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Running Head: Theory of Planned Behaviour Scaling

Beyond Scale Correspondence: A Comparison of Continuous Open Scaling and Fixed Graded Scaling when Using Social Cognitive Constructs in the Exercise Domain

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Abstract

The standard response format for self-reported exercise behaviour measurement is the continuous open scale, but popular social cognitive theories use fixed graded scales; a noncorrespondent format. Benefits of using continuous open scales for social cognitive constructs include scale correspondence with the behaviour measure, the potential of increased variability from an open response format, and potentially more accurate measurement from using a ratio-level scale. The purpose of this study was to create continuous open measures of theory of planned behaviour (TPB) constructs and compare these to standard fixed graded measures. Participants were 420 undergraduate students who completed measures of fixed graded and continuous open TPB scales and a 2-week follow-up of exercise behaviour. Psychometric properties were acceptable for both types of scaling, but the correlations of TPB constructs with exercise intention and behaviour were larger for continuous open scaling than fixed graded scaling. This result was due to the additional variability afforded by continuous open scaling and not from scale correspondence; furthermore, the two types of scales had convergent measurement domains. Finally, in an applied analysis, regression equations derived from the continuous open measures showed that higher levels of social cognition towards a behavioural frequency than the desired behavioural outcome are needed to produce that desired behavioural outcome. Overall, continuous open scaling may be a superior form of scaling for social cognitive constructs in the exercise domain in comparison to standard fixed graded measures.

Key Words: Theory of planned behaviour, attitude, subjective norm, perceived behavioural control, intention, exercise prescription

There is substantial evidence that *physical inactivity* is associated with the development of several chronic diseases and premature mortality (Blair & Brodney, 1999; Booth, Gordon, C.J., & Hamilton, 2000; Katzmarzyk, Gledhill, & Shephard, 2000). There is also extensive literature indicating that physical activity is an effective preventive strategy against cardiovascular disease, obesity, stroke, hypertension, type 2 diabetes, colon cancer, breast cancer, osteoporosis, and several psychological disorders (Blair & Brodney, 1999). Unfortunately, a majority of the North American population do not meet the minimal requirements for physical activity wherein health benefits are thought to occur (CFLRI, 2002; USDHHS, 1996). Thus, physical activity promotion is a *public health priority*.

Interventions to promote physical activity are likely to be facilitated by a sound understanding of the correlates and determinants of activity. Investigations of physical activity and exercise correlates are plentiful (e.g., Trost, Owen, Bauman, Sallis, & Brown, 2002) and usually rely on brief self-reports of behaviour. As a result, the validity of self-report scales in the physical activity and exercise domain is of paramount importance (Jacobs, Ainsworth, Hartman, & Leon, 1993). Courneya, Jones, Rhodes and Blanchard (2003) have noted that scales presenting exercise as a continuous (many response alternatives; usually days per week) behaviour and with an open (unprompted and unrestricted response options) response format are superior in measurement accuracy to all other response formats. Indeed, the continuous-open scale is considered the "gold standard" format for a self-report behavioural frequency in all behavioural domains because it yields more exact information than is possible in other truncated scaling formats (Menon, Raghubir, & Schwarz, 1995; Schwarz, 1999). Further, the ratio-level scaling (i.e., days/per week) often used in this format may create more clearly defined response categories than ordinal or quasi-interval scaling (Glass & Hopkins, 1996) used in graded scaling formats (e.g., strongly agree to strongly disagree).

Despite the advocacy for continuous open scaling in behavioural measurement, the type of scaling used to assess motivation in our most popular social cognitive theories does not correspond with continuous open scaling. For example, the theory of planned behaviour (TPB; Ajzen, 1991), social

cognitive theory (Bandura, 1998), and the transtheoretical model of behaviour change (Prochaska & Velicer, 1997), arguably the three most validated theories in the exercise domain, employ fixed graded measurement (sometimes referred to as dichotomous graded). Specifically, these measures include a fixed frequency (e.g., three times per week over the next month) and then ask respondents to grade their strength of advocacy (e.g., from strongly agree to strongly disagree). This scaling format may have been originally utilized because the theories (particularly the TPB and its predecessors) were initially focused on dichotomous behaviours such as casting a vote (Ajzen & Fishbein, 1980). Nevertheless, repeated behaviours such as regular exercise are better measured with continuous scaling and the type of measurement employed with these social cognitive theories is not correspondent (Courneya, 1994).

Courneya (1994) has shown that scale correspondence between measures affects the magnitude of their relationship, with scale correspondent measures producing relationships of stronger magnitude than mismatched scaling correspondence. Because explaining variability in exercise behaviour using theoretical models is an important research focus, improving measurement factors that impact the magnitude of social cognition-behaviour relations is useful (see Rhodes, Plotnikoff, & Spence, 2004 for an extended discussion).

Reviews of the TPB, and its predecessor, the theory of reasoned action, have advocated this importance of compatibility between social cognitive measures and behaviour for predictive utility (Ajzen & Fishbein, 1977; Conner & Sparks, 1996; Davidson & Jaccard, 1979; Fishbein & Ajzen, 1974; Sutton, 1998). Indeed, this principle of compatibility in context, target, time, and action between social cognitive and behaviour measures is a key tenet within both theories. Still, the practice of scale correspondence, a methodological tenet of compatibility, has not been adopted. Few studies have included Courneya's (1994; Courneya & McAuley, 1994) continuous open intention measure when intention is used to predict continuous open measures of behaviour, and the absence of continuous open social cognitive measures continues to violate scale correspondence. Thus, the need to extend the work of Courneya (1994) by examining continuous open social cognitive measures seems necessary.

Advantages of using continuous open social cognitive measures in the exercise domain may go beyond simple scale correspondence. Continuous open scales of behaviour assessment have the measurement advantage of unrestricted range, and this would likely extend to continuous open social cognitive measures. For example, Courneya (1994) identified continuous open measurement as the largest absolute correlation of all intention-behaviour scaling possibilities. The precision afforded by continuous open measurement of social cognitive constructs may better reflect the natural variability of these constructs. Fixed graded measures in the exercise domain will, undoubtedly, be fixed at frequencies that do not meet the behavioural target of many participants. Participants with lower levels of advocacy can, presumably, grade their cognitions about this target (e.g., slightly disagree), but participants who endorse higher levels of the behavioural target than the fixed frequency will be restricted by the top range of advocacy. For example, participants who would not enjoy exercising four times per week but who would enjoy exercising two times per week can grade their response with limited advocacy (e.g., somewhere between slightly agree to slightly disagree) and participants who hate exercise altogether can grade their response with more extreme disagreement. In contrast, those individuals who enjoy exercise four times a week would seem as likely to respond with extreme agreement as those individuals who enjoy exercising over four times per week. Because restricted range affects the magnitude of correlations (Glass & Hopkins, 1996), the relationships among social cognitive constructs using fixed graded scaling and exercise behaviour may be underestimated. Research is needed, however, to test this possibility.

The advantage of ratio-level measurement (i.e., days per week) often used in continuous open exercise behaviour measures may also extend to social cognitive constructs that employ this format. Time (e.g., hours per week, days per week) is a well-understood construct in our society and applied to almost every facet of human experience. This ratio-level scaling format should be more accessible with participants than graded scaling (e.g., strongly disagree to strongly agree), which is, arguably, a constructed scaling format solely for the purpose of the instrument. Ratio-level scaling may also provide additional information that is directly applicable to exercise prescription and promotion. For example,

understanding that intentions to exercise five days a week generally translate into four actual bouts of weekly exercise (i.e., continuous open scaling), is a more accessible research outcome than understanding that "moderately strong" intentions to exercise translates into a particular value (Rhodes & Courneya, 2005). Thus, research focused on how social cognitive constructs translate into accessible behavioural outcomes is warranted.

Finally, Ajzen and Fishbein (1980) have theorized that continuous open instruments measure a "choice" endorsement from participants while fixed graded instrumentation fixes the "choice" component and measures the "strength" of advocacy of that choice. Thus, assessment of "choice" and "strength" may reflect different measurement domains. Still, it is possible that the "strength" component is at least partially measured within the continuous open items. For example, those who enjoy exercising (i.e., strength) would likely indicate that they would enjoy exercising more frequently per week (i.e., choice) than those who do not enjoy exercise (i.e., strength). Similarly, those with a stronger subjective norm towards exercise would likely endorse that their social network wants them to exercise more frequently than those individuals with weaker normative pressure. Finally, "choice" intention items usually demonstrate strong internal consistency with "strength" intention items (e.g., Rhodes & Courneya, 2003a; Rhodes & Courneya, 2003b). Thus, a direct comparison of the measurement domains of "choice" and "strength" seems warranted.

Therefore, this study was designed to create continuous open measures of social cognitive constructs and compare these to standard fixed graded measures. Adjectives and phrases for items were kept as similar as possible between fixed graded and continuous open measures so as to try to vary only the scaling technique. We had four specific objectives in this study. First we sought to compare the psychometric properties of the two types of scales. Because researchers have not created continuous open measures of social cognitive constructs in any behavioural domain, a comparison of basic means, variability, and internal consistency is prudent. Based on our theorizing that continuous open measures

offer no restrictions in range, we hypothesized that variability in these scales would be higher than in the fixed graded measures.

Second, we sought to compare the magnitude of exercise intention and behaviour relations between the two scaling formats. We hypothesized, based on Courneya (1994), that continuous open measures would have larger correlations with intention and behaviour than fixed graded measures. We further hypothesized that the difference in this relationship would be better explained by the unrestricted range (variability) afforded by the continuous open constructs than just scale correspondence.

Third, we sought to examine the domain overlap in the two types of scaling formats. Although no researchers in any behavioural domain have focused on this research question, we hypothesized that the two measures would share significant domain overlap, and that responses to fixed graded measures could be differentiated by choice frequencies obtained from the continuous open measures.

Finally, we sought to apply a regression equation derived from the continuous open measures to determine the average frequencies of social cognitive constructs for Health Canada's recommended minimum weekly frequency of exercise behaviour. This procedure has never been reported in the literature, but it should demonstrate a useful analysis for understanding the potential levels of social cognition required for a given behavioural outcome (see also Rhodes & Courneya, 2005).

The social cognitive theory applied in this study was Ajzen's (1991) TPB. The TPB is a well validated theoretical structure in the exercise domain (Hagger, Chatzisarantis, & Biddle, 2002) that suggests that the proximal determinant of exercise is one's intention. Intention represents the summary motivation for the behaviour. Attitude and subjective norm towards a behaviour are suggested to exert their effects upon behaviour through intention. Attitudes are the affective (e.g., enjoyment, interest, etc.) and instrumental (e.g., benefit, utility, etc.) evaluations of performing the behaviour by the individual. Subjective norm represents the social pressures on the individual to perform or not to perform a particular behaviour. The TPB tries to also predict behaviours that are not completely volitional by incorporating perceptions of control over performance of the behaviour as an additional predictor of intention and, to

the extent that it represents "real control," behaviour (Ajzen, 1991). Perceived behavioural control (PBC) captures the perceived skills, resources, and opportunities to engage in a behaviour while holding motivation as a positive constant (Rhodes & Courneya, 2003b, 2004).

Method

Participants and Procedure

Undergraduate students (N = 489) participated in the study for extra credit in their introductory psychology and health psychology courses. Informed consent was obtained from the participants. In the first wave of data collection, 240 participants attended large group sessions during October and November 2002, completing self-report measures of the TPB. Some (n = 220) participants returned to complete 2-week follow-up measures of exercise behaviour. In the second wave of data collection, an additional 205 participants attended large group sessions during October and November 2004; 200 of these participants returned to complete the 2-week follow-up measures of exercise behaviour. No significant ($p > .05$) differences were present between the two data-sets for age, gender, year in university, exercise behaviour, and all of the social cognitive measures[1]. No differences ($p > .05$) between those who did not return for the follow-up and those who did were identified. Thus the total sample for the prospective study was 420 participants. The relatively small 2-week time lag was chosen to reflect optimal predictive accuracy, given the dynamic nature of social cognitions and the TPB tenets of time, context, target, and action (Ajzen, 1991, 2002). The mean age of participants was 21.52 (SD = 4.52 yrs), 81% were female, and the mean year in university for the sample was 2.75 (SD = 1.12).

Instruments

The definition of exercise was chosen to reflect Health Canada's position stand for recommended weekly exercise among adults (Health-Canada, 2002). For the fixed graded social cognitive measures, exercise was defined as activities performed at least at a moderate intensity, four or more times per week, for at least 30 min each time. The response format for these measures followed a 7-point gradation of advocacy (e.g., strongly disagree to strongly agree) and participants were asked to circle the grade of

advocacy below each question that best described how they felt (see Appendix A Form 1). For the continuous open social cognitive measures, exercise was defined as activities performed at least at a moderate intensity, for bouts of at least 30 min each time. Participants were asked to write the frequency of exercise, for each question, that best represents them in the spaces provided (see Appendix A Form 2). Thus the difference between the two definitions is the absence of a recommended frequency in the continuous open measures because this is the scaling property of this measure. The continuous open questions were pilot tested with a small independent sample (N = 5) of undergraduate students for the purpose of establishing comprehension and face validity. All five of the students indicated that the items were clear.

The order of instrumentation was counter-balanced between the two data collections in order to reduce the possibility of an order effect influencing responses on the measures. Previous research has demonstrated that the order of questions may influence responses (e.g., Budd, 1987; Budd & Spencer, 1986; Strack , Schwarz, & Waenke, 1991). Thus, continuous open items preceded fixed graded items in the first data collection and fixed graded questions preceded the continuous open questions in the second data collection.

Attitude towards regular exercise was measured in the fixed graded scaling format using 7-point bipolar adjective items as suggested by Ajzen and Fishbein (1980). Three items were used to tap the instrumental (e.g., useful-useless, wise-foolish, beneficial-harmful) and three items were used to tap the affective (enjoyable-unenjoyable, pleasant-unpleasant, interesting-boring) aspect of attitude as suggested by Ajzen (2002). The statement that preceded the adjectives was “For me, regular exercise over the next two weeks would be.” Continuous open scaling of attitude towards regular exercise was measured using the template set by Courneya (1994). We made a decision, however, to include only one descriptive anchor to represent each item, which varies from traditional semantic differential scaling. Overall, we felt the positive semantic anchor was the optimal scaling exemplar for these items because exercise attitude is usually skewed towards the positive end of the scale. The three items used to tap instrumental attitude

were: (a) “Exercising ---- (e.g., 0-7) times per week over the next 2 weeks would be useful,” (b) “It would be wise to exercise ---- (e.g., 0-7) times per week over the next 2 weeks,” and (c) “It would be beneficial to exercise ---- (e.g., 0-7) times per week over the next 2 weeks.” The three items used to measure affective attitude were: (a) “Exercising ---- (e.g., 0-7) times per week over the next 2 weeks would be enjoyable,” (b) “It would be pleasant to exercise ---- (e.g., 0-7) times per week over the next 2 weeks,” and (c) “It would be boring to exercise more than ---- (e.g., 0-7) times per week over the next 2 weeks.”

Subjective norm was measured by three items on a 7-point scale that ranged from 1 (strongly disagree) to 7 (strongly agree) for the fixed graded measure. Two items measured the injunctive component of subjective norm and one item measured the descriptive component of subjective norm based on the recommendation of Ajzen (2002). These components were aggregated to form a scale based on the findings of Rhodes and Courneya (2003a). The items were: (a) “Most people who are important to me want me to exercise regularly over the next 2 weeks," (b) “Most people who are important to me do not think I should exercise regularly over the next 2 weeks (reverse scored),” and (c) “Most people who are important to me will exercise regularly over the next 2 weeks.” Continuous open scaling of subjective norm was measured using the template set by Courneya (1994). The three items used to measure subjective norm were: (a) “Most people who are important to me want me to exercise ---- (e.g., 0-7) times per week over the next 2 weeks,” (b) “Most people who are important to me think I should exercise ---- (e.g., 0-7) times per week over the next 2 weeks,” and (c) “Most people who are important to me will exercise an average of ---- (e.g., 0-7) times per week over the next 2 weeks.”

Perceived behavioural control was measured by two questions previously used by Rhodes and Courneya (2003b; 2004) for fixed graded scaling. The two PBC items were: (a) “How much personal control do you feel you have over exercising regularly in the next 2 weeks if you really wanted to?”; on a 7-point scale ranging from 1 (very little control) to 7 (complete control), and (b) “How much do you feel that exercising regularly over the next 2 weeks is beyond your control even if you really wanted to?” (reverse scored); on a 7-point scale ranging from 1 (not at all) to 7 (very much).

Continuous open scaling of PBC followed the same format as the continuous open attitude and subjective norm measures. The two items used to measure PBC were: (a) "If I really wanted to exercise daily, exercising ---- (e.g. 0-7) times per week over the next 2 weeks would be completely under my control," and (b) "Exercising more than ---- (e.g., 0-7) times per week over the next 2 weeks is beyond my control even if I really wanted to exercise every day."

Exercise intention was assessed in fixed graded fashion by two items following the scaling recommended by Ajzen (2002). Items were answered using 7-point scales from 1 (strongly disagree) to 7 (strongly agree). The two items were (a) "I plan to exercise regularly over the next 2 weeks," and (b) "I intend to exercise regularly over the next 2 weeks." Continuous open measurement of intention used the template set by Courneya (1994). The items measuring intention were (a) "I intend to exercise ---- (e.g., 0-7) times per week over the next 2 weeks," and (b) "I plan to exercise ---- (e.g., 0-7) times per week over the next 2 weeks."

Exercise behaviour was measured by an item using the suggested prototype from Conner and Sparks (1996) for fixed graded scaling. The single item was phrased "I exercised regularly over the last 2 weeks"; scored on a 7-point scale from 1 (strongly disagree) to 7 (strongly agree).

Open ended measurement of exercise behaviour used was phrased "I engaged in exercise ---- (e.g., 0-7) times per week over the last 2 weeks. This single item measure resembles the Godin Leisure Time Exercise Questionnaire (Godin, Jobin, & Bouillon, 1986; Godin & Shephard, 1985), but utilizes the identical phrasing as the open-ended social cognitive measures. The item was created specifically for this study, but it did correlate significantly ($r = .68$; $p < .01$) with the Godin Leisure Time Exercise Questionnaire (administered at time 1), thus demonstrating concurrent validity with this instrument.

Results

Psychometric Properties of the Two Types of Scales

Descriptives, inter-scale correlations, and psychometric properties are reported in Table 1. Dependent t-tests identified that mean scores were significantly (results not shown, $p < .01$) lower for

continuous open measures in comparison to fixed graded measures. Variability was significantly ($p <$ .05) larger for the continuous open measures in comparison to the fixed graded measures, with the exception of intention. All inter-scale correlations between constructs were significant ($p < .01$).

For assessment of the psychometric properties of each scale, we included indices of the composite reliability of the construct and average variance extracted from the items by each construct (see Fornell & Larker, 1981). Fornell and Larker (1981) propose that a composite reliability below .70 and an average variance extracted that is less than .50 suggests that measurement of the construct is questionable. Standard fit statistics in confirmatory factor analysis (e.g., χ^2) were not available to test the psychometric quality of the measures because all scales are saturated models (0 degrees of freedom). All continuous open scales showed acceptable psychometric properties with the possible exception of PBC, which was borderline. Affective attitude, instrumental attitude, and subjective norm had markedly better psychometric properties using the continuous open scaling compared to the fixed graded scaling.

Intention and Behaviour Relations between the Two Scaling Formats

Our analyses comparing fixed graded and continuous open TPB scaling with 2-week behaviour and intention are reported in Table 2 and Table 3, respectively. Table 2 compares the constructs using "gold standard" continuous open intention and behaviour scales (Courneya, 1994; Courneya et al., 2003) and Table 3 compares the constructs using each scale's corresponding intention and behaviour measure (i.e., preserving scale correspondence). The statistical test used to compare dependent correlation coefficients was Hotelling's *t*. This test represents a common and reliable method of examining differences between dependent correlation coefficients (Glass & Hopkins, 1996). Cohen's (1992) effect size q^2 is also included in the comparisons, where $q < .10$ is trivial, $q = .10$ is small, $q = .30$ is medium and $q = .50$ is large.

Correlations of TPB constructs with the continuous open measure of exercise intention were systematically larger ($p < .01$) for continuous open scaling in comparison to fixed graded scaling (see

Table 2). Overall these differences can be considered a medium effect size. Correlations of TPB constructs with the continuous open measure of behaviour were larger ($p < .05$) for continuous open scaled instrumental attitude, subjective norm, PBC, and intention in comparison to fixed graded scaling (see Table 2). In terms of differences by effect size, however, small effects were identified for instrumental attitude, and PBC, and borderline small effects were identified for subjective norm and intention.

Comparison of correlations of continuous open and fixed graded TPB measures with intention and 2-week exercise behaviour when scale correspondence is conserved altered the results slightly (see Table 3). In this analysis, correlations of TPB constructs with intention were still systematically larger ($p < .01$), and with a medium effect size difference, for continuous open scaling in comparison to fixed graded scaling. Correlations of TPB constructs with behaviour were larger ($p < .05$) for continuous open scaled instrumental attitude, subjective norm, PBC, and intention in comparison to fixed graded scaling (see Table 3). In terms of differences by effect size, however, small effects were identified.

We also compared the differences between scaling styles for multiple Rs^3 (see Table 2 and 3). Because the TPB is conceived as a multivariate model, standard ordinary least squares multiple regression techniques for the TPB (Ajzen, 1991) were employed to represent the hypothesized pathways. This analysis allowed for an examination of the difference between multiple Rs for predicting intention and 2-week behaviour as well as a demonstration of whether a similar magnitude of ordering for TPB predictors existed across the scaling styles.

All regression models were significant ($p < .01$) and the results were similar to the univariate analyses. Specifically, the multiple R for predicting continuous open intention and behaviour was significantly ($p < .01$) larger with continuous open scaled TPB constructs than with fixed graded constructs (see Table 2). The differences in terms of effect size were medium for predicting intention and small for predicting behaviour. These same findings were also identified when scale correspondence was conserved across measures (see Table 3). Interestingly, the magnitude of the coefficients (and ordering)

did not differ markedly across scaling style. Affective attitude ranged between β = .36-.44, instrumental attitude ranged between β = .06-.12, subjective norm ranged between β = .19-.23, and PBC ranged between β = .17-.30 as predictors of intention. For prediction of behaviour, intention ranged between β = .50 -.53, and while PBC was not significant ($p > .05$) it ranged between β = .01 -.09.

Finally, a comparison of correlations between scaling styles was also conducted after the continuous open measures were truncated to compensate for their increased variability in the top end of the scale. Fixed graded measures were fixed at a frequency of 4+ bouts of weekly exercise, but the continuous open measures allowed for responses above 4 bouts of weekly exercise. Thus, the continuous open measures were "constrained" so that 4+ bouts of weekly exercise represented the top response category of the continuous open scale. The results of this comparison may be found in Table 4.

Correlations of TPB constructs (and the multivariate model) with the continuous open measure of exercise intention were still systematically larger ($p < .01$) for the "constrained" continuous open scaling in comparison to fixed graded scaling (see Table 4). These differences, however, were now of a small effect size. Further, only a significant ($p < .05$) difference between the scales of PBC with the continuous open measure of 2-week behaviour was identified for correlations of TPB constructs with exercise behaviour.

Measurement Domain Overlap in the Two Types of Scaling Formats

Discriminant/convergent validity between the continuous open and fixed graded TPB scales was tested using the procedures suggested by Anderson and Gerbing (1988). Specifically, using structural equation modeling, the covariance between the two scales was freed for estimation in the first model and then fixed to 1.00 in the second model. The two model fit statistics (i.e., χ^2) were then compared. Scales were fixed with 0 error to correspond with the previous correlation and ordinary least squares regression analyses.

Results of these analyses showed that affective attitude ($\Delta\chi^2 = 3.82$, $p > .05$), subjective norm ($\Delta\chi^2$ (1) = 0.08, $p > .05$), and PBC ($\Delta\chi^2$ (1) = 1.00, $p > .05$) were convergent across scaling styles, while instrumental attitude ($\Delta\chi^2$ (1) = 67.46, $p < .01$), and intention ($\Delta\chi^2$ (1) = 253.50, $p < .01$) had discriminant validity. Further, the results did not change significantly ($p < .05$ criterion) when we used the "constrained" continuous open measures created for Table 4.

To specifically examine whether responses on fixed graded TPB scales were related to continuous open responses, we employed the threshold analysis suggested by Rhodes and Courneya (2005). Participant responses on fixed graded scales of TPB constructs were categorized (1-7) by rounding all scale values to the nearest response number (1-7). A minimum *n* of 30 was considered a meaningful number of respondents per scale value based on the power analysis of Rhodes and Courneya (2005) for 7-point scales. To conserve all participants within the analysis, scale values with small *n*s were aggregated into the next closest scale value. Specifically, affective attitude, instrumental attitude, subjective norm, and PBC all had insufficient numbers at the low end of their scales to represent separate scale values. Thus, responses of 1 to 3 were aggregated together to create a scale value for affective attitude and subjective norm. The small number of respondents ($n = 6$) with scale values less than 4 for PBC were added to the scale value of 4. Similarly, the small number of respondents ($n = 4$) with scale values less than 5 for instrumental attitude were added to the scale value of 5 (see Table 5).

Examining means and standard deviations among the TPB constructs was achieved by using a series of one-way analysis of variance (ANOVA) tests. Each continuous open construct served as the dependent variable for the corresponding fixed graded scale. Significant ANOVAs were followed by post-hoc tests to discern which groups were significantly different from one another. Given that differences in group *n* can dramatically influence *p*-level (Glass & Hopkins, 1996), Cohen's (1992) effect size *d* was used as the post-hoc criterion. Cohen (1992) suggests $d < .20$ is trivial. All TPB constructs displayed significant ($p < .01$) F-tests on their respective continuous open scale. Further, post-hoc results generally

showed that increases in advocacy on the fixed graded scale correspond with increases in weekly frequency on the continuous open scale (see Tables 5 and 6).

Application of the Continuous Open Measures to Health Canada's Recommended Minimum Weekly Frequency of Exercise Behaviour

For our final analysis, we used ordinary least squares regression equations on the continuous open measures in order to ascertain the values of TPB constructs required to meet Health Canada's (2002) minimal guideline of four bouts of weekly exercise. The following analyses were computed: (a) continuous open intention was regressed on the TPB constructs in a series of analyses, and (b) 2-week continuous open exercise behaviour was regressed on the TPB constructs (including intention) in a series of analyses. Next, "4" was included into the resulting regression equations as the "y" variable, and the "x" variable was derived by subtracting the constant from "y" and then dividing by the slope (i.e., unstandardized beta).

Results of this analysis are in Table 7. Confidence intervals for this analysis were wide, because the TPB is not a perfect linear fit with behaviour (Sutton, 1998). Overall, however, affective attitude, instrumental attitude, and PBC were needed at frequencies of six bouts per week, and subjective norm and intention to exercise five times per week were needed to produce four actual bouts of exercise per week.

Discussion

The "gold" standard response format for self-reported behavioural frequency assessment is the continuous open scale, but popular social cognitive theories used to predict exercise behaviour employ fixed graded scales; a non-correspondent format. Benefits of using continuous open scales for social cognitive constructs include scale correspondence with behaviour measures, the potential of increased variability from an open response format, and potentially more accurate measurement from using a ratio-level scale. Therefore, the purpose of this study was to create continuous open measures of TPB constructs and compare these to standard fixed graded measures.

Psychometric Properties of the Two Types of Scales

An initial inspection of the means, variability, and comparative psychometric quality of the scales revealed that both types of scaling had acceptable psychometric quality. Indeed, the continuous open scales had noticeably better psychometric quality than standard fixed graded measures for three (affective attitude, instrumental attitude, subjective norm) of the five TPB constructs (Δ average variance extracted = .04 - .20). As hypothesized, the continuous open measures had significantly larger variance than the fixed graded scales. This was expected based on our theorizing that continuous open measures offer no restrictions in range. The only notable exception was intention, which did not differ between scales. This result is counter to our hypothesis and the findings from previous research (Courneya, 1994; Courneya & McAuley, 1994). We are unsure why this difference occurred in the data set, but the discrepancy warrants further replication.

Comparing the mean differences between scales also highlighted an interesting finding. All previous studies using social cognitive theories have been limited to a priori fixing of the behavioural frequencies for fixed graded scales. The fixed weekly exercise frequencies are usually based on clinical exercise guidelines for health benefits (e.g., ACSM, 2000; Health-Canada, 2002). These values may fail, however, to represent the natural sample variability of social cognition towards regular weekly exercise frequency. For example, a majority of Canadians are not even aware of Health Canada's (2002) recommended guidelines for weekly exercise (CFLRI, 2002). Thus, instead, most Canadians have developed their own social cognitive values towards weekly exercise and these may vary from the value used in the fixed graded scales. In this sample of undergraduate students, the fixed graded measures (4 bouts per week+) matched the mean frequency of the continuous open intention and affective attitude measures. In contrast, continuous open scale frequencies for instrumental attitude and PBC were higher than the fixed graded measures and subjective norm was lower than the fixed measures. Thus it appears that the natural variability of social cognition about regular exercise frequency differs across the constructs measured.

Intention and Behaviour Relations between the Two Scaling Formats

Our principle analysis, focused on comparing the correlations of TPB constructs with intention and behaviour, generally supported our hypotheses. That is, correlations of TPB constructs, and a multivariate TPB model, with exercise intention (6/6 tests) and behaviour (5/6 tests) were larger for continuous open scaling than fixed graded scaling. Overall these differences can be considered a medium effect size for intention and a small effect size for behaviour. Interestingly, similar results were identified even when scale correspondence was conserved between scaling styles. When the continuous open TPB measures were constrained at the top-end of their scales to equal the top graded frequency of the fixed scales, however, the difference in behaviour correlations by scaling style was generally not significantly different. Further, the intention difference was reduced to a small effect.

These results suggest that, although scale correspondence may be important across different scaling styles (Courneya, 1994), continuous open scales have a primary advantage in behavioural prediction from the increased range afforded by the open scaling format. This is in agreement with the basic statistical premise that increased variability increases the potential magnitude of a correlation (Glass & Hopkins, 1996). Taken together with the acceptable psychometric properties demonstrated in the continuous open scales, it appears that continuous open scaling may be a superior form of scaling for social cognitive constructs in the exercise domain in comparison to standard fixed graded measures. The primary advantage appears to be when prediction of behavioural frequency is sought by researchers. Although the effect size difference was small, small effect sizes are still of clinical significance in the exercise domain (Rutledge & Loh, 2004). Moreover, even when the continuous open scales were truncated to correspond with the fixed measures, the results support continuous open scaling as an acceptable alternative to standard fixed graded scaling.

Measurement Domain Overlap in the Two Types of Scaling Formats

Continuous open scaling for social cognitive constructs had been considered during the development of the theory of reasoned action, but Ajzen and Fishbein (1980) theorized that the two

scaling formats measured different constructs. They argued that "choice" endorsements measured through continuous open instruments were different from "strength" of advocacy endorsements of a fixed choice. In contrast, we hypothesized that the "choice" component is at least partially measured within the fixed graded items, particularly when the fixed choice is moderate (e.g., 3-4 times per week). Our results provide general support for this hypothesis. Specifically, three of the five TPB constructs showed convergent validity. Affective attitude, subjective norm, and PBC were influenced by the same latent variable regardless of scaling format. Furthermore, on all five TPB fixed graded scales, "strength" of advocacy (e.g., strongly disagree-strongly agree) could be distinguished by an increasing "choice" frequency in the continuous open scales. This directly supports our hypothesis that "strength" of advocacy of a fixed choice is related to "choice" of advocacy. Indeed, fixed graded scales may be a more constrained assessment of choice. Future research in this area is certainly needed, but these results are the first test of how fixed graded scales may be construed in the exercise domain.

Some empirical evidence that the two scaling styles capture similar domains is also present in their significant ($p < .01$) intercorrelations, similar internal consistencies, and particularly their similar magnitude in regression equations. For example, regardless of scaling style, partial correlation coefficients of affective attitude, instrumental attitude, subjective norm, PBC, and intention were of similar magnitude in each of the multivariate regression equations. This suggests that the two scales are generally measuring the same thing with the same proportionate effects on intention and behaviour, but continuous open items may be slightly more accurate measures. Perhaps a multiplicative system whereby participants are asked to respond to continuous open scaling first and then grade the strength of that choice will result in the optimal scaling. This resembles the expectancy x value assumptions in belief-based assessment of the TPB (Ajzen, 2002) and may be worthy of future research efforts.

Application of the Continuous Open Measures to Health Canada's Recommended Minimum Weekly Frequency of Exercise Behaviour

Finally, for an applied analysis of the continuous open scales, regression equations were derived to determine the average frequencies of social cognitive constructs needed to produce Health Canada's (2002) recommended minimum weekly frequency of exercise behaviour. This procedure takes advantage of the ratio-level scaling (i.e., days per week) afforded by using the continuous open TPB measures. The direct application of social cognition theory to absolute values of exercise intention and behaviour has been recommended because it moves from abstract theory testing to tangible outcomes for exercise prescription and promotion (Rhodes & Courneya, 2005; Rhodes, Courneya, & Jones, 2003). Further, these findings may have theoretical importance for dose-response relations in the TPB and application for the expected success of intervention efforts. In this analysis, it is assumed that the interindividual relationship of a TPB construct and its outcome variable can act as a proxy for understanding potential intra-individual behaviour change. This logic mirrors cross-sectional studies of the transtheoretical model and exercise behaviour (see Marshall & Biddle, 2001 for a review), where it is assumed that individuals at higher stages of change have moved through the lower stages of behaviour change.

Results of this analysis were interesting, and show that higher levels of social cognition towards a behavioural frequency than the desired behavioural outcome are needed to produce that desired behavioural outcome. This "negative" slope has been identified previously (see Rhodes et al., 2003), but never in terms of continuous open scaling values. The results showed that, on average, undergraduates would require an intention to exercise at least 5 times per week to produce the desired outcome of four bouts of actual exercise. This suggests that at least one intended bout of exercise is missed in a given week and demonstrates the need for exercise promoters to potentially advocate higher levels of exercise in order to produce the desired health outcome.

Interestingly, even higher levels of TPB constructs, in comparison to intention, are needed to achieve the desired outcome of four bouts of actual exercise (presumably through intention). This suggests that the downward slope from behaviour to intention continues to antecedent TPB constructs. Subjective norm values were the same as intention (i.e., five), but an average of six bouts of affective

attitude, instrumental attitude, and PBC are required, on average, to produce four actual weekly bouts of exercise. In this analysis, the 95% confidence intervals were wide, suggesting that individual variation is large. Nevertheless, these results demonstrate the very high levels of exercise social cognition that may be required to produce health benefits through exercise behaviour among undergraduates.

Limitations to the preceding study may confine the generalizability of these findings. First, the present study used a convenience sample of primarily female university undergraduates and self-reported exercise behaviour. Future research would benefit in quality and generalizability by using more objective measures of exercise (e.g., attendance to a fitness facility) and diverse samples of multiple age groups or clinical populations to strengthen the cross validation of the findings.

Second, the continuous open scaling items were created for this study and will benefit from future psychometric testing. Although the scales demonstrated acceptable internal consistency and predictive validity, we recommend alternate variations and process testing of continuous open scaling to improve this method for the future. For example, the scales used in this study are based on the assumption that participants hold a specific frequency threshold of exercise in mind. A more accurate assumption may be that participants have a range of acceptable thresholds (e.g., enjoy anywhere between 2-4 bouts of exercise per week). Perhaps continuous measures that ask for this range would improve the accuracy of continuous open scales.

Third, it is possible that the consistent difference in the magnitude between the two types of scaling may be less from improved scaling and more a result of a unique property of the wording used. This difference would thus be considered systematic error. Future research may be needed to help discern whether systematic error from the wording of the continuous open measures is responsible for the findings.

Fourth, our counterbalanced design did not follow a randomization procedure in terms of the ordering of the continuous open and fixed dichotomous measures. This may not have been a problem

because we did not find any differences in the results between the two datasets. Still, a randomized experimental design would have been a stronger design for the study.

Finally, the results of continuous open versus fixed graded scaling may differ by behavioural domain. Although we hypothesize results should be similar for all repeated behaviours using continuous open scales, future study in other behavioural domains is needed.

In summary, the purpose of this study was to create continuous open measures of TPB constructs and compare these to standard fixed graded measures. Results showed that psychometric properties were acceptable for both types of scaling, but the correlations of TPB constructs with exercise intention and behaviour were generally larger for continuous open scaling than fixed graded scaling. This result was due to the additional variability afforded by continuous open scaling and not from scale correspondence. Finally, in an applied analysis, regression equations derived from the continuous open measures showed that higher levels of social cognition towards a behavioural frequency than the desired behavioural outcome are needed to produce that desired behavioural outcome. Overall, continuous open scaling may be a superior form of scaling for social cognitive constructs in the exercise domain in comparison to standard fixed graded measures.

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Footnotes

1. We also analyzed the two data-sets separately for all of our four hypotheses. All of the results did not differ ($p > .05$) between the two samples when using independent sample Fisher *z* tests, and *t*-tests.

2. Cohen's *q* was derived for independent sample correlations. Although a correction factor for dependent correlations is sometimes employed (Rosenthal, 1991), Dunlop, Cortina, Vaslow, and Burke (1996) have demonstrated that the correction systematically biases the effect size upwards. These researchers, therefore, advocate that dependent sample effect sizes are most accurate when calculated in a similar fashion to independent samples. We followed the suggestions of Dunlop et al. (1996) when calculating the effect sizes for this study.

3. For an estimate of $r_{1,2}$ an averaged correlation across affective attitude, instrumental attitude, subjective norm, and PBC was used for the regression equation on intention and an averaged correlation across intention and PBC was used for the regression equation on exercise behaviour. These *r*s were converted to Fisher *z* scores, averaged, and then converted back to *r*s for the Hotelling *t* test.

Table 1
Descriptives and Psychometric Properties of Continuous Open and Fixed Graded TPB Scales

	Descriptives			Psychometric Properties	
Construct	Mean	SD	Inter-factor correlation	Average variance extracted	Composite reliability
Affective Attitude			.46*		
Open Scaled	4.19	1.45[a]		.71	.76
Fixed Graded	5.20	1.14		.67	.74
Instrumental Attitude			.33*		
Open Scaled	4.70	1.48[a]		.87	.92
Fixed Graded	6.35	0.70		.67	.75
Subjective Norm			.61*		
Open Scaled	3.16	1.48[a]		.71	.80
Fixed Graded	5.14	1.24		.58	.63
Perceived Behavioural Control			.44*		
Open Scaled	4.71	1.55[a]		.67	.65
Fixed Graded	5.83	1.29		.76	.68
Intention			.79*		
Open Scaled	3.73	1.82		.97	.97
Fixed Graded	5.14	2.03		.97	.97

Note: * $p < .01$. a = significantly ($p < .05$) larger variability.

Table 2
Correlations of the Theory of Planned Behaviour Constructs with Continuous Open Scaled Exercise Intention and Behaviour

Construct	Correlation with intention	t_{417}	*q*	Correlation with Behavior	t_{417}	*q*
Affective Attitude		8.14**	.44		0.66	.03
Open Scaled	.73**			.41**		
Fixed Graded	.45**			.39**		
Instrumental Attitude		7.65**	.43		2.83**	.15
Open Scaled	.59**			.31**		
Fixed Graded	.24**			.17*		
Subjective Norm		6.01**	.27		2.24*	.09
Open Scaled	.54**			.36**		
Fixed Graded	.32**			.28**		
Perceived Behavioural Control		7.13**	.40		4.21**	.22
Open Scaled	.58**			.40**		
Fixed Graded	.25**			.20**		
Intention		NA			2.83**	.08
Open Scaled				.58**		
Fixed Graded				.52**		
Multivariate TPB		8.16**	.47		2.42**	.10
Open Scaled	.79**			.60**		
Fixed Graded	.54**			.53**		

Note: *t* represents Hotelling's *t* for testing differences between two dependent correlation coefficients. *$p < .05$ one tailed; **$p < .01$ one tailed; *q* = Cohen's (1988, 1992) effect size *q*. Results for the multivariate TPB use a multiple R.

Table 3
Correlations of the Theory of Planned Behaviour Constructs With Their Respective Corresponding Scales of Intention and Behaviour

Construct	Correlation with intention	t_{417}	*q*	Correlation with behavior	t_{417}	*q*
Affective Attitude		12.21**	.42		0.89	.04
Open Scaled	.73**			.41**		
Fixed Graded	.47**			.38**		
Instrumental Attitude		8.60**	.39		2.25*	.12
Open Scaled	.59**			.31**		
Fixed Graded	.28**			.20**		
Subjective Norm		7.37**	.27		3.21**	.13
Open Scaled	.54**			.36**		
Fixed Graded	.32**			.24**		
Perceived Behavioural Control		5.76**	.26		4.41**	.23
Open Scaled	.58**			.40**		
Fixed Graded	.38**			.19**		
Intention		NA			3.89**	.11
Open Scaled				.58**		
Fixed Graded				.50**		
Multivariate TPB		11.98**	.34		2.70**	.10
Open Scaled	.79**			.60**		
Fixed Graded	.62**			.53**		

Note: *t* represents Hotelling's *t* for testing differences between two dependent correlation coefficients. *$p < .05$ one tailed; **$p < .01$ one tailed; *q* = Cohen's (1988, 1992) effect size *q*. Results for the multivariate TPB use a multiple R.

Table 4
Correlations of Fixed Graded and Constrained Continuous Open Scales on Continuous Open Intention and Behavior

Construct	Correlation with intention	t_{417}	*q*	Correlation with behavior	t_{417}	*q*
Affective Attitude		4.64**	.19		-2.76**	-.10
Constrained Open Scaled	.59**			.30**		
Fixed Graded	.45**			.39**		
Instrumental Attitude		3.85**	.20		0.36	.02
Constrained Open Scaled	.42**			.19**		
Fixed Graded	.24**			.17**		
Subjective Norm		5.55**	.21		0.73	.03
Constrained Open Scaled	.49**			.31**		
Fixed Graded	.32**			.28**		
Perceived Behavioural Control		5.41**	.26		1.91*	.10
Constrained Open Scaled	.48**			.29**		
Fixed Graded	.25**			.20**		
Intention		NA			0.00	.00
Constrained Open Scaled				.52**		
Fixed Graded				.52**		
Multivariate TPB		7.82**	.27		0.00	.00
Constrained Open Scaled	.70**			.53**		
Fixed Graded	.54**			.53**		

Note: *t* represents Hotelling's *t* for testing differences between two dependent correlation coefficients. *$p < .05$ one tailed; **$p < .01$ one tailed; *q* = Cohen's (1988, 1992) effect size *q*. Results for the multivariate TPB use a multiple R.

Table 5.

Mean Differences of TPB Continuous Open Scores Based on Fixed Graded Responses

	Mean (SD)					F	Eta^2	Post Hoc
Scores	1-3	4	5	6	7			
Affective Attitude	2.54 (1.38)	3.74 (1.37)	4.01 (1.20)	4.50 (1.20)	5.47 (1.49)	33.54*	.22	(1-3)<4,5<6<7
Instrumental Attitude			4.08 (1.43)	4.34 (1.28)	5.12 (1.33)	23.92*	.09	5,6<7
Subjective Norm	1.47 (1.19)	2.18 (1.10)	3.16 (1.13)	3.66 (1.26)	4.76 (1.31)	66.43*	.36	(1-3)<4<5<6<7
PBC		3.42 (1.62)	4.26 (1.44)	4.70 (1.54)	5.27 (1.32)	29.78*	.18	4<5<6<7

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

Table 6
Mean Differences of Intention Continuous Open Scores Based on Fixed Graded Responses

	Mean (SD)							F	Eta^2	Post Hoc
Scores	1	2	3	4	5	6	7			
Intention	1.07 (1.17)	1.81 (1.02)	2.05 (0.98)	2.28 (1.14)	3.36 (1.14)	3.96 (1.04)	5.31 (1.17)	136.94*	.64	1<2<3<4<5<6<7

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

Table 7
Values of TPB Constructs Required to Meet Health Canada's Minimum Recommended Weekly Exercise Frequency

Construct	Required Frequency Based on Regression Equation Results	
	4 bouts / per week (95% CI)	
	Intention	Behaviour
Affective Attitude	4.49 (4.13-4.93)	5.57 (4.54-7.20)
Instrumental Attitude	5.06 (4.48-5.74)	6.40 (4.89-9.28)
Subjective Norm	3.57 (3.15-4.14)	4.77 (3.73-6.33)
PBC	5.13 (4.53-5.82)	6.28 (5.09-8.19)
Intention	NA	4.93 (4.35-5.80)