42.9%).

For the standard bike condition, 22.6% of parents reported that the bike was enjoyable while 41.9% felt the bike was boring. However, many parents did see instrumental benefit to the bike as a good way to get their exercise (51.6%), an opportunity to get active (35.5%) and improve health and fitness (41.9%). This group also reported comfort barriers with bike use (45.2%) and genera l barriers such as lack of time (48.4%).

Discussion

Our hypothesis that the exergame condition would show higher use than the standard bike condition was not supported and suggests that entertainment-based exergames may not be a successful mechanism to encourage adult PA any more than standard exercise equipment. Interestingly, our results did show that adults had more favorable attitudes toward using the exergame over the standard bike after initial exposure, and reported the exergame as considerably more enjoyable and less boring to use than

the standard bike condition in follow-up interviews. This suggests that initial or comparative perceptions about exergames may not be reliable estimates of use.

Our hypothesis that both conditions would decline in use over time was supported. The results are aligned with one prior study showing that exercise equipment did not have sustained use over six weeks[27], but in contrast to supportive results of use in two other studies[28,29]. Clearly, there is a dearth of research on this important topic given that consumers spend considerable amounts of money on home exercise equipment[11]. Our results support the conception that use of exercise equipment may start at a meaningful volume but this declines substantively over a quarter of a year.

Our second research purpose was to explore the predictors of equipment use across time. To our knowledge, this is the first study to explore in-home predictors of adult exercise equipment use. Our results showed that sex did not relate to bike use but those parents who were physically active at baseline were more likely to use the equipment than parents who were inactive. This is not surprising as it suggests that active people use the bikes as a convenient way to maintain their PA. Unfortunately, the results also suggest that home exercise equipment did not act as much as a gateway to exercise adoption as it did a means of exercise maintenance for those who were already active at public health guidelines. Further, despite not being significant, parents in the standard bike group engaged in about twice as much baseline MVPA relative to the exergame bike group, so it is possible this had an effect on the results of our first hypothesis.

We were generally unable to predict bike use with SDT and TPB over the first six weeks of the trial. By contrast, intrinsic motivation predicted bike use over the final six weeks of the trial and intention proved to be the primary predictor of bike use for the TPB. The differences in prediction from baseline to six weeks and six weeks to three-months may show how a single exposure of exercise equipment is not sufficient to make accurate perceptions of use. This phenomenon of response shift due to a more fulsome understanding of task demands is a common limitation of measurement[30]. Thus, single-bout exposure designs are likely not helpful to understanding long-term exercise adherence with novel equipment.

Overall, the results yield a practical suggestion for consumers. Specifically, having a sense of whether one will enjoy using the equipment may be critical to its use and this judgment is best made after repeated exposures. We saw no evidence that identified regulation or instrumental attitude were predictive of use, so thoughts that the exercise equipment would be useful as a means of obtaining health benefits do not appear to be a sufficient motive for using exercise equipment.

Despite the novel findings in our study and the strong methods employed, there are noteworthy limitations. First, the duration of use was obtained through log-books which could introduce biases on self-reporting. An assessment of total weekly PA that can capture cycling is recommended for future research. Second, parents in the study reported high education and incomes, and were mainly white. Thus, it remains uncertain how well these results may generalize to lower socio-economic status families and different ethnic backgrounds.

Conclusions

Our results showed that an exergame bike and a standard bike in front of a TV had similar use in the family home among a sample of parents, and both groups declined across three months. Parents who were active at baseline and had the intention/intrinsic motivation to use the bikes were more likely to use the bikes.

Practical Implications

- Entertainment-based exergames may not be a successful mechanism to encourage adult physical activity any more than standard exercise equipment.
- Home exercise equipment use decreased rapidly over three months suggesting that mere accessibility is not sufficient to sustain continued use.
- Active parents at baseline were more likely to use the exercise equipment than inactive parents suggesting that home exercise equipment may be more useful for physical activity maintenance compared to adoption.
- Intention and intrinsic motivation predicted equipment use, but not instrumental attitudes or external regulations, suggesting that consumers of exercise equipment will not maintain use unless they possess strong intentions and enjoyment of the equipment.

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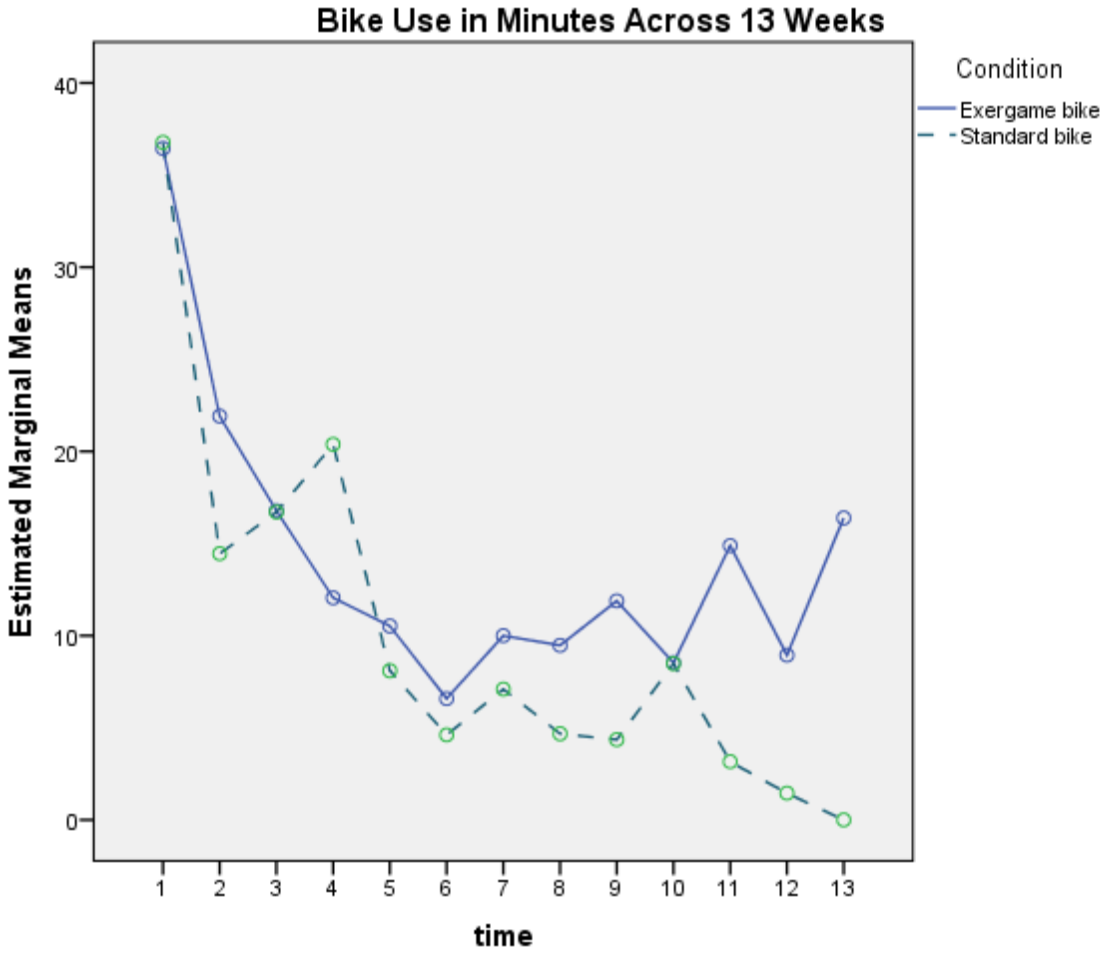
Figure Legends

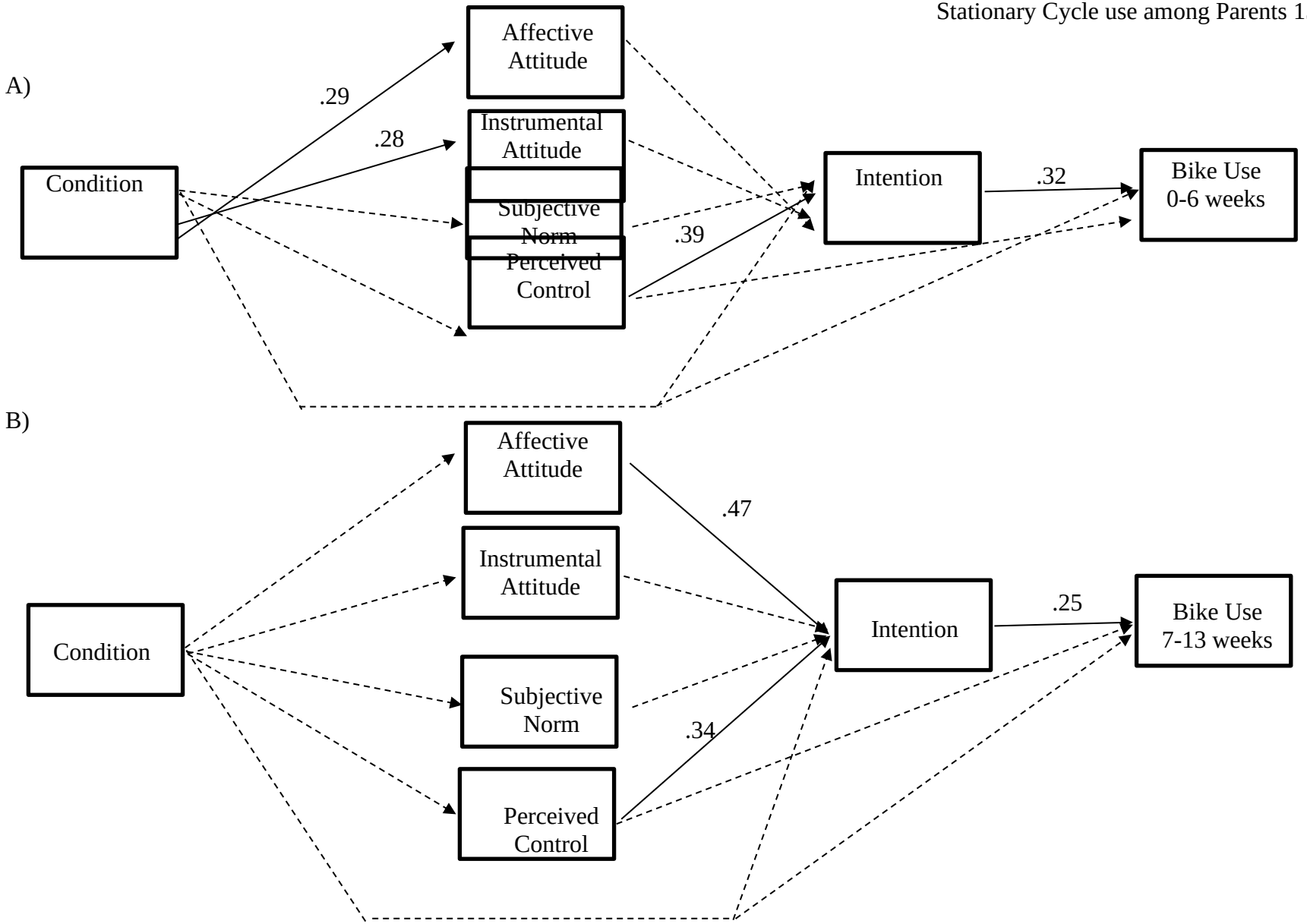
Figure 1: Weekly minutes of bike use over the 13-week intervention period by condition

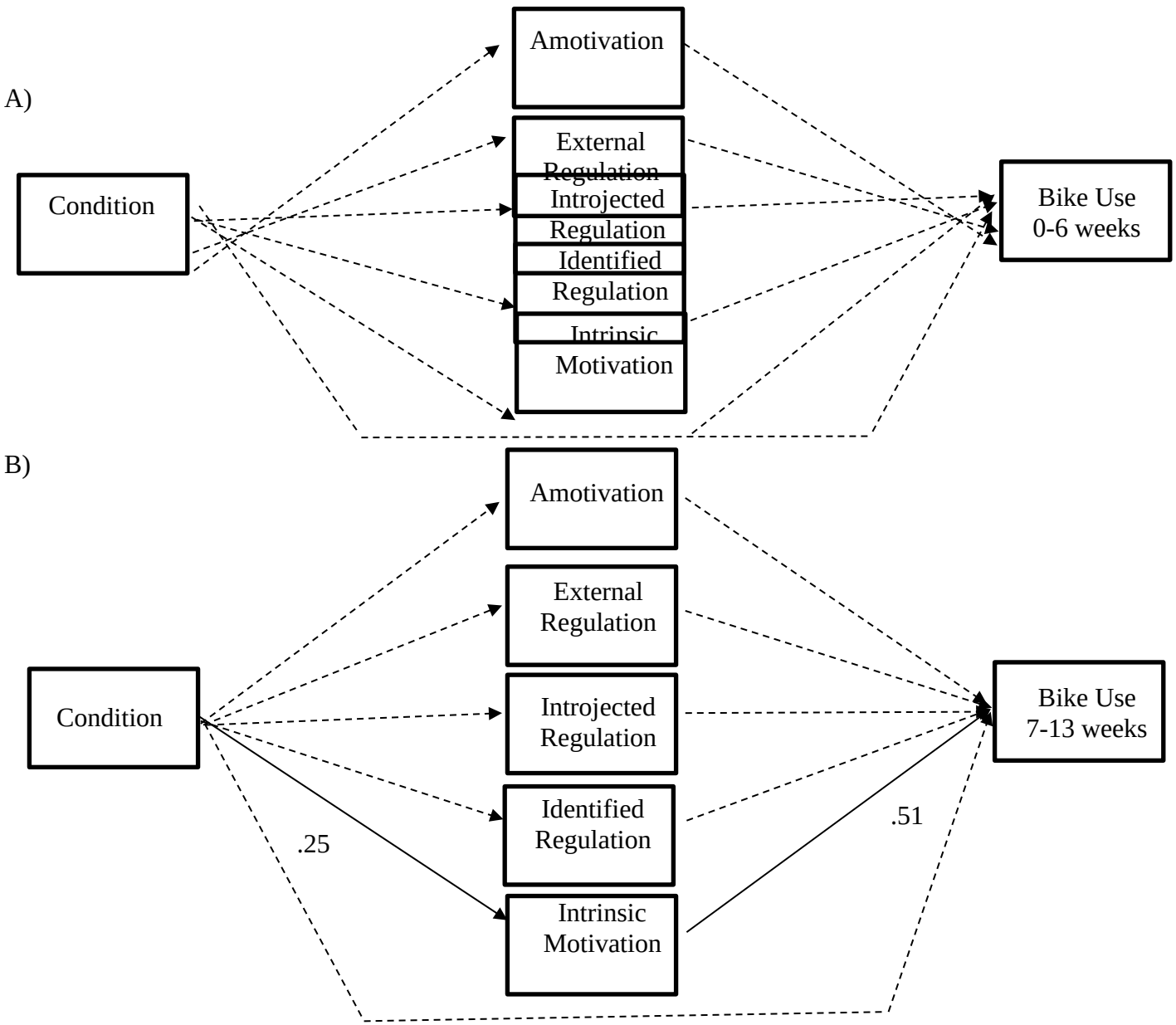
Figure 2: Prediction of bike use with the theory of planned behavior at (A) baseline to six weeks and (B) seven weeks to three months. Note: slotted lines = $p > .05$; full lines = $p < .05$.

Figure 3: Prediction of bike use with self-determination theory at (A) baseline to six weeks and (B) seven weeks to three months. Note: slotted lines = $p > .05$; full lines = $p < .05$.

Supplementary Figure 1: Participant Flow


Bike Use in Minutes Across 13 Weeks
Estimated Marginal Means
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
13
time
Condition
Exergame bike
Standard bike


A)
Affective Attitude
.29
Instrumental Attitude
.28
Condition
Subjective Norm
Perceived Control
.39
Intention
.32
Bike Use 0-6 weeks
B)
Affective Attitude
.47
Instrumental Attitude
Condition
Intention
.25
Bike Use 7-13 weeks
Subjective Norm
.34
Perceived Control


A)
Amotivation
External Regulation
Introjected Regulation
Identified Regulation
Intrinsic Motivation
Condition
Bike Use 0-6 weeks
B)
Amotivation
External Regulation
Introjected Regulation
Identified Regulation
Intrinsic Motivation
Condition
Bike Use 7-13 weeks
.25
.51