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Engagement, enjoyment, and energy expenditure during active video game play

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Abstract

Objective—Playing active video games can produce moderate levels of physical activity, but little is known about how these games motivate players to be active. Several psychological predictors, such as perceptions of competence, control, and engagement, may be associated with enjoyment of a game, which has in turn been hypothesized to predict energy expended during play. However, these relationships have yet to be tested in active video games.

Methods—Young adults aged 18–35 ($N = 97$, 50 female) < 300 pounds played a Dance Dance Revolution game for 13 minutes while energy expenditure was measured using indirect calorimetry. Self-reported measures of engagement, perceived competence, perceived control, and enjoyment were taken immediately afterwards. Mediation was analyzed using path analysis.

Results—A path model in which enjoyment mediated the effects of engagement, perceived competence, and perceived control on energy expenditure and BMI directly affected energy expenditure was an adequate fit to the data, $\chi^2(1, N = 97) = .199, p = .655$; CFI = 1.00; RMSEA < .001; 90% CI = .000 - .206; $p = .692$. Enjoyment mediated the relationship between engagement and energy expenditure (indirect effect = .138, $p = .028$), but other mediated effects were not significant.

Conclusion—Engagement, enjoyment, and BMI affect energy expended during active video game play. Games that are more enjoyable and engaging may produce greater intensity activity. Developers, practitioners, and researchers should consider characteristics that influence these predictors when creating or recommending active video games.

Keywords

video game; energy expenditure; physical activity; enjoyment; motivation

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Physical inactivity is a major and pervasive public health problem with impacts on diabetes, cardiovascular disease, and a host of other negative health outcomes (Dunstan et al., 2010; Hu, Li, Colditz, Willett, & Manson, 2003). Exercise-themed video games are popular, and the addition of physical activity to video gaming has been suggested as a method for increasing physical activity during leisure time (Lanningham-Foster et al., 2006; Maloney et al., 2008). There is mixed evidence as to whether video game-enhanced exercise produces greater energy expenditure and activity intensity than traditional exercise (Annesi & Mazas, 1997; L. Graves, Stratton, Ridgers, & Cable, 2007; Haddock, Siegel, & Wikin, 2009; Warburton et al., 2007). Also, while little is known about the mechanisms by which video games may affect energy expenditure, several psychosocial variables may exert influence.

One such psychosocial variable that has been shown to be highly associated with physical activity is enjoyment (Rhodes, Fiala, & Conner, 2009). Previous studies have found effects of body motion on enjoyment (Aymerich-Franch, 2010; Limperos, Schmierbach, Kegerise, & Dardis, 2011; Skalski, Tamborini, Shelton, Buncher, & Lindmark, 2011) and differences in enjoyment across video games and game types (Bailey & McInnis, 2011; L. E. Graves, Ridgers, Williams, et al., 2010; Lyons et al., 2011; Penko & Barkley, 2010). Studies of video game-enhanced stationary bicycles have found that these bicycles produced higher intensity physical activity than traditional stationary cycles (Rhodes, Warburton, & Bredin, 2009; Warburton et al., 2009), and have also found positive effects of enjoyment on adherence (Rhodes, Warburton, et al., 2009).

Studies of motion-controlled music games, such as Guitar Hero and Donkey Konga, have found that enjoyment can produce (and be produced by) movements in addition to those required by the game (Bianchi-Berthouze, 2009; Bianchi-Berthouze, Kim, & Patel, 2007). For example, players may engage in task-facilitating actions (those not required but that facilitate control of the game, such as standing to play guitar), role-related actions (those related to their role in the game, such as dancing like a rock star while playing guitar), emotional expressions (such as jumping with excitement during an especially enjoyable song), and social behavior (such as motioning to a friend while playing) (Bianchi-Berthouze, 2009). Though greater game skill likely affects energy expenditure in music games due to increased amounts of dancing and jumping, additional non-required movements may increase energy expenditure even in those with lower skill. These results suggest that enjoyment likely has a positive effect on energy expended during play of active video games, but the extent of this effect is not clear.

Recently, increasing emphasis has been placed on defining media enjoyment as the satisfaction of psychological needs (Przybylski, Rigby, & Ryan, 2010; Tamborini, Bowman, Eden, Grizzard, & Organ, 2010). Several variables may affect energy expenditure due to their effects on enjoyment. Distraction from fatigue and/or pain associated with physical activity by diverting attention from bodily sensations likely impacts enjoyment. Distraction via other media has been found to increase activity intensity during exercise (Annesi, 2001; De Bourdeaudhuij et al., 2002). The similar concepts of presence and engagement are often used as a measure of distraction from the real world in a technologically mediated virtual environment, such as exists in many video games (Skalski, Denny, & Shelton, 2010). Higher levels of presence/engagement in a video game have been associated with greater decreases

in pain perception (Hoffman et al., 2004), and preliminary data show that movement-based gaming, such as playing a dance simulation game, can increase presence as compared to other media (Aymerich-Franch, 2010; Bianchi-Berthouze et al., 2007).

Though many use the terms interchangeably, presence and engagement are typically defined as different but highly related concepts. Engagement specifically refers to attentional distraction and feelings of mental immersion rather than feelings of being “in the game” (International Society for Presence Research, 2000). Engagement may be a more appropriate measure for media-based distraction than the more general concept of presence. Little is known about the effects of distraction from the real world via use of an active video game, or how this distraction may relate to enjoyment and energy expenditure.

Perceptions of competence have consistently been found to affect enjoyment of video gaming (Przybylski et al., 2010), and objective measures of competence (i.e., skill level) appear to affect activity intensity during dance simulation game play (Sell, Lillie, & Taylor, 2008). Perceptions of control over the game may also affect enjoyment (Klimmt, Hartmann, & Frey, 2007; Limperos et al., 2011). Without adequate control, games can feel less interactive and more frustrating. Control has been conceptualized as necessary but not sufficient for video game enjoyment (Przybylski et al., 2010).

The literature on gaming and physical activity suggests that enjoyment is likely associated with energy expended during active game play. Additionally, several psychological variables may have indirect effects on energy expenditure via their effects on enjoyment. Dance simulation games have been studied for the purposes of estimating energy expenditure (Tan, Aziz, Chua, & Teh, 2002; Thin & Poole, 2010; Unnithan, Houser, & Fernhall, 2006), but participants’ affective and cognitive reactions to these popular games are rarely explored. The purpose of this study was to examine the relationships of engagement, perceived competence, and perceived control with enjoyment and energy expenditure. We hypothesized that the relationships of engagement, perceived competence, and perceived control with energy expenditure would be mediated by enjoyment.

Method

Sample

One-hundred ($N = 100$) 18–35 year old participants, equal numbers male and female, were recruited using a university online mailing list and television advertisements. To be included, participants were required to weigh <300 pounds (necessary for the use of other game controllers not discussed here), to have played video games at least 3 times over the past year (which may have included Dance Dance Revolution, the game played in this study), to be willing to fast 2.5 hours and be videotaped during the study protocol, and to have transportation to the study location. Of 757 individuals who requested information and eligibility criteria, 325 completed eligibility information; of those 325, 169 potential participants were scheduled, and 100 completed the protocol. Eligible participants who did not attend their appointments ($N = 49$) were considered drop-outs, and 156 eligible participants were wait-listed.

Games and Procedure

The study was conducted in a dedicated lab facility in a University-owned office building between April and August of 2009. The room included a 58" television, game chair with surround sound speakers, and measurement equipment. After participants provided informed consent, preliminary anthropometric (height, weight) and pre-experimental questionnaire measures were taken. The mask for indirect calorimetry was then fitted, adjusted, and tested as needed prior to a 20 minute rest period. Eight games were played in randomized order for 13 minutes each, with the first three minutes considered a training period. Water was available at all times. A rest period of at least ten minutes occurred between each game, and post-hoc analyses found no effects of game order (data not reported). Only two of the eight games were active. More details on the study design of the larger study can be found in a previous publication (Lyons et al., 2011).

For these analyses, only measures taken during play of one of the active games, a dance simulation game, were used. The dance simulation game played was Dance Dance Revolution: Universe 2 (DDR), for the Xbox360 console. DDR is a dancing game based on traditional rhythm gameplay in which players use a dance mat rather than a traditional controller. The mat (in this instance, a thin plastic mat that comes bundled with the game) is square in shape, with arrows at the top and bottom and left and right. To play, the participant steps on the appropriate arrows as patterns of up, down, left, and right arrows scroll across the screen in time with the beat of a song. Participants practiced on one song and then played one song on the lowest difficulty setting, then were free to choose subsequent songs and difficulty levels for the rest of the play period (approximately 10 minutes). The use of the DDR game in this analysis, as opposed to other games from the larger study, was decided a priori. It was based on the popularity of this game series among researchers (making it an appropriate exemplar active game), and its appropriateness as compared to the other games used (anticipated variability in energy expenditure, lack of randomization to different conditions during play of the game). The overall protocol lasted approximately four hours per participant with periods of rest and sedentary games mixed with more active games.

Measurement

Energy expenditure was measured via indirect calorimetry (Ultima CPX, Medgraphics, St. Paul, MN) using a neoprene mask and open pneumotach. The calorimeter was calibrated daily using a 3 liter syringe as well as prior to each test using certified gases. The umbilical hose connecting participants and the metabolic cart was routed behind the participants' body and was sufficiently long to allow movements required for each game. Height and weight were measured in street clothes without shoes using a wall-mounted stadiometer (Perspective Enterprises, Inc., Kalamazoo, MI) and calibrated scale (Tanita, Arlington Heights, IL). Previous experience with dance simulation games was measured with a single item: "How often have you played a game similar to this one?" (with response options from 1, "not very often," to 7, "very often").

Engagement was measured using items from the Temple Presence Inventory (Lombard et al., 2000). This six-item measure has been found to be reliable, and its components come

from well-validated past measures found in a literature search by the instrument's creators (Lombard et al., 2000). Questions included "How completely were your senses engaged?" and "To what extent did you feel mentally immersed in the experience?" Responses, on a 1–7 scale, were summed to create an engagement score (range: 1–7).

From the Intrinsic Motivation Inventory, the seven-item enjoyment subscale was used to measure enjoyment and the six-item competence subscale was used to measure perceived competence. This measure has shown adequate validity and reliability (McAuley, Duncan, & Tammen, 1989). Participants ranked their agreement with each statement on a Likert scale of 1 ("not at all true") to 7 ("very true"). Slight changes to wording were made to specifically reference video game playing. Items in the motivation subscale included "this game was fun to play" and "I thought this game was quite enjoyable." Items in the competence subscale included "I was pretty skilled at this game." Responses for each scale were averaged to create enjoyment and perceived competence scores (range: 1–7).

Perceived control was measured using five items from the Presence Questionnaire's control and immersion factors subscale that have been found to load onto a single control-related factor (Takatalo, Nyman, & Laaksonen, 2008; Witmer & Singer, 1998). These items have been used for the purpose of measuring perceived control during video game play in the past (Cavazza, Lugin, & Buehner, 2007). Items included "how much were you able to control events" and "how responsive was the environment to actions you initiated (or performed)?" Responses were summed to create a perceived control score (range 7–35).

Reliability evidence in this sample was high for all scales: enjoyment (Cronbach's $\alpha = 0.96$), engagement (0.90), perceived competence (0.94), and perceived control (0.81).

Data Analysis

Energy expenditure estimates were averaged over the last 10 minutes of play (excluding the three-minute training period). Prior to analysis, data were examined for the existence of outliers. Residual analysis found two outliers of note, with Cook's D statistics > 0.04 (using a cut point of $4 / [N - k - 1]$) (Fox, 1991). Video taken during play showed that both of these participants set the game to expert difficulty, whereas nearly all other participants played on beginner or basic. They also expended more energy (> 3 standard deviations from the mean) than others and reported extensive experience with dance simulation games (data not reported). The hypothesized model was tested using the entire data set and compared to the model reported below, which did not contain outliers. Overall, results were similar. The relationships between perceived competence, perceived control, and energy expenditure differed across the two analyses, but these differences did not affect significance. These players' much greater experience than average may have altered the relationship between their perceptions of competence and control and their energy expenditure. The two participants were judged to be extreme outliers and removed from the data set.

One other individual was removed due to incomplete data, bringing the study N to 97. Data were tested for heteroskedasticity and normality using Breusch-Pagan and Shapiro-Wilks tests. No significant results were found for either test.

Descriptive statistics and residual analysis were performed using SPSS Statistics version 17.0 (SPSS, Inc., Chicago, IL, 2008). The Breusch-Pagan test was performed using SAS version 9.2 (SAS, Cary, NC, 2008). A path model testing the effects of theoretical predictors on energy expenditure with enjoyment as an intervening variable were tested with the MPlus software package version 5.2 (Muthén and Muthén, Los Angeles, CA, 2008). Both direct and indirect effects were calculated using maximum likelihood estimation with code adapted from MacKinnon (2008). Use of path analysis rather than the more common causal steps method of testing mediation (Baron & Kenny, 1986) reduced the potential for Type I error by testing the independent variables simultaneously and provided greater statistical power. This method also allowed for the testing of indirect effects that might occur in the absence of significant direct or total effects; these effects would not be found due to failure at step one of the causal steps method. Because bootstrapping has been found to artificially inflate standard error estimates in sample sizes < 100 , the delta method was used to estimate standard errors of indirect effects (Nevitt & Hancock, 2004). All path coefficients presented are standardized estimates.

Model fit was evaluated using chi-square, Root Mean Square Error of the Approximation (RMSEA), and the Comparative Fit Index (CFI). A non-significant chi-square statistic, RMSEA $.05$ and a CFI > 0.9 were used to indicate acceptable fit of the model to the data. Alpha was set at $.05$.

Results

Descriptive Statistics and Associations

Means and standard deviations for participant characteristics and physiological and psychological outcomes are shown in Table 1. Participants ($N = 97$, 50 female) were in their early twenties, overweight, and reported that they did not play dance simulation games often. A large majority (80%) of participants listed college graduation or some college, 13% graduate work, and 6% a high school diploma. The sample was predominantly white (72%) with 16% Black, 8% Asian, and 4% Other. Hispanic ethnicity was reported by 6% of participants.

Bivariate relationships between the theoretical predictors and two outcomes were explored. Significant correlations were found between energy expenditure and BMI ($r = -.298, p = .003$), engagement ($r = .212, p = .036$), perceived control ($r = .244, p = .016$), and enjoyment ($r = .322, p = .001$). Significant correlations were found between enjoyment and all theoretical predictors: engagement ($r = .629, p < .001$), perceived control ($r = .426, p < .001$), and perceived competence ($r = .513, p < .001$).

Path Analysis

A theory-based model was tested which included direct paths from the theoretical predictors and enjoyment to energy expenditure as well as indirect paths from the predictors to energy expenditure through enjoyment. A path was also included from BMI to energy expenditure. Independent variables were predicted to covary. Correlations between included variables can

be found in Table 2, standardized estimates of direct and indirect effects are displayed in Table 3, and the path model is displayed in Figure 1.

The model was an adequate fit to the data, $\chi^2(1, N = 97) = .199, p = .655$; CFI = 1.00; RMSEA < .001; 90% CI = .000–.206; $p = .692$. No significant direct effect was found of any of the three predictors on energy expenditure (engagement, $\beta = .043, p = .716$; perceived competence, $\beta = -.080, p = .491$; perceived control, $\beta = .108, p = .339$). Enjoyment ($\beta = .318, p = .009$) and BMI ($\beta = -.304, p = .001$) were significant predictors of energy expenditure. Perceived competence ($\beta = .260, p = .004$) and engagement ($\beta = .486, p < .001$) predicted enjoyment, but perceived control did not ($\beta = .087, p = .336$).

Indirect effects from engagement, perceived competence, and perceived control to energy expenditure via enjoyment were calculated. The indirect effect of engagement was significant ($p = .016$). The indirect effect of perceived competence was of borderline significance ($p = .054$), and the indirect effect of perceived control was not significant ($p = .366$). This model explained approximately 22% of the variance in energy expenditure ($R^2 = .216$).

Discussion

Enjoyment and BMI were found to predict energy expenditure during play of an active video game, while engagement and perceived competence predicted enjoyment. An indirect effect of engagement on energy expenditure via enjoyment was found. Perceived control did not predict either enjoyment or energy expenditure in this study, and perceived competence only approached significance.

Overall, these findings are similar to those of past studies, which have found presence/engagement and perceived competence to predict enjoyment of a video game (Przybylski, Ryan, & Rigby, 2009; Ryan, Rigby, & Przybylski, 2006). Here, engagement, specifying the mental immersion aspect of presence, was found to predict enjoyment and to have an indirect effect on energy expenditure. Associations between presence/engagement and enjoyment have been found in several studies (Ijsselstein, de Kort, Westerink, & de Jager, 2006; Skalski et al., 2011), but to our knowledge this is the first investigation of their effects on energy expenditure. Correlations between engagement, perceived competence, perceived control, and enjoyment were significant and substantial (0.4–0.6). There are implications of these relationships for implementation of active gaming. Pre-testing prior to intervention to match games to individuals or groups may improve physical activity results by increasing engagement and enjoyment. Similarly, measurement of these variables may provide valuable information about the success or failure of interventions. There is evidence that some game-based activity interventions failed to produce increases in physical activity due to lack of adherence, possibly caused by boredom or insufficient enjoyment of the games provided (Madsen, Yen, Wlasiuk, Newman, & Lustig, 2007; Radon et al., 2011). Insufficient enjoyment may have led to lower adherence, as has been hypothesized, but it is also possible that insufficient enjoyment produced lower intensity activity than was expected by investigators. In an intervention that successfully increased active gaming, no corresponding increase in physical activity was found (L. E. Graves, Ridgers, Atkinson, &

Stratton, 2010); lower intensity due to lower enjoyment may partially explain these findings. Greater attention to the potential effects of psychological variables in active gaming research will help elucidate the causes of disappointing physical activity results.

Though an objective measurement of competence, i.e., skill level, has been found to predict energy expenditure (Sell et al., 2008), a significant effect of perceived competence on energy expenditure was not found in this study. However, the effect ($p = .054$) suggests that perceived competence should be included in future investigations. Different study designs or samples may find a relationship between the two variables. Objective and subjective competence may have differential effects on psychological as well as physiological responses to active video games. More research on objectively-measured skill, difficulty level, and perceptions of competence is necessary.

Unexpectedly, perceived control predicted neither enjoyment nor energy expenditure. It might be that the effect of control was not strong enough to produce an effect over and above engagement and perceived competence. Control may also have a more complex effect: it has been hypothesized that control may be better conceptualized as a precursor necessary for the satisfaction of psychological needs such as competence (Przybylski et al., 2010). Use of path models for future analyses would allow for exploration of different relationships between game control and other psychological variables. A better understanding of the effects of control on perceptions of competence, feelings of engagement and enjoyment, and energy expended during video game play could lead to more effective active game development and implementation.

Greater feelings of engagement and perceived competence predicted greater enjoyment. Though these results are encouraging, they also present a challenge: how can active games be made more enjoyable and thus, more motivating, in order to take advantage of associated energy expenditure increases? Though Dance Dance Revolution produced energy expenditure greater than several other games we have tested, when compared to other popular music-based games like Guitar Hero and Rock Band it was rated as less enjoyable and engaging (Lyons et al., 2011). Post-hoc analyses found no gender differences in the theoretical predictors or energy expenditure (data not reported), but we have previously found that women reported greater enjoyment of Dance Dance Revolution than men (Lyons et al., 2011). Targeting game types to specific populations may increase activity levels in active gaming interventions due to increased enjoyment. Further study of game and player characteristics associated with greater feelings of engagement and competence may result in active games that produce more intense activity. As enjoyment has also been found to be associated with better physical activity adherence (Rhodes, Fiala, et al., 2009), more enjoyable active games may benefit public health by producing both more intense and more frequent physical activity than less enjoyable games.

These results are preliminary but suggest that spontaneous movements not required by the game may be a fruitful area for future research. Though Dance Dance Revolution requires stepping and jumping movements in order to play, it also encourages other spontaneous, freely-chosen non-required movements like arm movements, bouncing to the beat, and integrating real dance moves into the required steps. It is likely that these movements are

affected by social play (e.g., motioning to friends or exaggerating dance moves for the humor value of those watching) as well as by enjoyment and its predictors. A better understanding of movements encouraged but not required by motion-controlled video games could help create games that motivate (rather than or in addition to requiring) players to be active.

Limitations

This study consisted of play of a single style of game for ten minutes in a laboratory setting; these results should be generalized with caution. Other active games, longer play periods, and/or home-based play may produce different results. Game play behavior in the home may differ substantially from behavior in an artificial, observed environment. Longitudinal studies that test the relationships of engagement, enjoyment, and energy expenditure over extended play periods more similar to real-life use are necessary to extend these preliminary findings.

Though the sample was much larger and included more females than previous active game studies, these results are not necessarily generalizable to other age groups. Other studies have found differences in energy expenditure by age (Lanningham-Foster et al., 2009); it is possible that psychological reactions to games differ by age as well. Future studies with larger samples may wish to investigate the invariance of similar models across age and gender groups.

Participants in this study were not frequent players of dance simulation games like Dance Dance Revolution. It is possible that investigations using a sample of more frequent dance game players would find a different pattern of psychological and physiological responses, especially in longitudinal studies. Additionally, long-term play over time may result in lower enjoyment and energy expenditure estimates as novelty decreases.

Resting energy expenditure rates observed here are lower than is typically expected ($0.76 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$ as compared to the standard assumed constant of $1.0 \text{ kcal} \cdot \text{kg}^{-1} \cdot \text{hr}^{-1}$). Several recent studies have found similar resting rates in adults and have suggested that obesity, fitness, and age contribute to differences in observed resting rates (Byrne, Hills, Hunter, Weinsier, & Schutz, 2005; Kozey, Lyden, Staudenmayer, & Freedson, 2010; Miller et al., 2012). It is possible that recruitment of a leaner, more fit sample would produce higher energy expenditure estimates.

These variables explained approximately 22% of the variance in energy expenditure; thus, though these results were significant, other predictors of energy expenditure exist. It should also be noted that the direction of the relationships in the path model are unclear. It is possible that enjoyment could lead to engagement, or that unmeasured variables may moderate some of the included relationships. Larger studies, in both scope and sample that measure changes over time are needed to further investigate how psychological reactions to video games affect both physiological reactions and one another.

Conclusion

Greater levels of enjoyment and engagement are associated with greater energy expenditure during play of an active video game. The more a player enjoys an active video game, the more energy he or she is likely to expend playing the game. Play of active games that successfully produce these psychological reactions may lead to more intense and frequent physical activity over time. Future active games that include more mentally engaging aspects may be more successful both at maintaining interest over time as well as in encouraging higher intensity activity. Researchers and practitioners should keep the importance of enjoyment and related variables in mind when selecting games for intervention or recommendation.

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Figure 1.
 Path model
 Dotted lines are non-significant paths
 * $p < .05$; ** $p < .01$; *** $p < .001$

Table 1**Participant Characteristics ***

Characteristic	Mean (SD)
Age	23.80 (4.01)
Height (cm)	171.60 (10.10)
Weight (kg)	80.18 (20.89)
BMI (kg/m ²)	27.17 (6.61)
Frequency of dance game play (Range: 1–7)	2.34 (1.72)
Resting energy expenditure (kcal • kg ⁻¹ • hr ⁻¹)	0.76 (0.18)
DDR energy expenditure (kcal • kg ⁻¹ • hr ⁻¹)	2.85 (0.72)
DDR oxygen consumption (VO ₂ , mL • kg ⁻¹ • min ⁻¹)	9.98 (2.52)
Engagement (Range: 1–7)	4.18 (1.41)
Perceived competence (Range: 1–7)	3.77 (1.44)
Perceived control (Range: 7–35)	25.79 (6.00)
Enjoyment (Range: 1–7)	4.73 (1.52)

Cm, centimeter; kg, kilogram; m, meter; kcal, kilocalorie; hr, hour; mL, milliliter; min, minute

* For psychosocial and frequency measures, lower scores indicate less positive responses or lower frequency

Table 2

Correlations for the Six Variables Included in the Path Analysis

	Engagement	Perceived Competence	Perceived Control	Enjoyment	BMI
Perceived Competence	.419***				
Perceived Control	.402***	.554***			
Enjoyment	.629***	.513***	.426***		
BMI	.128	.045	-.086	.079	
Energy Expenditure	.212*	.146	.244*	.322**	-.298**

* $p < .05$

** $p < .01$

*** $p < .001$

Table 3

Standardized Path Coefficients and Indirect Effects

Path	β	SE	95% CI	
Direct effect				
Engagement to enjoyment	.486***	.076	.336	.635
Engagement to EE	.043	.119	-.190	.276
Competence to enjoyment	.260**	.090	.083	.473
Competence to EE	-.080	.117	-.309	.148
Control to enjoyment	.087	.090	-.090	.264
Control to EE	.108	.113	-.113	.330
Enjoyment to EE	.318**	.121	.081	.556
BMI to EE	-.304**	.089	-.477	-.130
Engagement with competence	.419***	.084	.255	.583
Engagement with control	.402***	.085	.235	.568
Competence with control	.554***	.070	.416	.692
Indirect effect (via enjoyment)				
Engagement to EE	.155*	.064	.028	.281
Competence to EE	.083	.043	-.001	.167
Control to EE	.028	.031	-.032	.088

β , standardized path coefficient; SE, standard error; CI, confidence interval; Competence, perceived competence; Control, perceived control; EE, energy expenditure

*
 $p < .05$;

**
 $p < .01$;

 $p < .001$