Can current physical activity act as a reasonable proxy measure of future physical activity? Evaluating cross-sectional and passive prospective designs with the use of social cognition models

Rhodes, R. E., & Plotnikoff, R. C.

2005

Running Head: CROSS-SECTIONAL DESIGNS & PHYSICAL ACTIVITY

Can Current Physical Activity act as a Reasonable Proxy Measure of Future Physical Activity? Evaluating Cross-Sectional and Passive Prospective Designs with the use of Social Cognition Models

Ryan E. Rhodes, PhD,[a,*] and Ronald C. Plotnikoff, PhD[b]

[a]School of Physical Education, University of Victoria, Victoria, British Columbia, Canada

[b]Centre for Health Promotion Studies, Alberta Centre for Active Living & Faculty of Physical Education, University of Alberta, Edmonton, Alberta, Canada

June, 2003

[*]Corresponding author. School of Physical Education, PO Box 3015 STN CSC, University of Victoria, Victoria BC, V8W 3P1, CANADA, Tel: (250) 721-8384, Fax: (250) 721-6601, E-mail address: rhodes@uvic.ca

Abstract

Background: The standard methodological approach for evaluating social cognitive theories when predicting physical activity behavior is the passive prospective/longitudinal survey design. Although this design is logical, a cross-sectional design may be a cost-effective alternative if the relationships between social cognitive constructs and physical activity are relatively stable. The purpose of this study was to evaluate the utility of a concurrent measure of physical activity used in a cross-sectional design in comparison to the standard prospective measure.

Methods: This study included two six-month prediction time-periods, between 1997 and 1998, for the purpose of analysis replication, and the theory of planned behavior, the transtheoretical model, protection motivation theory, and social cognitive theory as the models of interest in a population sample (N=703).

Results: Results showed trivial (69% of tests; $q < .10$) to small (31% of tests; $q = .11$-$.18$) differences in the correlations between social cognitive constructs and vigorous physical activity occur when using a cross-sectional or prospective design. The cross-sectional design estimated slightly larger coefficients than the prospective design.

Conclusions: It appears that a measure of concurrent physical activity included in a cross-sectional design can act as a reasonable proxy measure of future behavior measured in a passive prospective/longitudinal design. These findings support the use of cross-sectional designs when researchers seek a standard correlational investigation of physical activity and social cognitive constructs with the possibility that coefficients may be slightly biased upwards.

Key words: Theory of planned behavior, social cognitive theory, protection motivation theory, transtheoretical model

Introduction

Engaging in regular physical activity has well-documented benefits, but less than optimal participation rates [1]. It is widely accepted that regular physical activity is associated with a significant decline in all-cause mortality [2] and the prevention of numerous other disease states, such as cancer [3], type 2 diabetes mellitus [4], and cardiovascular disease [5]. Nevertheless, recent statistics indicate that a majority of individuals in many developed countries are insufficiently active to obtain these health benefits [1,6]. Therefore, the need to understand exercise behavior and implement effective intervention strategies is paramount.

Social cognitive theories are popular frameworks for understanding physical activity and exercise behavior. Examples of these theories include the theory of planned behavior (TPB) [7], the transtheoretical model of behavior change (TTM) [8], social cognitive theory (SCT) [9], and protection motivation theory (PMT) [10]. These theories often include similar constructs, the same constructs, or constructs that overlap in their measurement domains [9,11]. Thus, unsurprisingly, these social cognitive frameworks all explain approximately the same amount of variability in physical activity, which is approximately 30% explained variance [12-14].

Briefly, the TPB [7] suggests the proximal determinant of volitional behavior is one's intention to engage in that behavior. Intention is the summary motivation to engage or not engage in a behavior. Attitudes and subjective norms are theorized to exert their effects upon behavior through intention. Attitudes are the overall evaluations of performing the behavior by the individual. Subjective norms assess the social pressures on the individual to perform or not to perform a behavior. Further, the TPB tries to also predict behaviors that are not completely volitional by incorporating perceptions of control over performance of the behavior as an

additional predictor of intention and behavior. Perceived behavioral control (PBC) is the individual's perception of ability to perform a behavior while holding motivation constant.

The TTM [8] posits that people progress through stages of readiness when making a lifestyle physical activity change. Five main constructs influence physical activity readiness: pros, cons, behavioral processes of change, cognitive processes of change, and self-efficacy. Self-efficacy [9] is the perception of capability to execute and enact physical activity behavior. Pros and cons are the positive and negative aspects of the outcomes derived from engaging in physical activity. Finally, the processes of change are the covert and overt activities that people use to progress through the stages of readiness and are considered either cognitive/experiential or behavioral. The five experiential processes are consciousness raising (gathering information), self-reevaluation (reconsidering the consequences of the behavior on oneself), dramatic relief (experiencing affect), environmental reevaluation (reconsidering the consequences of the behavior on others), and social liberation (attending to social norms). The five behavioral processes are counter conditioning (substituting new behaviors for old ones), stimulus control (controlling environmental cues), reinforcement management (rewards), helping relationships (social support), and self-liberation (committing to change).

PMT [10] explains the cognitive mediation process of behavioral change in terms of threat and coping appraisal. The threat appraisal consists of: (1) the individual's estimate of the severity of the health issue/disease (perceived severity); and (2) his or her estimate of the chance of contracting ill health/disease (perceived vulnerability). The model's coping appraisal consists of: (1) the individual's expectancy that carrying out recommendations can remove the threat (response efficacy); and (2) belief in one's capability to execute the recommended course of action successfully (self-efficacy). The strength of protection motivation is estimated through

measuring intentions to adopt the recommended behavior, with behavior as the expected outcome of strong intentions.

SCT [9] comprises a broad range of constructs which in part include self-efficacy, outcome expectations (conceptually similar to pros and cons), and environmental factors. The social environment may include one's family, friends and community; the physical environment typically includes characteristics of the natural environment (e.g., weather) and constructed environment (e.g., facilities). These SCT constructs have been widely applied in the physical activity domain [15].

The most common methodological approach for evaluating social cognitive theories when predicting physical activity behavior is the passive (i.e., non-interventional) prospective/longitudinal survey design (PD). Specifically, social cognitive constructs are measured at baseline, and behavior is predicted at a second measurement period. This temporal spacing is a standard assumption in prediction, and a necessary feature for causality [16]. Furthermore, the methodological artifact of consistency effects between behavior and social cognitive constructs may occur during a cross-sectional design (CD; i.e., one-shot survey). That is, because the participant is answering both behavior and social cognitive measures at the same sitting, the ease of maintaining consistency between measures may bias correlations upwards.

Finally, the use of time-frame compatibility between social cognitive measures and the future behavior measure is considered an essential methodological tenet of attitude-behavior models like the TPB [7]and its predecessor, the theory of Reasoned Action [17] . For example, Ajzen and Fishbein [17,18] stipulate the best methodology to examine a relationship between an attitude and a behavior is to ensure the prospective context, action, target, and time-frame are matched between measurement of attitude and behavior. These assumptions are considered

essential for use of the TRA and TPB, but have not been regularly adopted for SCT, TTM and PMT [19].

Although the use of PDs and time-frame compatibility between social cognitive measures and physical activity behavior make logical sense, tests of these methodologies are scarce. Indeed, the only studies that have focused on support of time-frame compatibility of social cognitive constructs were for oral contraceptive behavior [20] and blood donation [21]. No examinations of the PD in comparison to the cross-sectional survey design (CD) have been reported in the physical activity domain. Thus, exploration of whether a concurrent measure of physical activity behavior included in a CD may act as a reasonable proxy measure of a future physical activity measure included in a PD is needed.

The main rationale for examining the utility of concurrent physical activity as a proxy measure for future physical activity is the cost-benefit of CDs in comparison to PDs. If the findings from PDs are no different from CDs, then physical activity surveys need not be as costly. First, the additional supplies (e.g., paper, stamps, long-distance phone calls) and human resources (i.e., time, wages, participant burden) required for PDs are considerable in comparison to CDs. Second, participant dropout between time periods of PD surveys often exceeds 30% [22]. For researchers to achieve the appropriate power, this often means over-sampling to account for this dropout. The additional cost to account for the PD may be unnecessary if the effects in PDs are not different from CDs. Finally, PDs almost always suffer from missing data issues as a result of attrition across measurement times resulting in the limitation of reduced sample generalizability. These issues could also be minimized by the employment of CDs.

Theory and previous research has provided some evidence that a concurrent measure of physical activity behavior included in a CD may act as a reasonable proxy measure of future

physical activity. First, some evidence supports the notion that, in the absence of an intervention, the relationship between social cognition on behavior (or vice versa) is in relative stasis. That is, in relatively stable systems of individuals and their environments, the same social cognitions may be acting upon physical activity, which in turn provide the same behavioral experiences that feedback to their social cognitions. Analysis of change results using social cognition theories often show trivial to small differences predicting exercise behavior change across time in the absence of an intervention [14,23-25]. This suggests that although some intra-individual differences are likely present across time, social cognition and physical activity behavior are in relative stasis.

Second, intra-individual differences in behavior across time may not relate to social cognition. In support of this conjecture, Baranowski, Anderson, and Carmack [12] have demonstrated that behavioral changes are often not even related to social cognitive constructs measured prior to behavior. Baranowski et al. [12] found that most of the variance in behavior changes could not be accounted for by changes (i.e., mediation) in social cognitive variables. Indeed, the reason for the behavior changes is largely unknown. Thus, even if some behavioral changes are occurring, the relationship between social cognition and behavior may still be in relative stasis.

Finally, the physical activity literature supports the general invariance of physical activity behavior patterns. The exercise psychology and behavioral medicine research literature demonstrates the difficulty in changing physical activity patterns even when implementing our best intervention strategies [12,26]. Thus, physical activity patterns are relatively stable. Indeed, past exercise/physical activity behavior is frequently cited as the best predictor of future behavior, almost always out-predicting the constructs found in social cognition models

[14,25,27]. Therefore, it seems reasonable to conclude that a concurrent measure of physical activity behavior included in a CD may act as a reasonable proxy measure of future physical activity.

Research has identified that shorter time-frames between social cognition and behavior predict behavior better than longer time frames [28]. This research counters the notion that social cognition and behavior relations are in relative stasis, because time-frame moderates the relationship. Regardless, as pointed out by Ajzen [29] for general social psychology, specific actions are not of interest; regularities and consistent patterns of action are of interest. This is particularly true of the physical activity domain, as *continued* regular participation in physical activity is required for health outcomes [1,30]. Thus, understanding *patterns* of physical activity behavior should be a goal when using social cognition models.

The aim of this study was to investigate the relative stasis of social cognition and physical activity behavior relations for the purpose of evaluating the utility of a concurrent measure of physical activity rather than a prospective measure. Consistency effects from CDs may bias social cognitive constructs and behavior correlations upwards when compared to PDs. Nevertheless, it is theorized that physical activity behavior and physical activity social cognition relations are in relative stasis, and thus a measure of concurrent physical activity behaviour would act as an acceptable proxy measure of future behavior. Specifically, it is hypothesized 1) that physical activity patterns would not differ across three**,** six-month physical activity assessments, 2) social cognitive constructs used to predict physical activity would not differ across two six-month assessments, and 3) social cognitive constructs would be invariant in their relationships with physical activity across concurrent (i.e. physical activity over the past six months), and prospective (i.e., physical activity over the past six months measured six months

prospectively) measurement. For these analyses, included were two**,** six-month prediction time-periods (i.e., 3 time-points) for the purpose of replication, and constructs from the TPB, TTM, PMT, and SCT as the social cognition models of interest.

Method

Participants and Procedures

This data set has been utilized for a previous analysis of stage transitions in the TTM [31], and TPB [32] and a detailed description of participants and procedures can be found in these published papers. Briefly, participants were a representative sample of 1602 adults (age18-65 years) from the Ottawa-Carleton region of Ontario, Canada. A telephone randomization protocol produced 4,122 eligible households with 2520 refusals. This resulted in 1602 time 1 (March 1997) participants. The 1602 participants were contacted again by telephone at time 2 (September 1997) and through a mail-based physical activity behavior follow-up survey at time 3 (March 1998). The attrition at times 2 and 3 resulted in 703 individuals (43.4% of the original sample) completing all three survey periods. Ethical approval was obtained from the University of Ottawa review board before commencing the study.

Demographics for the sample (N = 703) were as follows: mean age was 40.6 years (SD = 11.04), 54% were female, 60% were working full-time, 11% were working part-time, 8 % were retired, 4% were students, 63% were married/common law, and 44% of the sample had completed university. In terms of health behavior indicators, 14% were regular drinkers of alcohol (>3 times per week over the past year), 21% were moderately regular drinkers of alcohol (2 to 3 times per week over the past year), and 21% of the sample were smokers.

Instruments

All questions were related to regular vigorous physical activity, which was defined for participants as "strenuous activities which usually make you sweat, breathe harder, and feel your heart beat." Examples of vigorous physical activities were provided and the term "regular" was defined as "at least three times per week for at least 20 minutes each time." Participants were instructed to answer all questions based on this definition of regular vigorous physical activity.

Intention was measured using the following item: "on a scale of 0% to 100%, how likely is it that you will get regular vigourous physical activity within the next 6 months?" The item was scored in 10% intervals from 0% to 100% and has been employed in similar studies [32,38].

Attitude was assessed with four items each using the phrase "It would be …….for me to do physical activity over the next 6 months". The adjectives used in the four items were *demanding*, *gratifying*, *boring* (reversed scored), and *fun*. Five-point scales from 1 (not at all) through 5 (very much) were used for assessment. Reliability for the time 1 (α = .62) measure and the time 2 (α = .65) measure was borderline [32,38].

Subjective Norm was measured using the following two items: 1) "my family thinks I should participate in physical activity," and 2) "my doctor or health care provider thinks that I should participate in physical activity." These items were scored using five-point scales from 1 (strongly disagree) to 5 (strongly agree). Reliability for the time 1 (α = .57) measure and the time 2 (α = .67) measure was borderline [32,38].

Perceived Behavioral Control was measured using the following two items: 1) "How much control do you have over whether or not you engage in regular physical activity?" and 2) "How much control do you have over the amount of time you have for physical activity?" These items were scored using five-point scales from 1 (absolutely no control) to 5 (complete control).

Reliability for the time 1 (α = .66) measure and the time 2 (α = .69) measure was borderline acceptable [32,38].

Pros and Cons of physical activity were the initial measures developed by Marcus, Selby, Niaura, and Rossi [33] and extensively validated in the Canadian population [34]. Items used to measure pros were: 1) physical activity would help me reduce tension or stress; 2) I would feel more confident about my health by getting physical activity; 3) Getting physical activity would help me sleep better; 4) Physical activity would help me have a more positive outlook; and 5) Physical activity would help me control my weight. Items used to measure cons were: 1) I am too tired to get physical activity because of my other daily responsibilities; 2) physical activity would take too much of my time; 3) I would have less time for my family and friends if I participated in physical activity; 4) I'd worry about looking awkward if others saw me being physically active; and 5) Getting more physical activity would cost too much money. All items were scaled using 5-point Likert-type scales from 1 (not at all) to 5 (very much). Internal consistency for the scales was adequate (pros time 1 α = .77, time 2 α = .83; cons time 1 α = .69, time 2 α = .69) [34].

Behavioral and Cognitive Processes of change measures [31] (based on Marcus et al. [33]) included 10 items used to measure the cognitive processes and 11 items used to assess the behavioral processes. Internal consistency for the 5-point scales was adequate (behavioral processes time 1 α = .85, time 2 α = .85; cognitive processes time 1 α = .79, time 2 α = .80) [31].

Self-efficacy was assessed with an 8-item measure [34], based on Marcus and colleagues' existing exercise self-efficacy scale [33], with five point rating scales ranging from 1 (not at all confident) to 5 (extremely confident). The items measured perceived confidence for

doing regular vigorous physical activity when one: is tired, in a bad mood, has to do it by one's self, finds it boring, can't notice any improvements in fitness, has other demands on one's time, feels stiff or sore, and perceives the weather to be poor. Internal consistency was high (time 1 α = .87, time 2 α = .89) [31].

Perceived Severity was measured by the item "for me, being physically inactive would be a very bad thing," and rated on a five-point scale from 1 (strongly disagree) to 5 (strongly agree).

Perceived Vulnerability was measured by the item "if I don't get enough physical activity, I would be at risk for serious health problems," and rated on a five-point scale from 1 (strongly disagree) to 5 (strongly agree).

Response Efficacy was measured using the following three items: 1) "for me, physical activity will keep me healthy," 2) "for me, physical activity will help me get physically fit," and 3) "for me, physical activity will reduce my chances of getting serious health problems." These items were rated using a five-point scale from 1 (strongly disagree) to 5 (strongly agree). Internal consistency for the three-item scale was acceptable (time 1 α = .78, time 2 α = .84). The measures of severity, vulnerability and response efficacy have been validated and employed in population-based studies [35,36].

Physical Environment was measured by the item "I have easy access to places where I can get physical activity," and rated on a five-point scale from 1 (strongly disagree) to 5 (strongly agree). This item has been supported in previous research by Sallis, Hovell, Hofstetter and Barrington [37].

Social Support was measured by the item "How much support do you receive for participating in regular physical activity from the people closest to you," and rated on a five-

point scale from 1 (not at all) to 5 (very much). This measure was based on Sallis et al. [37] and modified by Courneya, Plotnikoff, Hotz and Birkett [32,38].

Vigorous Physical Activity. A measure of vigorous physical activity frequency was calculated based on a stages of exercise change strategy developed by Reed, Velicer, Prochaska, Rossi and Marcus [39]. Those in precontemplation (not currently exercising and not intending to start in the next 6 months) and contemplation (not currently exercising, but intending to start in the next 6 months) were coded as 1; those in preparation (exercising, but not regularly) were coded as 2; and those in action (currently exercising for less than 6 months) and maintenance (currently exercising for more than 6 months) were coded as 3**.**

Results

The first analysis determined whether mean levels of six-month vigorous physical activity differed across three consecutive assessments, for a total of 18 months. Complete results of this analysis can be found in Table 1. The univariate repeated measures analysis of variance indicated a statistically significant difference across vigorous physical activity measures ($F_{2,700} = 5.03$, $p < .01$), but assessment using Cohen's [40] guidelines for η^2 suggested the effect was trivial ($\eta^2 = 0.01$).

The next analysis evaluated whether mean levels of the social cognitive constructs used to predict behavior differed across the six-month interval (i.e., baseline vs. six-month assessment). The complete results of these analyses can be found in Table 2. Of note, descriptives and correlations for time 1 and 2 TTM and TPB measures have been previously reported in Plotnikoff, Hotz, Birkett and Courneya [31] and Courneya et al. [32]. Dependent sample t-tests of the constructs found that only intention ($t_{702} = 2.82$, $p < .01$) and attitude ($t_{702} =$

5.50, $p < .01$) were significantly different across the six-month time period, but assessment using Cohen's [40] guidelines for effect size *d* suggested these effects were trivial ($d < .20$).

The main analyses compared the relationships between social cognitive constructs and behavior using a (1) cross-sectional behavior measure and (2) a six-month prospective follow-up behavior measure. This comparison analysis was conducted using time 1 to time 2 data and then replicated for time 2 to time 3 data. Univariate rs for each social cognitive construct can be found in Table 3, while multiple Rs for the TPB (intention, attitude, subjective norm, PBC), TTM (pros, cons, experiential processes, behavioral processes, self-efficacy), PMT (intention, severity, vulnerability, response efficacy, self-efficacy), and SCT (self-efficacy, pros, cons, social support, perceived environment) can be found in Table 4. Comparisons were made using Hotelling's t test for dependent correlations and Cohen's [40,41] q[1] for comparing correlations where $q < .10$ is trivial, $q = .10$ is small, $q = .30$ is medium, and $q = .50$ is large. For the univariate analyses of the social cognitive constructs, 9 out of 28 of the examinations between the cross-sectional measure of behavior and the six-month prospective measure of behavior were significant ($p < .01$). Evaluation of these findings using effect size, however, suggested only five of these differences were nontrivial ($q > .10$). Further, the five non-trivial differences were small ($q = .10$ - $.13$) and did not replicate across both time-periods of measurement for any social cognitive construct. For the social cognitive theories, seven of the eight examinations between the cross-sectional measure of behavior and the six-month prospective measure of behavior were significant ($p < .01$). Only six of the effects were nontrivial when evaluated using effect size ($q > .10$). All six of the non-trivial differences were small effects ($q = .11$ - $.18$). Finally, all differences for the univariate social cognitive constructs and the social cognitive theories identified that

relationships with the cross-sectional behavior measure were larger than with the six-month prospective measure.

Discussion

The standard methodological approach for evaluating social cognitive theories when predicting physical activity behavior is the PD, whereby social cognitive constructs are measured at baseline and behavior is predicted at a second measurement period. This temporal spacing is a standard assumption in prediction, and a necessary feature for causality [17]. Further, the methodological artifact of consistency effects between behavior and social cognitive constructs may occur during a CD which artificially inflate construct-behavior correlations upwards. Still, in the absence of a behavioral intervention, it is conceivable that the relationship between social cognition on behavior (or vice versa) is in relative stasis. In this case, a concurrent measure of physical activity behavior included in a CD may act as a reasonable proxy measure of a future physical activity measure included in a PD. The main rationale for examining the utility of concurrent physical activity as a proxy measure for future physical activity is the cost-benefit of CDs in comparison to PDs. Thus, the purpose of this study was to evaluate the utility of a concurrent measure of physical activity used in a CD in comparison to the standard prospective measure. For these analyses, included were two, six-month prediction time-periods for the purpose of replication, and constructs from the TPB, TTM, PMT, and SCT as the social cognition models of interest.

Results supported the relative temporal stability of physical activity social cognition and behavior. Although intra-individual differences were apparent in the medium stability coefficients for behavior (.42-.45) and social cognition (.32-.69) across time, no overall mean differences across time were identified. Thus, intra-individual variability was cancelled out in the

inter-individual analyses. The main hypothesis that social cognitive constructs would be invariant in their relationships with physical activity across concurrent (i.e. physical activity over the past six months), and prospective (i.e., physical activity over the past six months measured six months prospectively) measurement was also generally supported. Trivial differences in the magnitude of the correlation coefficients between social cognitive constructs and either a concurrent or a prospective measure of physical activity were found for 82% (23/28) of the tests. Further, only small differences between coefficients were identified for the remaining five tests. In general, the CD estimated slightly larger coefficients than the PD, but these differences were not of clinical significance [40]. The aggregate of this difference, however, was evident when multiple Rs for the TPB, TTM, PMT, and SCT were compared using a CD and a PD. In this case, 75% (6/8) of the tests identified a small effect favoring coefficients for the CD in comparison to the PD. Therefore, consistency effects from CDs may have small effects in the prediction equations of complete social cognitive theories.

Overall, the findings suggest that trivial to small differences in the correlations between social cognitive constructs and vigorous physical activity occur when using a CD or PD. The CD may slightly bias correlations upwards, probably due to a consistency effect from answering all questionnaire items in one sitting, particularly the multiple R for a complete social cognitive theory when explaining behavior. Nevertheless, it appears that a measure of concurrent physical activity behavior included in a CD can act as a reasonable proxy measure of future behavior measured in a PD. From a cost-efficiency point of view, these findings support the use of CDs when researchers seek a standard correlational investigation of physical activity and social cognitive constructs. These CDs should provide essentially the same information for less cost than PDs.

It is important to note that advocacy for CDs extends only to standard correlational assessments between social cognitive constructs and behavior. Prospective designs are essential for an analysis of change [42,43] and the evaluation of physical activity interventions [12]. Still, the most common methodological approach for evaluating social cognitive theories when predicting physical activity behavior is the PD. Therefore, the results suggest that a cross-sectional measure of physical activity behavior may be an acceptable proxy for a prospective measure when researchers desire a standard assessment of social cognitive correlates of physical activity.

Despite the population-based sampling of the present study, there are limitations that need to be taken into consideration when interpreting the results. First, though the social cognitive measures used in this study have been validated in other research and showed significant correlations with the behavioral outcome measure, the measurement reliability of these constructs varied. Several of the measures were single item with unknown reliabilities, and other measures possessed borderline reliability. Some of the measures, such as the unipolar items used for attitude assessment instead of semantic differential items, are nonstandard and may explain the low internal consistencies. Other measures of these constructs may yield different findings. Further, the disparity in the reliability of measures makes it difficult for comparisons across theories. Interestingly, no substantive differences in the Rs between theories and behavior were apparent (see Table 4).

Second, the measure of vigorous physical activity was also single item and the precision in the measure is probably less than optimal. The loss of precision may have influenced the mean and correlation analyses between the three behavior time-points. Nevertheless, the framing of the vigorous physical activity measure matched correspondence in physical activity intensity,

frequency, and duration with the social cognitive measures and corresponds with the American College of Sports Medicine's [46] position stand for vigorous physical activity. Thus, the lost precision at the top end of the scale (i.e., frequencies per week of 4+) is unlikely to be of applied interest for physical activity promoters and the precision at the low end of the scale is compromised by only one frequency point on the scale (i.e., participants are forced to aggregate 1-2 weekly bouts). Still, future research may benefit from a more reliable and valid self-report measure of vigorous physical activity or more objective measures (e.g., pedometers, attendance to a fitness club).

Third, the overall study response rate was modest and the study experienced a significant attrition rate (56%) over the three time points. These factors create unknown biases that limit the population generalizability of the results. However, it is important to note that these participants (N=703) were compared (t-tests and chi-square analyses revealed no meaningful differences) with the 1602 who completed only the time 1 assessment, which revealed similar demographic, social cognitive, and behaviour scores, limiting potential generalization bias. Further, the current study is not necessarily claiming population generalizability as its central aim; its focus is on the theoretical and applied use of CDs and PDs.

Fourth, the six-month time lag between measures may not be generalizable to other shorter or longer measurement times. As mentioned previously, time has been found to moderate the social cognition and physical activity behavior relationship [28]. Therefore, future research may better understand differences between CD's and PDs by including measurements at more or less frequent time intervals.

Finally, this analysis has been conducted using a data-set with previous TTM [31], and TPB [32,38] analyses. Although the analysis presented here is novel, the findings may be

capitalizing on a particular sub-set of respondents. Thus, the findings should not be treated as independent from these other papers and would be inappropriate to include in meta-analyses with these papers. Replication using an independent data-set would improve the veracity of the findings.

In summary, the findings suggest that trivial to small differences in the correlations between social cognitive constructs and vigorous physical activity occur when using a CD or a PD. Correlations may be slightly larger in CDs compared to PDs, probably due to a consistency bias from completing the social cognition measures and behavior measure in the same sitting. Nevertheless, it appears that a measure of concurrent physical activity behavior included in a CD can act as a reasonable proxy measure of future behavior measured in a PD. The findings support the use of CDs when researchers seek a standard correlational investigation of physical activity and social cognitive constructs with the possibility that coefficients may be slightly biased upwards.

Acknowledgements

Ryan E. Rhodes is supported by a scholar award from the Michael Smith Foundation for Health Research and with funds from the Canadian Foundation for Innovation, the British Columbia Knowledge and Development Fund, and internal grants from the University of Victoria.

Ronald C. Plotnikoff is supported by Salary Awards from the Alberta Heritage Foundation for Medical Research and the Canadian Institutes for Health Research.

References

[1] U.S. Department of Health and Human Services. Physical activity and health: a report of the Surgeon General. Atlanta, GA: U.S. Department of Health and Human Services, 1996.

[2] Myers, J, Prakash, M, Froelicher, V, Do, D, Partington, S, Atwood, JE. Exercise capacity and mortality among men referred for exercise testing. N Engl J Med 2002;346:793-801.

[3] Friedenreich, CM, Orenstein, MR. Physical activity and cancer prevention: etiologic evidence and biological mechanisims. J Nutr 2001;132:34:56S-64S.

[4] Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346:393-403.

[5] Kohl, HW. Physical activity and cardiovascular disease: evidence for a dose response. Med Sci Sports Exerc 2001;33:S472-83.

[6] Canadian Fitness and Lifestyle Research Institute. 2001 Monitor. Ottawa, ON: Canadian Fitness and Lifestyle Research Institute, 2001.

[7] Ajzen, I. The Theory of Planned Behavior. Org Behav Hum Dec Proc 1991;50:179-211.

[8] Prochaska, JO, Velicer, WF. The Transtheoretical Model of health behavior change. Am J Health Prom 1997;12:38-48.

[9] Bandura, A. Health promotion from the perspective of Social Cognitive Theory. Psychol Health 1998;13:623-49.

[10] Rogers, RW. Cognitive and physiological processes in fear appeals and attitude change: A revised Theory of Protection Motivation. In JT Cacioppo and RE Petty, editors. Social Psychophysiology. New York: Guilford Press, 1984;153-76.

[11] Fishbein, M, Triandis, HC, Kanfer, FH, Becker, M, Middlestadt, SE, Eichler, A. Factors influencing behavior and behavior change. In A Baum, TA Revenson, editors. Handbook of Health Psychology. Mahwah, NJ: Lawrence Erlbaum Associates, 2001.

[12] Baranowski, T, Anderson, C, Carmack, C. Mediating variable framework in physical activity interventions: how are we doing? how might we do better? Am J Prev Med 1998;15:266-97.

[13] Lewis, BA, Marcus, BH, Pate, RR, Dunn, AL. Psychosocial mediators of physical activity behavior among adults and children. Am J Prev Med 2002;23:S26-35.

[14] Hagger, MS, Chatzisarantis, NLD, Biddle, SJH. A meta-analytic review of the Theories of Reasoned Action and Planned Behavior in physical activity: predictive validity and the contribution of additional variables. J Sport Exerc Psychol 2002;24:1-12.

[15] Baranowski, T, Perry, C, Parcel, G. How individuals, environments, and health behavior interact. In K Glanz, BK Rimer, FM Lewis, editors. Health Behavior and Health Education. 3rd edition. San Francisco: Jossey-Bass, 2002; 165-184.

[16] Krathwohl, DR. Methods of Educational and Social Science Research. New York: Longman, 1993.

[17] Ajzen, I, Fishbein, M. Understanding Attitudes and Predicting Social Behavior. Englewood Cliffs, NJ: Prentice Hall, 1980.

[18] Ajzen, I, Fishbein, M. Attitude-behavior relations: a theoretical analysis and review of empirical research. Psychol Bull 1997;84:888-918.

[19] Sutton, S. Predicting and explaining intentions and behavior: how are we doing? J Appl Soc Psychol 1998;28:1317-38.

[20] Davidson, AR, Jaccard, JJ. Variables that moderate the attitude-behavior relation: results of a longitudinal survey. J Pers Soc Psychol 1997;37:1364-76.

[21] Bagozzi, RP. Attitudes, intentions, and behavior: a test of some key hypotheses. J Pers Soc Psychol 1981;41:607-27.

[22] Dillman, DA. Mail and Internet Surveys: The Tailored Design Method. 2nd ed. John Wiley Co.: New York, 2000.

[23] Duncan, TE, Stoolmiller, M. Modelling social and psychological determinants of exercise behaviors via structural equation systems. Res Q Exerc Sport 1993;64:1-16.

[24] Plotnikoff, R, Rhodes, RE, Courneya, KS, Hotz, S, Birkett, N. Physical activity in a Canadian population-based sample: a three-wave, two group structural equation model of Protection Motivation Theory. J Sport Exerc Psychol 2000;22:S86.

[25] Rhodes, RE, Courneya, KS. Modelling the Theory of Planned Behaviour and past behaviour. Psychol Health Med 2003;8:57-69.

[26] Dishman, RK, Buckworth, J. Increasing physical activity: a quantitative synthesis. Med Sci Sports Exerc 1996;28:706-19.

[27] Ouellette, JA, Wood, W. Habit and intention in everyday life: the multiple processes by which past behavior predicts future behavior. Psychol Bull 1998;124:54-74.

[28] Courneya, KS, McAuley, E. Can short-range intentions predict physical activity

participation? Percept Mot Skills 1993;77:115-22.

[29] Ajzen, I. Attitudes, Personality, and Behavior. Chicago: Dorsey Press, 1988.

[30] Health Canada. Health Canada's Physical Activity Guide. http://www.hc-sc.gc.ca/english/lifestyles/physical_activity.html. 2002. Retrieved November 1, 2002.

[31] Plotnikoff, RC, Hotz, SB, Birkett, NJ, Courneya, KS. Exercise and the Transtheoretical Model: a longitudinal test of a population sample. Prev Med 2001a;33: 441-52.

[32] Courneya, K, Plotnikoff, R, Hotz, S, Birkett, N. Predicting exercise stage transitions over two consecutive 6-month periods: a test of the Theory of Planned Behaviour in a population-based sample. Br J Health Psychol 2001;6:135-50.

[33] Marcus, BH, Selby, VC, Niaura, RS, Rossi, JS. Self-efficacy and the stages of exercise behavior change. Res Q Exerc Sport 1992;63:60-6.

[34] Plotnikoff, RC, Blanchard, C, Hotz, S, Rhodes, R. (2001b). Validation of the decisional balance constructs of the Transtheoretical Model in the exercise domain: a longitudinal test in a population sample. Measure Phys Educ Exerc Sci 2001b;5:191-206.

[35] Plotnikoff, R, Higginbotham, N. Predicting low-fat diet intentions and behaviours for the prevention of coronary heart disease: an application of Protection Motivation Theory among an Australian population. Psychol Health 1995;10:397-408.

[36] Plotnikoff, R, Higginbotham, N. Protection Motivation Theory and the prediction of exercise and low-fat diet behaviors among Australian cardiac patients. Psychol Health 1998;13:411-29.

[37] Sallis, JF, Hovell, MF, Hofstetter, CR, Barrington, E. Explanation of vigorous physical activity during two years using social learning variables. Soc Sci Med 1992;34:25-32.

[38] Courneya, K, Plotnikoff, R, Hotz, S, Birkett, N. Social support and the Theory of Planned Behavior in the exercise domain. Am J Health Behav 2000;24:300-08.

[39] Reed, GR, Velicer, WF, Prochaska, JO, Rossi, JS, Marcus, BH. What makes a good starting algorithm: examples from regular exercise. Am J Health Promot 1997;12:57-67.

[40] Cohen, J. Statistical Power Analysis for the Behavioral Sciences. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum, 1988.

[41] Cohen, J. A power primer. Psychol Bull 1992;112:155-9.

[42] Gottman, JM, Rushe, RH. The analysis of change: issues, fallacies, and new ideas. J Consult Clin Psychol 1993;61:907-10.

[43] Hertzog, C, Nesselroade, JR. Beyond autoregressive models: some implications of the trait-state distinction for the structural modeling of developmental change. Child Dev 1987;58:93-109.

[44] Rosenthal, R. Meta-Analytic Procedures for Social Research. Newbury Park, CA: Sage, 1991.

[45] Dunlop, WP, Cortina, JM, Vaslow, JB, Burke, MJ. Meta-analysis of experiments with matched groups or repeated measures designs. Psychol Methods 1996;1:170-7.

[46] American College of Sports Medicine. Guidelines for exercise testing and prescription. Lippincott, Williams & Wilkins: Baltimore, Maryland, 2000.

Table 1.
Mean Differences of Physical Activity Behavior Across Three Six-Month Measurements.

	Mean (SD)			$F_{2,700}$	η^2	Post Hoc	Stability Coefficients		
	Baseline[1]	6-Months[2]	12-Months[3]				r_{12}	r_{13}	r_{23}
Exercise Behavior	2.04 (0.93)	2.15 (0.93)	2.04 (0.94)	5.03*	.01	NA	.42*	.42*	.45*

Note: *=p<.01; Post Hoc tests are based on Cohen's (1988, 1992) effect size *d* (>.20).

Table 2.
Mean Differences of Social Cognitive Constructs Across Six-Month Measurements.

	Mean (SD)		t_{692}	*d*	Stability Coefficient
	Baseline	6-Months			
Intention	76.99 (28.21)	74.25 (28.63)	2.82*	.10	.59*
Attitude	4.22 (0.68)	4.09 (0.74)	5.50*	.18	.61*
Subjective Norm	3.61 (0.96)	3.58 (1.02)	0.89	.03	.49*
Perceived Control	3.81 (0.90)	3.82 (0.87)	0.44	.01	.57*
Pros	3.99 (0.87)	3.96 (0.92)	0.82	.03	.57*
Cons	1.92 (0.75)	1.92 (0.72)	0.05	.00	.48*
Behavioral Processes	2.57 (0.84)	2.61 (0.84)	1.48	.05	.55*
Cognitive Processes	2.48 (0.77)	2.51 (0.77)	1.47	.04	.58*
Self-Efficacy	3.11 (0.84)	3.15 (0.83)	1.68	.05	.69*
Severity	4.22 (1.11)	4.29 (1.07)	1.43	.06	.32*
Vulnerability	4.02 (1.00)	4.07 (0.94)	1.18	.05	.41*
Response Efficacy	4.41 (0.56)	4.42 (0.60)	0.31	.02	.45*
Physical Environment	4.08 (1.01)	4.07 (1.03)	0.19	.00	.51*
Social Support	3.34 (1.28)	3.28 (1.28)	1.36	.05	.60*

Note: *=p<.01. d = Cohen's (1988, 1992) effect size *d*.

Table 3.
Correlations among Social Cognitive Constructs and Physical Activity Behavior Across Three Six-Month Measurements.

Construct		Physical Activity		t_{700}	*q*
		Cross-Sectional	6-Month Prospective		
Intention					
	Baseline	.48*	.41*	2.03*	.09
	6-Months	.57*	.48*	2.89*	.13
Attitude					
	Baseline	.33*	.26*	1.84	.08
	6-Months	.37*	.35*	.56	.02
Subjective Norm					
	Baseline	.11*	.06	1.24	.05
	6-Months	.13*	.09*	1.02	.04
PBC					
	Baseline	.22*	.19*	.76	.03
	6-Months	.28*	.17*	2.89*	.12
Pros					
	Baseline	.16*	.13*	.75	.03
	6-Months	.19*	.21*	-.52	-.02
Cons					
	Baseline	-.28*	-.21*	-1.80	-.08
	6-Months	-.27*	-.27*	.00	.00
Behavioral Processes					
	Baseline	.38*	.28*	2.68*	.11
	6-Months	.40*	.32*	2.24*	.09
Cognitive Processes					
	Baseline	.10*	.09*	.25	.01
	6-Months	.08	.13*	-1.27	-.05
Self-Efficacy					
	Baseline	.48*	.39*	2.59*	.11
	6-Months	.50*	.43*	2.11*	.09
Severity					
	Baseline	.12*	.06	1.48	.06
	6-Months	.23*	.23*	.00	.00
Vulnerability					
	Baseline	.09*	.06	.74	.03
	6-Months	.09*	.08	.25	.01
Response Efficacy					
	Baseline	.23*	.23*	.00	.00
	6-Months	.18*	.17*	.26	.01
Physical Environment					
	Baseline	.28*	.19*	2.31*	.09
	6-Months	.30*	.27*	.80	.03
Social Support					
	Baseline	.24*	.12*	3.04*	.12
	6-Months	.22*	.26*	-1.05	-.04

Note: t = Hotelling's t-test for dependent correlations. *=p<.01; q = Cohen's (1988, 1992) effect size q.

Table 4.
Multiple Correlations for Social Cognitive Theories and Physical Activity Behavior Across Three Six-Month Measurements.

Construct		Physical Activity			
		Cross-Sectional	6-Month Prospective	t_{700}	q
TPB					
	Baseline	.50*	.43*	2.07*	.09
	6-Months	.58*	.49*	2.94*	.13
TTM					
	Baseline	.57*	.44*	4.03*	.18
	6-Months	.58*	.48*	3.24*	.14
PMT					
	Baseline	.55*	.47*	2.48*	.11
	6-Months	.60*	.50*	3.33*	.14
SCT					
	Baseline	.52*	.41*	3.26*	.14
	6-Months	.53**	.47**	1.88	.08

Note: t = Hotelling's t-test for dependent correlations. *=p<.01; q = Cohen's (1988, 1992) effect size q. TPB = theory of planned behavior, TTM = transtheoretical model, PMT = protection motivation theory, SCT = social cognitive theory.