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Abstract

The purpose of this study was to examine the predictive capability of a habit construct, controlling for intention and perceived behavioural control, with moderate and strenuous intensity physical activity. This approach was expanded through an examination of whether conscious deliberation in the initiation of physical activity would attenuate these findings and a test of the intention-habit interaction. Participants were 337 undergraduate students who completed the habit measure and measures of intention, deliberation and perceived behavioural control phrased in either moderate or vigorous intensities at time 1. This was followed by a measure of behaviour two weeks later. Results using stacked structural equation models (moderate, vigorous intensity) demonstrated the direct effect of habit accounted for significant a significant effect on physical activity after controlling for intention and perceived behavioural control; this effect was invariant to intensity and conscious deliberation. A three-way interaction, however, was identified for the habit x intention relationship and intensity. In the moderate intensity condition, those who report higher habits showed a lower intention-behaviour relationship when compared with those who report modest or low habits. By contrast, those who reported high habit in the vigorous physical activity condition demonstrated a larger intention-behaviour relationship than their modest and low habit counterparts. The results support the notion that some properties of physical activity may have an automatic component and that habits may be important to physical activity action initiation.

Key Words: Theory of Planned Behaviour, Automaticity, Exercise

Most popular social cognition theories postulate that volitional motivation (i.e., intention) or a conscious goal is the defining proximal antecedent of enacted behaviour [1-5]. To this end, models like the theory of planned behaviour [1] and social cognitive theory [2] among others have been applied regularly to understand physical activity. Regular physical activity is associated with numerous health benefits [6], but plagued by low adherence despite general awareness of these benefits [7]. Thus the need to understand the behaviour is paramount in order to create effective interventions.

Research applying these motivational models has proved useful; the intention construct, for example, has a medium-sized relationship with physical activity behaviour [8, 9]. While experimental evidence for this relationship is scant, a recent meta-analysis identified some support for the effect of motivation on behaviour [10]. Still, considerable variance remains in the explanation of physical activity. This has lead researchers to either a) explore the so called intention-behaviour gap through moderators of the intention behaviour relationship or b) to explore additional predictors of behaviour independent of intention/goals [11, 12].

While much of this research has focused on other volitional or motivational variables that could affect behaviour, the premise that some behavioural action may become automatized was postulated in social cognition models decades ago [13]. Triandis [13] suggested that habit, that is goal-directed automaticity [14-17], may provide an independent role in explaining behaviour from intention and interact with the intention-behaviour relationship. The proposal sparked several debates, from philosophical (i.e., free will vs. predetermined action) to methodological (how does one measure habit?) and pragmatic (is the construct even useful for promotion initiatives?); including habit in the physical activity domain has been no less controversial [18]. The basic premise of theorizing behind a habit construct is that practiced behaviours that have become

efficient to perform and are likely highly reinforcing eventually side-step motivation and are performed from external cues to action [15]. The construct is in partial concert with implementation intentions, whereby external cues to action are used to tie intention and behaviour [19]; indeed, implementation intentions have been likened to creating habits via a volitional planning exercise [20].

From a physical activity standpoint, the habit construct has been criticized on similar methodological grounds as those from general social psychology. Most tests of the construct have used a measure of past behaviour as a proxy of habit. Past physical activity is generally the best predictor of future behaviour [8], but behaviour is an omnibus of all reasons for prior behavioural performance; thus past behaviour is not an appropriate measure of habit [21]. Habit indices [22], however, have improved upon this measurement concern. Although the literature is limited in physical activity, these indices have generally shown some discriminant validity from behaviour [23] and supportive findings in an independent or interactive predictive capacity with intention [24, 25]. Continued tests with measures stripped of behavioural frequency seem prudent [26, 27].

Perhaps most poignant is the consideration of how habit fits within our current understanding of physical activity behaviour. As Maddux [18] has suggested, regular physical activity is a potentially aversive physical experience that requires effort, planning/scheduling, and takes considerable time. The behaviour does not have considerable evidence that forgetfulness is responsible for low adherence which would seemingly be a key link with automaticity [20]. Instead, physical activity is plagued by barriers to motivation (time, fatigue, social support) [28]. While these are notable concerns, several advances in the thinking of habit in

complex behavioural enactment suggest that its role may be important in action initiation rather than the performance of the act itself [15]. Thus, automaticity may have a partial role (e.g., acting within a certain time of the day, putting-on exercise apparel, driving to the facility, etc.) in the complex act of physical activity behaviour but it is unlikely to supplant motivation (organizing and maintaining the physical activity schedule and/or equipment, determination in the face of constraints). Verplanken and Melkevik [23], for example, have suggested that habit may reflect efficiency in the form of low deliberation to act. Whether this extends to automatic action without conscious thought rather than simply low volitional deliberation, however, requires examination. Deliberation, on a variance from excessive rumination to low conscious thought, would still represent the motivational domain and not the habit construct. Research is needed to shed light on this theorizing.

The type of physical activity, marked through intensity of the act also seems prudent to our understanding of motivation and habit. While strenuous activities seem ripe for motivational antecedents of behaviour, moderate intensity activities are more affectively pleasing [29, 30], often linked with behaviours other than rote exercise [31], and thus may be automatized with greater ease. Indeed, while strenuous activities would conceivably rely on initiation habits to help translate motivation into behaviour, moderate intensity activities seem more suitable to the seamless translation of cues to behaviour without volitional motivation. The most compelling evidence for habit in physical activity has support through cycling for travel or moderate intensity activities [24, 26, 27]. In these studies, habit moderated the intention-behaviour relationship, whereby those with higher habits demonstrated a smaller relationship compared to those without activity habits. Formal tests of the habit, intention, and physical activity relationship by intensity, however, have not been performed. Such a test is needed to evaluate this conjecture.

Therefore, the purpose of this study was to explore the predictive capability of a habit construct, stripped of any items that measured behavioural frequency or descriptive identity, with moderate and strenuous intensity physical activity. First, the predictive capability of habit, intention, and perceived behavioural control was evaluated by intensity of physical activity. It was hypothesized that habit would have a larger relationship with behaviour for moderate physical activity compared to strenuous activity based on the rationale that lower intensity behaviours would be less influenced by motivational considerations. Both intensities of activity, however, were hypothesized to have a significant effect of habit on behaviour given the proposed role of habit on action initiation behaviours [23].

Second, the predictive capabilities of these constructs were examined while controlling for conscious deliberation in the initiation of physical activity. Based on the theorizing that habit represents automatic nonconscious action initiation, it was hypothesized that the former effects would be unaffected by this conscious deliberation variable.

Finally, the interaction between habit and intention was explored in the prediction of behaviour by moderate and strenuous physical activity behaviour. In this three-way interaction, it was hypothesized that habit and intention would have a negative interaction for moderate intensity activities more than for strenuous activities. That is, commensurate with prior research in moderate intensity activities [24, 27], those with high moderate activity habits would demonstrate a lower intention-behaviour relationship than those with low habits in comparison to the same interaction in strenuous activities.

Method

Participants and Procedure

This data-set has been used previously to examine the effect of physical activity intensity on the theory of planned behaviour [32]. Please see this prior published report for full details on the methods. That study, however, did not include habit or deliberation measures; thus the research questions and key variables proposed in this study are unique to this report. Briefly, participants (N = 386) were recruited through classes at a university on the west coast of Canada during the spring 2008 semester (January to February). A list of all classes at the university was used to randomly select classes, stratified by faculty and course year (i.e., 1-5), using a random number generator. This university had 10 faculties ranging from Fine Arts to Sciences and a population complement of 19,475 students.

Instructors of selected classes were contacted and asked if a research assistant could recruit participants from their class. Of those instructors contacted, 41.2% consented to involvement. With instructor approval, recruitment occurred at the start of class. All students who wished to volunteer for the study were provided with an invitation and a web link to either the moderate or vigorous physical activity questionnaire. These links (moderate, vigorous) were distributed at random, and coded without the intensity key word. Participants completed the survey online at their convenience. The total number of students registered in the classes surveyed was N = 2406 but this is undoubtedly much larger than the exposure numbers because some students would not be attending that particular day (attendance can sometimes be as low as 50%). The institution's human ethic's review board approved the protocol for the study and all participants provided informed consent.

Two weeks after the initial questionnaire, participants were contacted through information provided in the initial questionnaire and were asked to complete a one-page follow-up questionnaire (behavior measure only). Participants completed all items in the online survey.

The sample attrition rate was 13% (final $N = 337$) and no significant differences ($p < .05$) were identified between those who responded to the follow-up and those who did not across demographic, social cognitive, habit, and behaviour variables or intensity condition. Thus, these missing data can be considered missing completely at random and were not used in the analyses.

Instruments

For this examination of regular physical activity by intensity, we deemed it necessary to make frequency and duration equivalent across groups in order to reduce extended confounds. Health Canada [33] recommends at least 30 minutes of activity at least at a moderate intensity on 4 or more days per week. We used this definition in terms of frequency and duration and simply modified the recommended intensity to either vigorous or moderate activities performed during free time. Examples of moderate activities following exemplars from Health Canada and Ainsworth and colleagues [34] included: brisk walking, cycling, casual swimming and dancing; exemplars for vigorous activities included: jogging, running, rowing, jumping rope, tennis, fast bicycling, hockey and basketball. Activities not included in a specific intensity were also listed. For example, participants asked to consider moderate intensity activities were asked not to consider activities like vigorous running, etc. Participants were asked to use these parameters when asked about physical activity-related questions.

For this study, intention was included as the measure of summary motivation commensurate with the theory of planned behaviour [1] and related models [4, 35, 36]. We also included a measure of perceived behavioural control in order to account for behavioural properties that are not entirely under volitional control. This is supported by the theory of planned behaviour [1] and similar to the conceptualization in social cognitive theory [35]. Thus, the

inclusion of this variable supports current models of direct motivational variables on behaviour and represents the most rigorous test for a habit construct.

Perceived Behavioral Control was measured using three items: "In the next two weeks, I have complete personal control over doing regular [moderate/vigorous] intensity physical activity if I wanted to" and "engaging in regular [moderate/vigorous] intensity physical activity is mostly up to me in the next two weeks if I wanted to" were rated from strongly disagree (1) to strongly agree (7). Finally "engaging in regular [moderate/vigorous] intensity physical activity over the next two weeks if I wanted to would be…" was rated from extremely difficult (1) to extremely easy (7). These items were constructed to adhere to the suggestions of Ajzen [37] and have been validated by Rhodes and Courneya [38, 39]. Internal consistency for the measure was acceptable (moderate intensity $\alpha = .78$; vigorous intensity $\alpha = .82$).

Intention was assessed by three items from Rhodes, Blanchard, Matheson and Coble [40] that have demonstrated validity in measuring the motivational domain of physical activity: "I intend to engage in regular [moderate/vigorous] intensity physical activity __ times per week over the next two weeks", I am motivated to engage in regular [moderate/vigorous] intensity physical activity over the next two weeks" rated from extremely unmotivated (1) to extremely motivated (7), and "I am determined to engage in regular [moderate/vigorous] intensity physical activity over the next two weeks" rated from extremely undetermined (1) to extremely determined (7). Internal consistency was acceptable (moderate intensity $\alpha = .86$; vigorous intensity $\alpha = .86$).

Habit was assessed with five items from the measure developed by Verplanken and Orbell [22] and adapted to physical activity by Chatzisarantis and Hagger [25]. The original measure contains 12 items that span assessments of uncontrollability, lack of awareness, and efficiency as

recommended by Bargh [41]. For our measure, however, we only retained specific items that pertained to efficiency and lack of awareness in order to reduce pre-acknowledged potential confounds [15, 21, 25]. Specifically, the items that were direct assessments of past behaviour were removed because past behavioural frequency may be a more omnibus antecedent to automaticity and not an appropriate measure onto itself [15, 21]. Further, it may artificially inflate associations between habit and PA. Similarly, items that assess uncontrollability were removed because they reflect exercise dependence [42], which is conceived as an addictive behavioural quality and not the intended measurement domain of automatic habits [15]. Thus, physical activity (moderate/vigorous) was defined again in a lead-in to the response stems and the five items included in the measure were: "I do automatically (e.g., without intending to do it)," "I do without having to consciously remember," "I do without consciously thinking about it," "I start doing before I realize I'm doing it," and "I have no need to think about doing." These items were scored on a 4-point scale (1 = never; 2 = infrequently; 3 = most of the time; 4 = always) and the reliability was excellent (moderate intensity = α = .91; vigorous intensity = α = .92).

Deliberation was measured using five items created for this study. These items were designed to assess the variance in rumination and speed of conscious decision making for enactment of physical activity. Thus, physical activity (moderate/vigorous) was defined again in a lead-in "as something": "I make excuses for myself to bail on doing," "I hesitate in my decisions to start," "I never need to talk myself into," "I seize the moment and just get it done," and "I am always ready to jump at doing it." These items were scored on a 4-point scale (1 = never; 2 = infrequently; 3 = most of the time; 4 = always) and the reliability was acceptable (moderate intensity = α = .83; vigorous intensity = α = .79).

Physical activity behaviour was assessed with a two-week follow-up using the Godin Leisure-Time Exercise Questionnaire (GLTEQ) [43]. The GLTEQ contains three open-ended questions regarding the frequency of mild (e.g., easy walking), moderate (e.g. fast walking) and vigorous (e.g. jogging) PA. The duration was adapted from 15 min to greater to or equal to 30 minutes per session based on current public health guidelines and the framing of the study. The results of the vigorous intensity question were used for the vigorous condition and the results of the moderate intensity question were used for the moderate intensity condition.

Analysis

Bivariate correlations and descriptives of all constructs were calculated. The main research questions were examined using a two-group (moderate, vigorous intensity) stacked path analysis approach in structural equation modeling with LISREL [44]. This approach is an advantage of structural equation modelling as it allows for the examination of model invariance between the two groups [45]. Specifically, model A tested the independent effect of habit on physical activity behaviour while controlling for perceived behavioural control and intention. Model B was extended to include the deliberation variable. Finally, model C included the habit x intention interaction term. Model C mimics the approach of testing for interactions in ordinary least squares regression [46]; the addition of the two-group structural equation model, however, provides an examination of the three (intensity x habit x intention) way interaction.

Correlations among the exogenous constructs (e.g., intention, habit, perceived behavioural control) were freed to correlate and the measurement model was fixed to 0 error for each construct which is commensurate with ordinary least squares multiple regression. This approach has precedent [32, 47] and was used to improve testing power for the model (i.e., reduce

multiple freed measurement parameters) and was deemed acceptable given the very similar internal consistencies of the TPB measures by condition (i.e., < .05 difference in α).

The base models represent saturated fit (i.e., perfect fit parameters), but nested models, whereby a path coefficient was freed across the two conditions and subsequently compared in fit to a model constrained to be equal, were used to test the invariance of the two intensity-based models. Comparisons of the invariance of the specific structural paths were tested using the $\Delta \chi^2$ difference test and Δ CFI as recommended by Cheung and Rensvold [48]. Model 3 featured mean centered variables to reduce collinearity with the product term and interaction effects were subsequently plotted using simple slopes analyses [46].

Results

A total sample of $n = 158$ for the moderate condition and $n = 179$ for the vigorous condition was used in the analyses. The mean age of participants was 21.98 years ($SD = 5.47$); 63.7% were female and 36.3% were male, and the mean year of studies was 2.78. These descriptives generalize almost perfectly to the University populace (Tony Eder, e-mail communication, June 11, 2008), suggesting basic representation. Further, no differences in these descriptors were identified by condition ($p > .05$).

Table 1 features the descriptive statistics and correlations among the variables of interest. Perceived behavioural control, intention, deliberation and habit were all correlated with physical activity for both moderate and vigorous intensity conditions ($p < .01$). Intercorrelations among these variables of interest were also present though they ranged from small effect size associations (e.g., perceived behavioural control and habit) to large associations (e.g., intention and deliberation). All variables were normally distributed.

Path coefficients are detailed in Figure 1 models A through C. In model A, intention (standardized effect = .36 moderate intensity; .42 vigorous intensity) and habit (standardized effect = .29 moderate intensity; .32 vigorous intensity) were significant predictors of physical activity explaining 32% (adjusted R^2 = .31) and 45% (adjusted R^2 = .44) of the variance for moderate and vigorous intensity behaviours respectively. Perceived behavioural control did not contribute to the regression equation in either model. Systematic evaluation of each freed coefficient compared to constrained (to be equal) models showed no significant differences ($\Delta \chi^2$ $p > .05$; Δ CFI = 0.00) between the moderate and vigorous intensity conditions.

Model B, with the inclusion of the deliberation construct, did not alter the results of model A. Deliberation did not add significantly to the prediction equation and did not attenuate the results of habit on physical activity for either intensity condition.

Finally, model C showed that the habit x intention interaction terms in both models were significant ($p < .05$) additional predictors of physical activity, explaining an additional 3% and 4% variance to the base model A. Furthermore, evaluation of this interaction coefficient compared to constrained (to be equal) models showed a significant difference ($\Delta \chi^2$ (1) = 17.84; $p < .01$; Δ CFI = .04) between the moderate and vigorous intensity conditions[A]. Follow-up simple slopes analyses are presented in Figure 2 for the moderate intensity condition and Figure 3 for the vigorous intensity condition. Of interest, in the moderate intensity condition, those who report higher habits show a lower intention-behaviour relationship when compared with those who report modest or low habits. By contrast, those who reported high habit in the vigorous physical activity condition demonstrated a larger intention-behaviour relationship than their modest and low habit counterparts.

Comment

The purpose of this study was to explore the predictive capability of a habit construct, stripped of any items that measured behavioural frequency or descriptive identity and controlling for intention and perceived behavioural control, with moderate and strenuous intensity physical activity. This approach was expanded through an examination of whether conscious deliberation in the initiation of physical activity would attenuate these findings and a test of the intention-habit interaction. The results proved interesting and help characterize the role that habit may play in the physical activity domain.

First, it was hypothesized that habit may predict behaviour independent of intention and perceived behavioural control based on the theorizing of Triandis and others [13, 15, 23] that some components of physical activity behaviour are automatic. This had support in both samples. Specifically, habit had a medium-sized independent relationship with physical activity comparable to intention. Contrary to our tentative hypothesis, the direct effect of habit on physical activity was invariant to intensity. Verplanken and Melkevik [23] have argued that habit's primary role in physical activity resides in the initiation of the act and not in its performance. That is, the preparation for physical activity may be so routine that it requires less thought. This argumentation could support why the main effect of habit on physical activity was invariant to the intensity of the act; presumably, activities regardless of intensity may require preparatory actions and these actions are not related to the engagement itself.

By contrast, our results did show a marked difference between the intention-habit interaction and this extended to a three way interaction with physical activity intensity. The interaction between habit and intention has been relatively well-established in social psychology research [15] and has seen similar support with physical activity [24, 25, 27]. The argument put forward has been that habitual behaviours rely less on intentional acts and thus the intention-behaviour

relationship is diminished under conditions of high habit. We hypothesized that moderate intensity activities should see this relationship more than vigorous activities given the demands placed of vigorous acts. As Maddux [18] has pointed out, exercise, presumably vigorous exercise, requires hard work and represents a potentially aversive physical stimulus. It seems unlikely that this act could be transferred to automatic processes. Moderate activity, however, may include activities more physically benign; this has support from studies of core affect where activities above the ventilator threshold are less pleasurable than activities below this threshold [30].

The results of this study supported this hypothesis. The interaction of habit and intention was significant for both intensity conditions but the two conditions were also significantly different from one another. Specifically, moderate intensity activity showed the hypothesized diminished relationship between intention and behaviour under high habit conditions more than moderate or low habit. In contrast, vigorous activity showed a larger relationship between intention and behaviour under high habit conditions compared to low. We believe the findings in this condition may represent the importance of habit to action control in vigorous activity [49, 50]; that is, those who have habituated physical activity initiation are more likely to realize their good intentions but the behaviour remains intentional as Maddux had surmised [18]. Still, this finding requires replication and has seen contrary findings in the physical activity domain [25].

The characterization of the habit construct remains contentious mainly because it could represent residual past behaviour rather than automatic action initiation [21]. Previous work in the physical activity domain has demonstrated that a habit index is different from simple measures of past behaviour [23]. Our attempt to eliminate any behavioural frequency or descriptive identity items from the habit measure further reduces this concern. One remaining issue, however, was whether the habit construct simply acts as a proxy measure for the speed of deliberation in the

act. Conscious deliberation of the act is arguably a function of motivation and not the automaticity sought in measures of the habit construct [15]. The results of our study suggested that habit is not confounded with conscious deliberation in its relationship with behaviour. Specifically, deliberation did not attenuate the relationship between habit and physical activity. This provides further evidence for the potential automatic effects of physical activity and the veracity of a habit index.

Given the support for the habit construct in these data, the practical application of the findings need consideration. Verplanken, Aarts and colleagues [15, 16, 23] suggest that environmental aspects should play a key role. Habits are conceived as behavioural responses brought on by environmental cues. Having a highly salient environment for physical activity (a specific work-out room/place, a specific piece of equipment, apparel etc.) may be important for habit formation. Habits are also conceptualized as occurring from behaviours with strong reinforcing properties and ease of access [15]. We also theorize that routine (same time, same place, etc.) and protected time may be essential for habit formation. Specifically, these would seem helpful to ease the cognitive burden of constant scheduling/re-scheduling and overcoming related physical activity barriers.

In terms of habits by intensity, it may be that moderate intensity activities can minimize cognitive control of the act through presumably their lower physiological effort. It may also be that moderate intensity activities are incidental to the behaviour because they are performed for reasons other than health and fitness [31]. Active transport, for example, serves a different role from rote exercise and may be easier to create habit structures. By contrast, creating habits for strenuous activities may be to instil efficiency of intentional action control but not for the transfer to behaviour below cognitive awareness. More research is needed to test this theorising.

Despite the useful extensions to this limited literature, there are some limitations to the work that need consideration. First, the measure of behaviour was obtained through self-report. Self-reported physical activity may contain considerable measurement error from recall bias [51]. This error, however, may not impact the overall findings of this study unless it affects intention, intensity or habit differently. Second, the measure of motivation (intention) used in this study may not represent the spectrum of volitional physical activity motivation and thus different measures could yield other results. These measures employed, however, represent the standard for the theory of planned behaviour at this present time. Third, we examined intensities of PA in independent samples and further research could examine both intensities in the same questionnaire. Finally, the college sample of undergraduate students in this study may not generalize to the population at large and replication of these findings would be prudent.

In summary, the direct effect of habit accounted for significant variance in physical activity after controlling for intention and perceived behavioural control; this effect was invariant to intensity and conscious deliberation. A three-way interaction, however, was identified for the habit x intention relationship and intensity. In the moderate intensity condition, those who report higher habits showed a lower intention-behaviour relationship when compared with those who report modest or low habits. By contrast, those who reported high habit in the vigorous physical activity condition demonstrated a larger intention-behaviour relationship than their modest and low habit counterparts. The results support the notion that some properties of physical activity may have an automatic component and that habits may be important to physical activity action initiation.

Footnote A. To examine the sensitivity of our fixed error structural equation model, we also estimated all paths with latent variable procedures. The structural coefficients and interaction

effect were similar in magnitude and all results were identical in terms of statistical significance findings.

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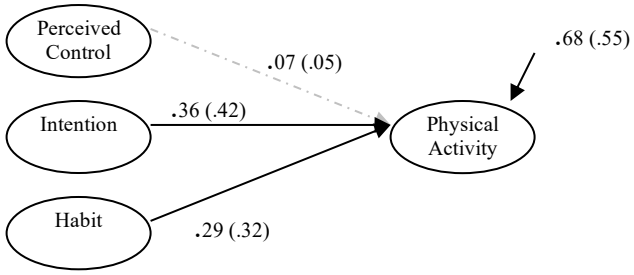
Table 1.

Descriptives and Correlations for Habit, Deliberation, Intention, Perceived Behavioural Control and Physical Activity

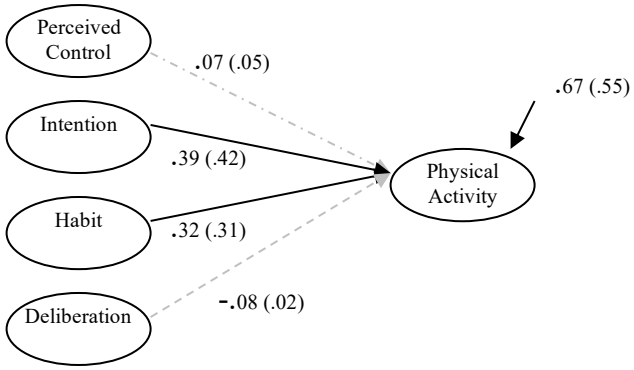
	2	3	4	5	Mean	SD
1. Perceived Control	.39**(.52**)	.27**(.36**)	.12* (.23**)	.25**(.34**)	5.74(5.26)	1.12(1.49)
2. Intention		.62**(.64**)	.40**(.53**)	.48**(.62**)	5.03(4.80)	1.46(1.56)
3. Deliberation			.53**(.59**)	.39**(.48**)	2.66(2.56)	0.54(.55)
4. Habit				.36**(.55**)	2.30(2.08)	0.69(.78)
5. Physical Activity					2.75(2.63)	2.24(2.29)

Note: ** $p < 0.01$, * $p < 0.05$, two-tailed. Moderate intensity is reported outside parentheses. Vigorous intensity is reported inside parentheses.

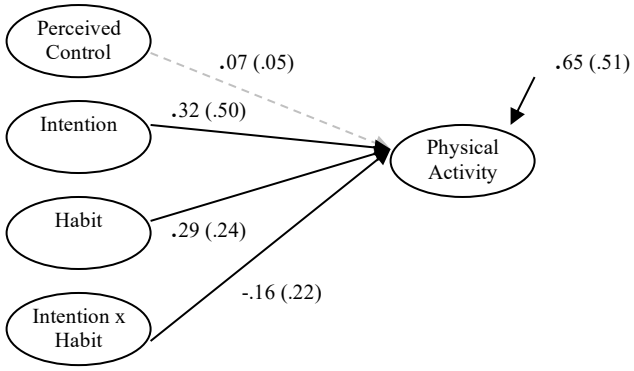
A)

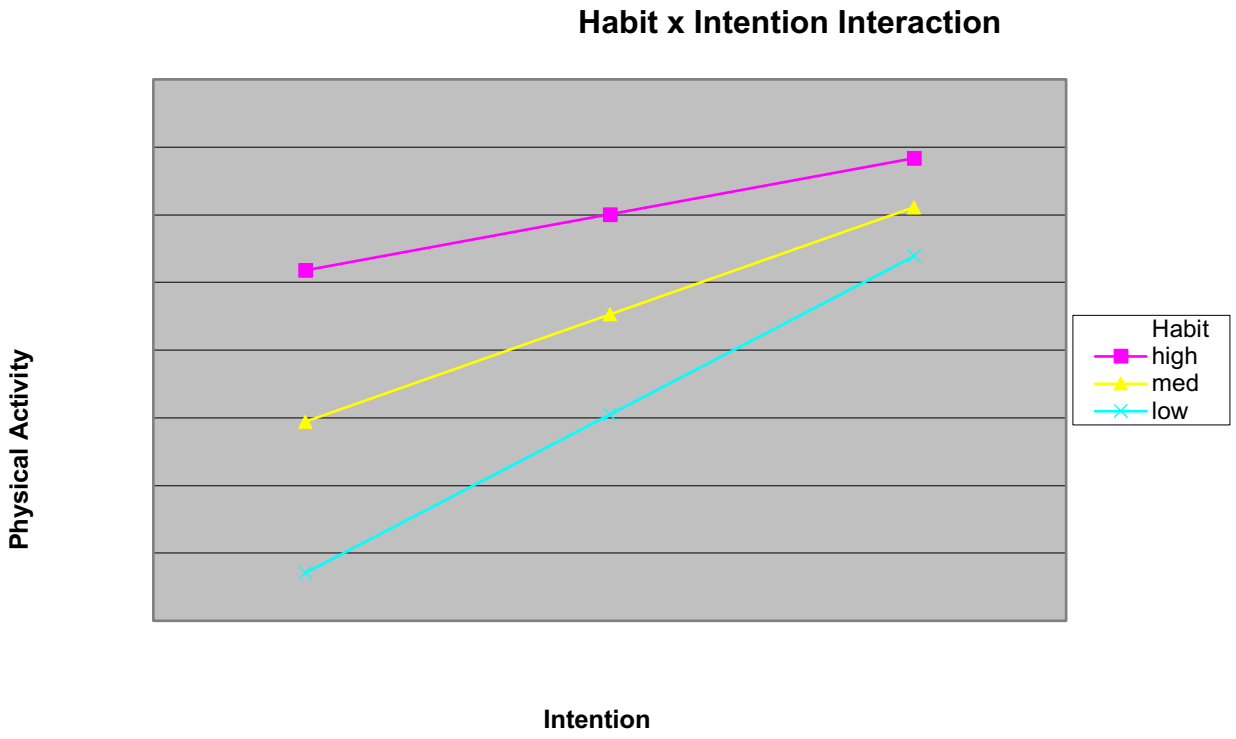

Perceived Control
Intention
Habit
Physical Activity
.07 (.05)
.36 (.42)
.29 (.32)
.68 (.55)

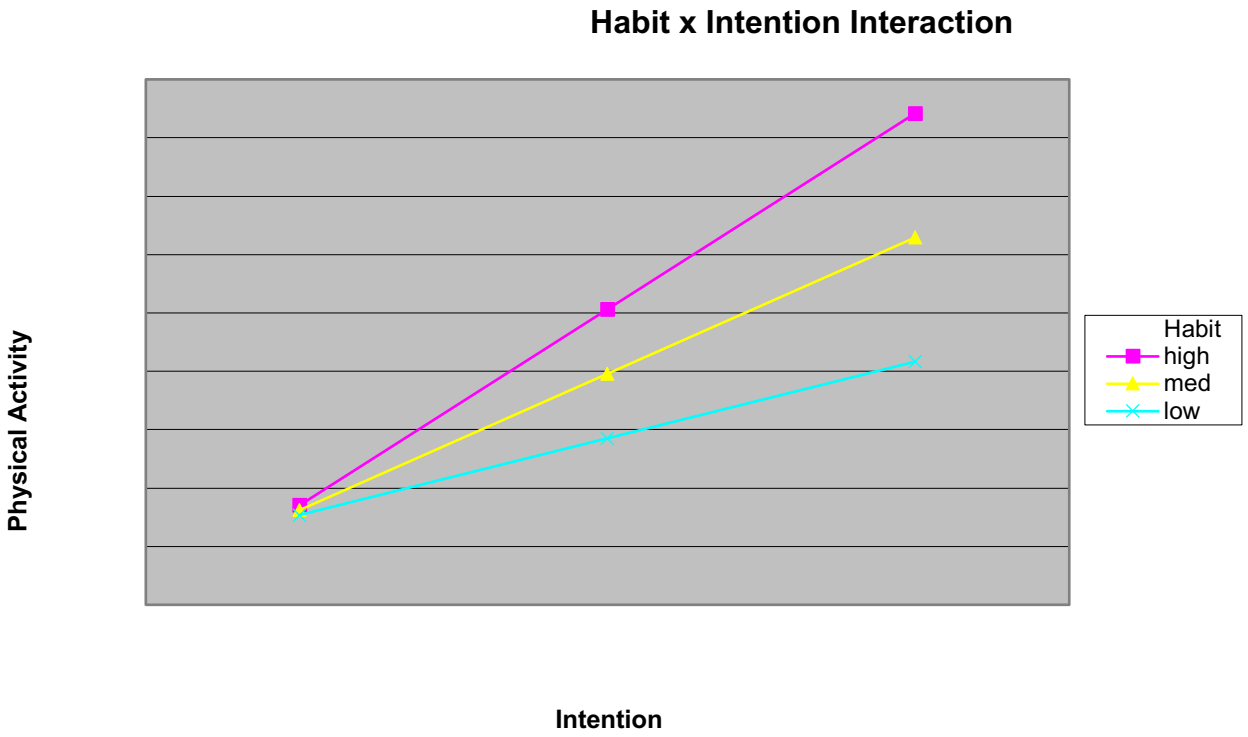
B)


Perceived Control
Intention
Habit
Deliberation
Physical Activity
.07 (.05)
.39 (.42)
.32 (.31)
-.08 (.02)
.67 (.55)

C)


Perceived Control
Intention
Habit
Intention x Habit
Physical Activity
.07 (.05)
.32 (.50)
.29 (.24)
-.16 (.22)
.65 (.51)


Habit x Intention Interaction
Physical Activity
Intention
Habit
high
med
low


Habit x Intention Interaction
Physical Activity
Intention
Habit
high
med
low