



Subjective norms matter for physical activity intentions more than previously thought: Reconsidering measurement and analytical approaches

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ABSTRACT

Objectives: Existing literature consistently demonstrates that subjective norms within the Theory of Planned Behavior (TPB) are a weak predictor of physical activity (PA) intentions, which contradicts humans' innate need to relate to others. A potential explanation relates to methodological shortcomings. Previous studies often ignored individuals' salient normative referents (e.g., parents, friends) and the proposed sub-components of subjective norms: *normative belief (NB)* and *motivation to comply (MC)* with the pressures. The purpose of this study was to reassess the relationship between subjective norms and PA intentions by addressing these shortcomings.

Design: Online surveys were administered at baseline ($N = 535$) and two-weeks post-baseline ($N = 340$).

Method: Salient normative referents were elicited with each participant, and NB and MC were assessed in relation to the individually elicited normative referents. Response surface analyses were used to examine the interaction of NB and MC in predicting PA intentions.

Results: NB and MC interacted in a complex manner predicting PA intentions. Intentions were higher when NB and MC were both high or both low, and when NB was high and MC was low. The results varied across normative referents.

Conclusions: The current results suggest that the weak support for subjective norms found in previous studies may be a function of overlooking individuals' salient normative referents and their willingness to comply with the normative pressures.

1. Introduction

Engaging in regular physical activity (PA) results in numerous health benefits (Warburton, Nicol, & Bredin, 2006). Despite such benefits, individual physical inactivity rates remain high, which have become a global concern (e.g., Hallal et al., 2012). As such, promoting PA behavior is a primary goal of the exercise psychology discipline. Various theories of human behavior have been proposed and tested in attempts to understand meaningful predictors of PA (Rhodes & Nigg, 2011). The Theory of Planned Behavior (TPB; Fishbein & Ajzen, 2010), in particular, has received a substantial amount of empirical attention.

The TPB (Fishbein & Ajzen, 2010) proposes that an individual's engagement in PA is directly predicted by one's intention to engage in the behavior. In turn, PA intentions are predicted by three conceptually distinct constructs: *attitudes* (appraisal/evaluation of the behaviors), *subjective norms* (perceived social pressures from significant others to engage in the behaviors), and *perceived behavioral control* (PBC;

perceived control over engaging in the behaviors). PBC is also proposed to directly predict behavior (in addition to the indirect pathway via intentions) depending on the degree to which the individual *actually* has control over the action. These constructs can each be broken down into two different types: *instrumental* (e.g., beneficial/harmful) and *affective* (e.g., pleasant/unpleasant) attitudes; *injunctive* (i.e., perception of *socially approved* behaviors) and *descriptive* (i.e., perception of *typical* behaviors) subjective norms; and *capacity* (i.e., confidence) and *autonomy* (i.e., control over behavior) aspects of PBC (Ajzen, 2002). The TPB is an expectancy-value based theory, which implies that each construct is a product of the belief strength (i.e., expectancy) and the evaluation of the belief (i.e., value). Salient to the focus of the current study, subjective norms can be reflected by the degree to which an individual feels pressured to engage in the behavior (i.e., *normative belief*; NB), and his/her *motivation to comply* (MC) with such pressures (Fishbein & Ajzen, 2010).

Researchers have extensively tested the TPB as a framework for

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understanding PA and several reviews of the relevant literature now exist (e.g., Conner & Armitage, 1998; Rhodes & Nigg, 2011). One consistent finding in this body of literature is that subjective norms, particularly the injunctive type, tend to be a weaker predictor of PA intentions in comparison to attitudes and PBC (Rhodes & Nigg, 2011). The weak support for subjective norms is one of the factors that has led to the questioning of the validity of the TPB in recent debates of this theory (e.g., Ajzen, 2015; Sniehotka, Pesseau, & Araújo-Soares, 2014). In fact, Rhodes and Nigg (2011) asserted that ‘no researcher observing good evidence-based practice would embark on an intervention targeting subjective norm ...’ (p. 115) and suggested its removal from future studies.

The weaker evidence base for subjective norms is puzzling considering that human beings have an innate need to build and maintain social relationships (Baumeister & Leary, 1995) and are driven to adhere to the norms that exist in their environments (Cialdini & Trost, 1998). In other popular socio-cognitive theories of human behavior, social influences are often considered as an integral component. For instance, Self-Determination Theory (Deci & Ryan, 2000) asserts that satisfying the need for *relatedness* (i.e., feeling connected to others) is important for promoting more intrinsic forms of motivation. Within Social Cognitive Theory (Bandura, 2004), the expectation of social approval is proposed to lead to behavior engagement. In sum, the weak relationships between subjective norms and PA intentions, though empirically demonstrated on a consistent basis, appear conceptually at odds with theoretical propositions. As such, exploring other explanations for the weak findings is warranted. One possible explanation pertains to the way subjective norms have been measured in previous studies.

Ajzen (2002) discussed that subjective norms can be measured directly or indirectly. *Direct* measures involve asking participants to report perceived social pressures to engage in PA (i.e., rating statements such as ‘most important people to me think I should engage in regular PA’). *Indirect* measures differ in two ways. First, indirect measures consider the sources of the participants’ beliefs and the degree to which they are personally salient (Ajzen, 2002). In fact, previous literature discussed that the predictive mechanisms in the TPB are stronger when the constructs are measured in relation to the beliefs that are salient to the individuals (e.g., Conner & Armitage, 1998; van der Pligt & de Vries, 1998). In the context of subjective norms, the sources of the salient NBs are the normative referents (e.g., parents, friends) who exert such pressures to the individual. As such, Ajzen recommended researchers employ elicitation tactics, which involve selecting a subsample from the population of interest and eliciting the salient normative referents based on a preliminary questionnaire. The elicited referents are subsequently incorporated in the subjective norm questionnaire (Ajzen, 2002).

The second way that the indirect measures differ from direct measures is that indirect measures consider both NB and MC components (Ajzen, 2002). Specifically, the normative referents (e.g., parents) elicited in the preliminary questionnaire are reflected in NB (e.g., ‘My parents think I should engage in regular PA’) and MC (e.g., ‘When it comes to regular PA, I want to do what my parents think I should do’) items. Ajzen (2002) recommended the multiplication of NB and MC scores to represent an overall subjective norm score.

To examine the ways subjective norms have been measured in the literature, Kim, Dunn, Rellinger, Robertson-Wilson, and Eys (2017) conducted a scoping review that included 125 TPB-based studies in American and Canadian contexts. Their findings demonstrated that 96 articles (76.8%) solely assessed NB (i.e., direct measures), and only 32 articles (25.6%) considered both NB and MC components.¹ Further, only 15 articles (12.0%) employed elicitation tactics, 83 articles

(66.4%) used general normative referents (e.g., ‘most people important to me’), and 58 articles (46.4%) used specific normative referents (e.g., parents, friends) without employing elicitation tactics.² This over-reliance on direct measures, in conjunction with the lack of consideration of salient normative referents, may be problematic because they do not consider the sources of the NBs and individuals’ MC. In fact, Hagger, Chatzisarantis, and Biddle (2001) demonstrated weak associations between subjective norm scores based on indirect measures and those based on direct measures, highlighting the disparity between the two types of measures.

Given the importance of eliciting salient normative referents and considering individuals’ MC (Ajzen, 2002), indirect measures may be a superior method of assessing subjective norms over direct measures. However, two potential problems with indirect measures should also be noted. First, Ajzen (2002) instructed researchers to elicit salient normative referents based on a smaller group of individuals from the population of interest and incorporate the elicited normative referents in the subsequent subjective norm questionnaire administered to the entire sample. A potential problem with this procedure is that individual variations may exist in the salient normative referents. For instance, the subsample may not report ‘siblings’ as salient normative referents, but it is likely that some participants in the overall sample view their siblings as important normative referents. As an illustration, Symons Downs and Hausenblas’ (2005) systematic review of TPB studies showed that spouse/romantic partners and friends were elicited the most often, although there was substantial variation across the reviewed studies regarding other referents such as parents, siblings, healthcare professionals, and so on.

Second, the indirect measures involve assessing the NB and MC components separately and multiplying the two to represent an overall subjective norm score (Ajzen, 2002). An inherent problem with this calculation is that the product of these two scores disregards each component’s relative contributions. For instance, on a 7-point Likert-scale, an overall subjective norm score of 7 may reflect two conceptually distinct scenarios: one scenario involving high NB (i.e., score of 7) and low MC (i.e., score of 1), versus another scenario involving low NB (i.e., score of 1) and high MC (i.e., score of 7). The former scenario represents an individual who feels strong pressures by his/her important others to engage in PA but is not willing to comply with such pressures, whereas the latter scenario represents an individual who does not feel pressured by his/her important others and intends to comply with the lack of pressure. Given this inherent problem, simple multiplication of the scores likely does not accurately represent individuals’ subjective norms. As such, other analytic methods are necessary to provide a more robust test of the ability of subjective norms to predict PA intentions.

In sum, the existing literature has consistently demonstrated that subjective norms are a weak predictor of PA intentions, which appears puzzling given the inherent social needs of human beings. One potential explanation may relate to how subjective norms have been measured and analyzed. Specifically, most previous research relied on direct measures, and thus often ignored the role of salient normative referents and one’s MC, both of which may be critical in influencing behavioral intentions. The studies that did consider salient normative referents were limited to eliciting the referents based on a subsample as per Ajzen’s (2002) guidelines, which ignore the possible individual variation across participants. Further, the studies that considered both NB and MC components were limited to a simple multiplication of the two scores, which does not fully consider the relative contributions of each component.

The purpose of the study was to reassess the role of subjective norms in predicting PA intentions by addressing the noted shortcomings. To

¹ The percentages do not add up to 100% since some articles included both direct and indirect measures.

² The percentages do not add up to 100% since some articles included both general and specific normative referents.

do so, normative referents were elicited from all participants, and NB and MC scores were analyzed in relation to PA intentions via response surface analysis (RSA; Schönbrodt, Humberg, & Nestler, 2018). RSA is an advanced statistical technique that has been increasingly employed within the psychology discipline to examine complex interactions of two predictors in relation to an outcome. Pertinent to the current study, an advantage of RSA is that it avoids using simple discrepancy or product scores between the two predictors. The results can be represented in a 3D graph, which can be used to draw meaningful interpretations (Humberg, Nestler, & Back, 2018; Schönbrodt et al., 2018). To further demonstrate the advantages of this analysis, the current study compared the results based on: (1) direct measures, (2) indirect measures involving multiplying NB and MC scores, (3) a traditional moderation analysis (Baron & Kenny, 1986), and (4) the RSA.

2. Method

2.1. Participants and procedure

Upon approval from the institutional Research Ethics Board, participants were recruited to fill out an online survey (configured with Qualtrics software) at two time points (TPB components at baseline and PA behaviors at two-week follow-up). To help generalize the results, two populations were recruited. First, psychology undergraduate students (N_{T1} : 373; N_{T2} : 259; 69.4% retained; $M_{age} = 19.62 \pm 3.48$) participated to obtain credits toward their introductory courses. Second, adults aged 18+ (N_{T1} : 162; N_{T2} : 81; 50.0% retained; $M_{age} = 28.05 \pm 9.29$) were recruited via social network platforms (e.g., Facebook) to enter a draw for a chance to win gift cards. In total, 535 participants (129 males, 405 females, 1 undisclosed; $M_{age} = 22.70 \pm 7.93$) filled out the survey at time 1, and 340 participants (63.6% retention rate; 67 males, 272 females, 1 undisclosed; $M_{age} = 21.63 \pm 6.52$) filled out the follow-up survey.

2.2. Instruments

Regular PA was defined for all participants as engaging in activities performed with moderate to strenuous intensity, accumulating at least 30 minutes each time, 4 or more times per week. Although an updated definition from the Canadian Society for Exercise Physiology (2011) exists that includes minor differences (e.g., 10-minute bouts of activities), the older definition was adopted to allow for comparisons of the current results to previous TPB literature.

2.2.1. PA behaviors

PA behaviors were measured using the adapted Godin Leisure Time Exercise questionnaire (Godin & Shephard, 1985). Specifically, the respondents were asked to report the number of times they engaged in mild (e.g., archery, walking), moderate (e.g. easy bicycling, fast walking), and strenuous (e.g., running, vigorous bicycling) intensity PA for at least 30 minutes in duration per week over the past two weeks. Then, based on the definition of regular PA employed in the study (i.e., activities performed with moderate to strenuous intensity), the weekly frequency of moderate PA and the weekly frequency of strenuous PA were summed together to represent the total average frequency of PA completed per week.

2.2.2. PA intentions

PA intentions were assessed with six items: three based on a fixed, and the other three based on an open, scaling (Rhodes, Matheson, & Blanchard, 2006). Three fixed items were answered using 7-point scales from 1 ('strongly disagree') to 7 ('strongly agree'), and began with 'I intend to ...', 'I plan to ...', and 'I will try to ...', each of which was followed by 'engage in regular PA for the next 2 weeks'. Three open items asked the participants to report the number of times they intend to engage in PA from 0 to 7 times, and began with 'I intend to ...', 'I

plan to ...', and 'I will try to ...', each of which was followed by 'engage in PA _ times per week for the next 2 weeks'. The mean of the three fixed items were computed to represent *fixed intentions* ($\alpha = 0.93$) and the mean of the three open items represented *open intentions* ($\alpha = 0.95$).

2.2.3. Direct measures of antecedents of intentions

A 7-point Likert scale from 1 ('strongly disagree') to 7 ('strongly agree') was adopted for all items assessing attitude, subjective norm, and PBC (Rhodes, Matheson, & Mark, 2010).

Attitude. Instrumental attitude and affective attitude were assessed with three items each. Each item began with a statement, 'For me, engaging in regular PA would be ...' and was anchored by 'useful', 'wise', and 'beneficial' for instrumental attitude ($\alpha = 0.88$), and by 'enjoyable', 'pleasant', and 'exciting' for affective attitude ($\alpha = 0.93$).

Subjective norm. Injunctive and descriptive subjective norm were assessed with two items each. Two injunctive norm items were 'Most people who are important to me think I should engage in regular PA' and 'Most people whose opinions I value would want me to engage in regular PA' ($\alpha = 0.86$). The two descriptive norm items were 'Most people who are important to me engage in regular PA' and 'Most people whose opinions I value engage in regular PA' ($\alpha = 0.93$).

PBC. The participants' perceptions of autonomy and capacity were assessed with two items each. Two autonomy items were 'Engaging in regular PA, if I really wanted to, is under my control' and 'Whether or not I participate in regular PA is completely up to me' ($\alpha = 0.89$). Two capacity items were 'I am confident that I could engage in regular PA if I wanted to' and 'Engaging in regular PA, if I wanted to do so, would be easy' ($\alpha = 0.68$).

2.2.4. Indirect measures of antecedents of intentions

As per Ajzen's (2002) recommendation, salient beliefs were elicited prior to asking the belief strength and value questions. Specifically, the participants were given a list of common behavioral, normative, and control beliefs (cf. Symons Downs & Hausenblas, 2005; Supplemental Table 1), and asked to select as many options as possible that were personally salient to them. Subsequently, the Qualtrics software was configured to ask the participants to rate the belief strength and value items in reference to only the beliefs that they selected. As in the case of direct measures assessing the determinants of intentions, all belief strength and value items were answered on a 7-point scale from 1 ('strongly disagree') to 7 ('strongly agree').

Attitude. The participants were asked to select advantage/positive outcome(s) and disadvantage/negative outcome(s) of engaging in regular PA from a list of common outcomes (Supplemental Table 1). The subsequent belief strength item was 'Engaging in regular PA will result in the following ...' anchored by 'benefit/outcome(s)' and 'disadvantage/negative outcome(s)'. The value item was 'The following benefit/outcome(s) of regular PA is/are important to me' for positive outcomes and 'The following disadvantage/negative outcome(s) of regular PA is/are detrimental to me' for negative outcomes.

Subjective norm. The participants were asked to select the individuals and/or groups of people who have significant influence on their beliefs, values, and behaviors from a list of common normative referents (Supplemental Table 1). Subsequently, the participants were asked to report their NB and MC in reference to only the selected normative referents. The NB item was 'The following person(s) think(s) that I should engage in regular PA' and the MC item was 'When it comes to regular PA, I want to do what the following person(s) think(s) I should do'.

PBC. The participants were asked to select factor/circumstance(s) that would make it easier (i.e., positive control factors) and more difficult (i.e., negative control factors) to engage in regular PA from a list of common control factors (Supplemental Table 1). Then, the participants were asked to report the control belief strength and power of control in relation to the factors selected. The control belief strength item was 'I expect that the following factor(s) will be ...' anchored by

'present/improved' for positive factors and 'present/exacerbated' for negative factors. The power of control item was 'The following factors make it _ for me to engage in regular PA' with 'easier' (positive factors) and 'more difficult' (negative factors) inserted in the blank.

2.3. Data analyses

2.3.1. Approach #1: direct measures

Structural equation modeling was used (IMB SPSS Amos 24.0.0) to analyze the theoretical relationships among TPB components assessed via direct measures (i.e., attitudes, subjective norms, PBC, and PA intentions at time 1, PA behavior at time 2). Models were specified using the full information maximum likelihood estimation and each TPB construct (instrumental and affective attitudes, injunctive and descriptive subjective norms, autonomy and capacity aspects of PBC, and intentions) was specified as latent variables. Overall model fit was assessed with χ^2 goodness-of-fit test, which assesses the degree to which the predicted covariance matrix and parameter estimates of the specified model deviate from the observed covariance matrix. The comparative fit index (CFI) was assessed as an absolute fit index (i.e., assessing how well the specified model fit the data), and the root mean squared error of approximation (RMSEA) was assessed as an incremental fit index (i.e., testing the specified model's improvement in fit with data over a null baseline model). CFI above 0.95 and RMSEA below 0.07 were deemed as criterion values indicating acceptable fit (Hu & Bentler, 1999).

2.3.2. Approach #2: indirect measures

As recommended by Ajzen (2002), the belief strength and value items assessed in relation to selected salient beliefs were multiplied together to create product scores for each selected belief. Then, the mean of the product scores was computed across all selected beliefs and was used for analysis. For example, for subjective norm, if a participant selected parents and siblings as his/her salient normative referents, two product scores were computed (one for parents and one for siblings) by multiplying the NB and MC scores for each referent, and the mean of the two product scores was used as his/her subjective norm score.

As in the case for direct measures, structural equation modeling was used to test the relationships among TPB components (i.e., attitudes, subjective norms, PBC, and intentions at time 1, PA behavior at time 2). Because there were two separate belief elicitation questions (positive vs. negative outcomes/control factors) for attitudes and PBC, there was a total of five determinants of intentions (attitudes assessed in relation to positive and negative outcomes, PBC assessed in relation to positive and negative control factors, and subjective norms). Attitudes and PBC based on positive factors (outcomes and control factors, respectively) and subjective norms were expected to be positively associated with intentions, whereas attitudes and PBC based on negative factors were expected to be negatively associated with intentions.

2.3.3. Approach #3: traditional moderation analysis

A moderation analysis was conducted with the TPB components assessed via indirect measures using multiple regression. The outcome variable of interest was PA intentions, as subjective norms are theoretically purported to directly influence PA intentions rather than PA behaviors (Fishbein & Ajzen, 2010). In the first model, the two mean product scores of attitudes (one for positive outcomes and one for negative outcomes) and the two mean product scores of PBC (one for positive control factors and one for negative control factors) were entered as controlling variables. In model 2, the standardized mean NB and MC scores (i.e., averaged across selected normative referents) were entered. In model 3, the product of the two standardized mean scores (NB and MC) was entered to test moderation (Baron & Kenny, 1986).

2.3.4. Approach #4: RSA

RSA was used to assess NB and MC scores concurrently as they

relate to PA intentions. As in the case of approach #3, the outcome variable was PA intentions as subjective norms are purported to directly influence intentions rather than behaviors (Fishbein & Ajzen, 2010).

First, there should be sufficient numbers of participants who display discrepancy between the two predictors (i.e., NB and MC) to conduct this analysis (Humberg et al., 2018). The discrepancy was inspected by following the procedure described by Fleenor, McCauley, and Brutus (1996), which compares standardized scores of the two variables and considers the difference of half a standard deviation or greater as discrepancies. Among 535 participants, 264 participants (49.3%) did not show discrepancy, 140 participants (26.2%) indicated higher MC than NB, and 131 participants (24.5%) indicated higher NB than MC. Given high degree of discrepancy (271 participants; 50.7%), the analysis was deemed appropriate.

Eight RSAs were conducted with intention at time 1 as the outcome: one using mean scores of NB and MC (averaged across salient normative referents for each participant) and the other seven focusing on each normative referent, separately.³ For each analysis, NB and MC scores were centered by subtracting them by 4 (i.e., around midpoint of the scale). Then, an R package developed by Schönbrodt et al. (2018) for conducting RSA was used, which allows the computation and the statistical test of several models/fit patterns between two predictor variables in relation to an outcome variable. Specifically, the R package examines the surface diagram of the relationship among the variables and tests its fit against various possible patterns pertaining to whether the surface is shifted and/or rotated from the line of congruence between the two predictors, and whether it is tilted up/downwards toward a certain direction (see Table 1, Figure 1). In addition, it provides statistical comparisons between the tested models, which helps determine the most conceptually sound and parsimonious one(s). To select the best-fitting model/fit(s) to the data, several criteria are used. First, the model with the smallest corrected Akaike Information Criterion (AICc) is considered to be best-fitting, and any other models with $\Delta AICc$ (i.e., difference in AICc compared to the best model) of 2 or less are considered to be practically equivalent (Schönbrodt, 2016). In addition, models with higher CFI values (> 0.95 ; Hu & Bentler, 1999), and those that achieved statistical significance for the overall regression model were favored. Among models with similar fits to the data, those with smaller free parameters (k) were favored given higher parsimony⁴ (Schönbrodt, 2016).

Once the best-fitting model(s) is(are) determined, individual parameter estimates can be examined to understand the relationships among the variables of interest. First, raw regression coefficients in the model can be examined: b_1 = linear effect of normative belief, b_2 = linear effect of motivation to comply, b_3 = curvilinear effect of normative belief, b_4 = interaction effect of normative belief and motivation to comply, and b_5 = curvilinear effect of motivation to comply. In addition, four surface values that test the slope and curvature of the lines of congruence and incongruence between NB and MC can be examined: a_1 = linear additive effect of line of congruence, a_2 = curvature on the line of congruence, a_3 = shift of the ridge from the line of congruence, a_4 = general effect of incongruence. A statistically significant a_1 indicates that intentions increase as NB and MC increase (positive a_1) or decrease (negative a_1) together (i.e., the slope of the line of congruence). A significant a_2 represents a non-linear slope of the line of congruence: A positive value indicates a convex (U-shape), and a negative value indicates a concave (inverse U-shape), curve. a_3 tests the slope of the line of incongruence at the center point of the surface (i.e., both NB and MC at 0), and a significant a_3 indicates that

³ RSA of normative influences from children was not conducted as only 36 participants selected children.

⁴ Given the purpose of the study was to assess the interaction of NB and MC, models that assess only one predictor (i.e., only NB or only MC) or only the simple additive effect (i.e., independent effects of NB and MC) were excluded.

Table 1
Response surface analysis results (overall means across normative referents).

a) Fixed intention						
Models	k	AICc	ΔAICc	CFI	Adj. R ²	p
IA	5	1806.39	0.00	> 0.99	0.06	< .001
SRRR	6	1806.91	0.52	> 0.99	0.06	< .001
SRR	5	1807.98	1.59	0.96	0.05	< .001
Parameter estimates						
	Estimate	Robust SE	95% CI (lower)	95% CI (upper)	p	
IA model						
b ₁	.28	.07	.14	.41	< .001	
b ₂	-.07	.07	-.20	.06	.293	
b ₃	N/A	N/A	N/A	N/A	N/A	
b ₄	.04	.04	-.03	.11	.274	
b ₅	N/A	N/A	N/A	N/A	N/A	
a ₁	.21	.09	.04	.38	.016	
a ₂	.04	.04	-.03	.11	.274	
a ₃	.35	.10	.15	.55	< .001	
a ₄	-.04	.04	-.11	.03	.274	
b) Open intention						
Models	k	AICc	ΔAICc	CFI	Adj. R ²	p
SRRR	6	1980.55	0.00	> 0.99	.07	< .001
Full	7	1982.05	1.50	> 0.99	.06	< .001
Parameter estimates						
	Estimate	Robust SE	95% CI (lower)	95% CI (upper)	p	
SRRR model						
b ₁	.21	.07	.06	.35	.005	
b ₂	-.15	.06	-.27	-.03	.013	
b ₃	.06	.03	-.002	.12	.057	
b ₄	.06	.02	.02	.11	.006	
b ₅	.02	.02	-.02	.05	.316	
a ₁	.05	.07	-.09	.19	.483	
a ₂	.14	.04	.07	.21	< .001	
a ₃	.36	.11	.14	.58	.002	
a ₄	.01	.03	-.04	.07	.628	

Note. Models with ΔAICc < 2 are presented. k = number of free parameters estimated. Tested models include Full (Fully polynomial), IA (Interaction), SRRR (Shifted and rotated rising ridge), SRR (Shifted rising ridge), RR (Rising ridge), SRSQD (Shifted and rotated squared difference), SSQD (Shifted squared difference), SQD (Basic squared difference), and Null (Intercept only). b₁ = linear effect of NB, b₂ = linear effect of MC, b₃ = curvilinear effect of NB, b₄ = interaction effect of NB and MC, b₅ = curvilinear effect of MC, a₁ = linear additive effect of line of congruence, a₂ = curvature on the line of congruence, a₃ = shift of the ridge from the line of congruence, a₄ = general effect of incongruence. N = 535.

the highest point (i.e., highest intentions) along the line of incongruence is located away from the center of the surface: positive value indicating to the right side, (i.e., higher NB than MC) and negative value indicating to the left side (i.e., higher MC than NB), of the surface. Lastly, a significant a₄ represents the shape of the surface above the line of incongruence: A positive value indicates a convex, and a negative value indicates a concave, curve. For a full description of the analysis, see Schönbrodt et al. (2018), Humberg et al. (2018), and Schönbrodt (2016).

3. Results

Prior to the main analyses, the dataset was examined for missing data. There were small proportions of indirectly assessed TPB

components (i.e., products of belief strength and value in relation to elicited beliefs) that were missing: attitudes in relation to positive (n = 6; 1.1%) and negative (n = 16; 3.0%) outcomes and PBC over positive (n = 7; 1.3%) and negative (n = 4; 0.7%) control factors. These missing values occurred either because the participants did not answer one or both of the belief strength and value items (i.e., thus product scores could not be computed), or because they did not select any salient factors for a given TPB construct (i.e., thus the participants were not given any subsequent belief strength and value items). No missing values were observed for directly measured TPB components, indirectly measured NB and MC, PA intentions, and PA behavior at time 2. The missing values for indirectly measured variables were handled by using the full information maximum likelihood estimation in structural equation modeling for the indirect measure analysis and by list-wise deletion for the traditional moderation analysis (Enders & Bandalos, 2001). Bivariate correlations among variables of interest are summarized in Supplemental Tables 2 (direct and indirect measures) and 3 (RSA).

3.1. Normative referent elicitation

Information regarding the elicited salient normative referents is summarized in Table 2. Friends (84.9%) and parents (79.8%) were the most common referents, whereas children (7.5%) were the least common referents in the sample (student and general adult samples combined). There were 96 distinct combinations of selected normative referents, with the most common combination being spouse/boyfriend/girlfriend, parents, siblings, and friends (n = 41).

3.2. Direct measures

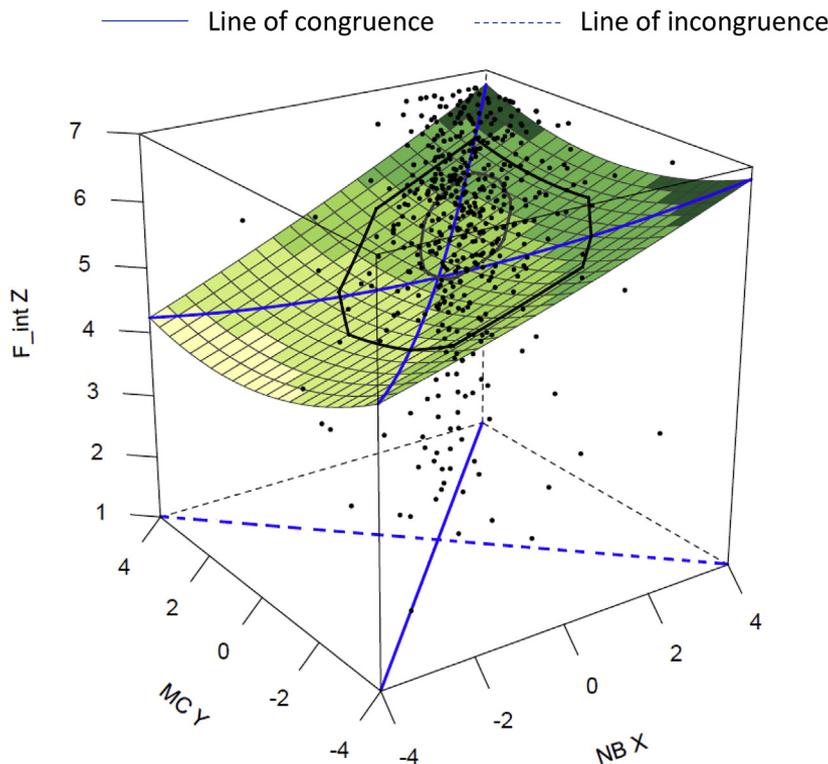
Supplemental Figures 1 (fixed intention) and 2 (open intention) provide the summary of the results based on TPB components measured directly. The loadings for the items measuring the TPB components (attitudes, subjective norms, PBC, intentions) were all relatively high (ranging from 0.66 to 0.96). The overall model fits were acceptable, $\chi^2(112) = 245.07, p < .001; CFI = 0.98; RMSEA = 0.05$ (fixed intention), $\chi^2(112) = 219.84, p < .001; CFI = 0.98; RMSEA = 0.04$ (open intention).⁵ In both models, theoretical relationships in the TPB were generally in line with previous literature. That is, (a) intentions at time 1 predicted PA behavior at time 2, (b) attitude and PBC were significant predictors of intentions, and (c) subjective norms was a non-significant or a weaker predictor of intentions. One exception was that the autonomy component of PBC had negative associations with PA intentions and behavior.

3.3. Indirect measures

Supplemental Figures 3 (fixed intention) and 4 (open intention) provide the summary of the results based on TPB components measured indirectly. The overall model fits were acceptable, $\chi^2(15) = 20.34, p = .159; CFI = > 0.99; RMSEA = 0.03$ (fixed intention), $\chi^2(15) = 12.18, p = .665; CFI = > 0.99; RMSEA < 0.001$ (open intention). In both models, theoretical relationships in the TPB were generally in line with previous literature. That is, (a) intentions at time 1 predicted PA behavior at time 2, (b) attitude and PBC were significant predictors of intentions, and (c) subjective norms was a non-significant predictor of intentions.

⁵ Although the significant Chi-square results provide evidence against the fit of the model to the data, Chi-square results are likely to be statistically significant with minimal discrepancies between the model and the data with large sample size (Tanaka, 1987). Given our sample size (N = 535), the fits were considered to be acceptable based on the CFI and RMSEA.

a) Fixed intentions as the outcome



b) Open intentions as the outcome

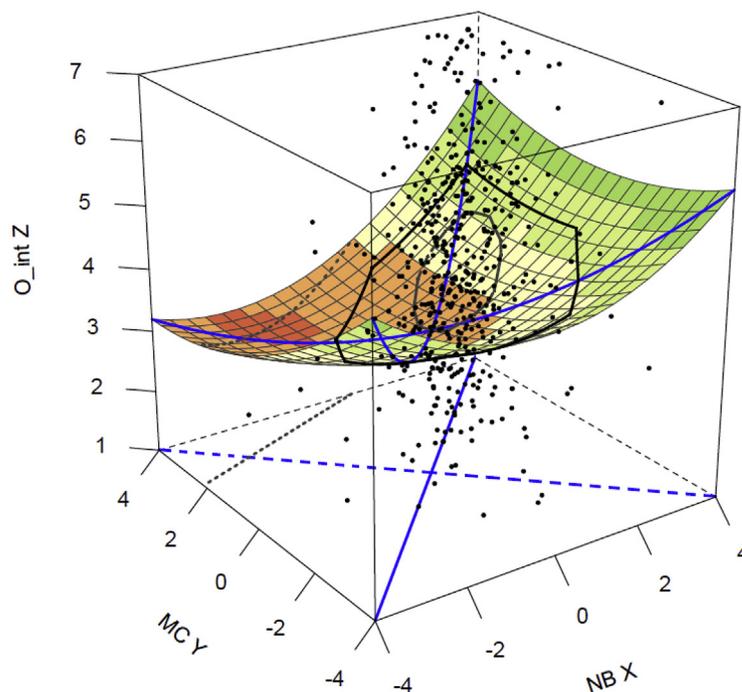


Figure 1. Response surface analysis of normative belief and motivation to comply scores across normative referents. $N = 535$.

3.4. Traditional moderation analysis

Mixed results were found between intentions measured based on fixed scaling vs. open scaling. For fixed intention as the outcome, the interaction term between NB and MC was not significant, $\beta = 0.06$, $t(497) = 1.35$, $p = .179$. For open intention as the outcome, the

interaction term between NB and MC was statistically significant, $\beta = 0.11$, $t(497) = 2.63$, $p = .009$ (Overall model: $\Delta R^2 = 0.03$, $F(7, 497) = 22.72$, $p < .001^6$; Supplemental Table 4). These results

⁶ ΔR^2 represents the difference between the final model (with standardized

Table 2
Salient normative referents.

Normative referents	Students (n = 373)	General (n = 162)	Total (N = 535)
Friends	325 (87.1%)	129 (79.6%)	454 (84.9%)
Parents	322 (86.3%)	105 (64.8%)	427 (79.8%)
Siblings	216 (57.9%)	72 (44.4%)	288 (53.8%)
Spouse/boyfriend/ girlfriend	160 (42.9%)	112 (69.1%)	272 (50.8%)
Community	135 (36.2%)	35 (21.6%)	170 (31.8%)
Healthcare professionals	111 (29.8%)	43 (26.5%)	154 (28.8%)
School/work personnel	79 (21.1%)	51 (31.5%)	130 (24.3%)
Children	13 (3.5%)	27 (16.7%)	40 (7.5%)
Other	14 (3.8%)	4 (2.5%)	18 (3.4%)

Note. For the ‘Other’ option, participants specified extended family (e.g., aunt, uncle, cousins), society, role models, myself, celebrities, coaches, teammates, church leaders, professors, and classmates.

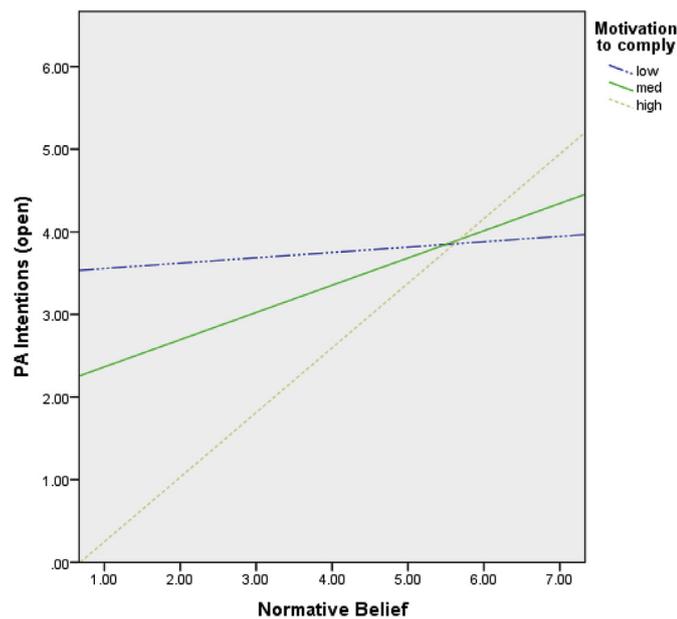


Figure 2. Traditional moderation analysis with open intentions as outcome. Low = motivation to comply 1 standard deviation below the mean. Med = motivation to comply within 1 standard deviation (–1 to +1) around the mean. High = motivation to comply 1 standard deviation above the mean. Normative belief and motivation to comply scores are averaged across salient normative referents.

demonstrate that the relationship between NB and PA intentions was moderated by MC, such that the relationship was stronger under the conditions of higher MC (See Figure 2).

3.5. RSA

RSA results for overall means across normative referents are summarized in Table 1 and Figure 1. RSA results for each specific referent are summarized in Online Supplemental Tables and Figures 5-11. In each table, the model comparisons omitted any models with ΔAICc greater than 2, and individual parameter estimates are provided for the best-fitting model(s).⁷

(footnote continued)

NB, MC, and NB x MC) and model 1 (without standardized NB, MC, and NB x MC).

⁷ Some of the analyses pertaining to specific normative referents (Online Supplemental File) revealed two models that had relatively equivalent fits to the data. In such cases, parameter estimates for both models were provided. For

For fixed intention as the outcome (Table 1a, Figure 1a), the IA (interaction) model had the best fit to the data. Examination of the parameter estimates for this model revealed a statistically significant positive linear effect of normative belief, $b_1 = 0.28$, $SE = 0.07$, 95% CI: [0.14, 0.41], $p < .001$, and a positive linear additive effect of line of congruence, $a_1 = 0.21$, $SE = 0.09$, 95% CI: [0.004, 0.38], $p = .016$, indicating that increasing values of intentions were associated with increasing values of NB and MC simultaneously. Lastly, a positive slope of the line of incongruence at the center was noted, $a_3 = 0.35$, $SE = 0.10$, 95% CI: [0.02, 0.55], $p < .001$, indicating that the highest datapoint above the line of incongruence was associated with a combination of higher NB and lower MC (i.e., right side of the figure; Figure 1a).

For open intention as the outcome (Table 1b, Figure 1b), the SRRR (shifted and rotated rising ridge) model had the best fit to the data. Examination of the parameter estimates for this model revealed a positive linear effect of normative belief, $b_1 = 0.21$, $SE = 0.07$, 95% CI: [0.06, 0.35], $p = .005$, a negative linear effect of motivation to comply, $b_2 = -0.15$, $SE = 0.06$, 95% CI: [-0.27, -0.03], $p = .013$, and a positive interaction effect, $b_4 = 0.06$, $SE = 0.02$, 95% CI: [0.02, 0.11], $p = .006$. Further, a positive non-linear effect of the line of congruence was noted, $a_2 = 0.14$, $SE = 0.04$, 95% CI: [0.07, 0.21], $p < .001$, indicating a convex (U-shape) curve, and a positive slope of the line of incongruence at the center was noted, $a_3 = 0.35$, $SE = 0.10$, 95% CI: [0.02, 0.55], $p < .001$, indicating that the highest datapoint above the line of incongruence was associated with a combination of higher NB and MC (i.e., right side of the figure; Figure 1b).

Taken together, PA intentions appeared to be higher when (1) NB and MC were both high, (2) NB and MC were both low (open intentions only), and (3) NB was higher than MC, whereas PA intentions were lower when NB was lower than MC (Figure 1).

4. Discussion

The purpose of the current study was to reassess the role of subjective norms for the prediction of PA intentions, specifically by comparing the results deduced based on direct and indirect measures of subjective norms (Ajzen, 2002), a traditional moderation analysis (Baron & Kenny, 1986), and RSA (Schönbrodt et al., 2018). The results based on the direct and indirect measures (Ajzen, 2002) were consistent with the previous literature; subjective norms were a weak predictor of PA intentions. However, the results based on the traditional moderation analysis and the RSA revealed that NB and MC interact in a complex manner predicting PA intentions, which highlights the shortcomings of the analytic methods typically employed in previous studies. The traditional moderation analysis revealed that individuals are likely to intend to engage in more frequent PA if they feel pressures from important others to engage in PA and are willing to comply with the pressures, but not when they are less willing to comply with the pressures. Such explanation is logically intuitive and aligns with the theoretical emphasis on the role that both NB and MC play in shaping one’s intentions to engage in PA behaviors (Ajzen, 2002). These results suggest that researchers should examine both components as opposed to using the direct measures of subjective norms that ignore the MC component.

The results from the RSA extended the findings based on the traditional moderation analysis and offered several implications. First, the positive a_1 for fixed intentions indicated higher intentions were associated with individuals who reported higher NB and MC concurrently, and the positive a_2 for open intentions indicated that higher intentions were noted when the participants’ NB and MC were both higher or both

(footnote continued)

cases with three relatively equivalent models, parameter estimates for two of the models were provided.

lower (U-shape curve; Figure 1b). The association of higher intentions with higher NB and MC makes conceptual sense (i.e., one feels pressured, is willing to comply, and thus intends to be active). However, the association of higher open intentions with lower NB and MC is a novel finding and implies that those who perceive that important others do not value PA may still intend to be active by *rejecting* the lack of pressures. It appears that when individuals have low perceived pressures to engage in PA (i.e., low NB), they can either comply with the low pressures (i.e., high MC) and thus have low PA intentions, or reject the low perceived pressures (i.e., low MC) and thus have high PA intentions. This finding offers a potential explanation to the weak associations between subjective norms and PA intentions commonly found in studies based on direct measures of subjective norms, as they do not consider individuals' willingness to comply with the pressures and thus cannot distinguish between those who accept vs. reject the low perceived pressures.

The significant a_3 (i.e., slope of the line of incongruence) in both Figures 1a (fixed intention) and 1b (open intentions) indicated that intentions were higher when NB was high and MC was low, and that intentions were lower when NB was low and MC was high. Although the latter scenario appears logical (i.e., one does not feel pressured to be active and complies with the lack of pressure, and thus has low intentions), the former scenario appears counterintuitive (i.e., one feels pressured to be active, is less willing to comply, but has higher intentions). A potential explanation is that the social pressures/norms have such profound influences on humans (Baumeister & Leary, 1995; Cialdini & Trost, 1998) that even those who explicitly report less willingness to comply with such pressures are subconsciously affected by them. In addition, given that the participants were instructed to select personally salient normative referents, social pressures from these important individuals may have been strong enough to overwhelm the lower motivation to comply. More importantly, this finding highlights the inherent problem with the simple multiplication of NB and MC scores. That is, multiplying the two scores results in the same overall subjective norm score (i.e., centered scores of $-2 \times +2$; overall score = -4) in both scenarios, yet one scenario is associated with higher intentions and the other is associated with lower intentions. As such, weaker previous findings in studies that utilized multiplication scores may have been a function of disregarding the *direction of the discrepancy* between the two components, which was found to be meaningful in the current study.

The results regarding the normative referents are also worthy of discussion. Not surprisingly, some notable differences existed between the student sample and the general adult sample (Table 2). For example, parents were selected more commonly among undergraduate students (86.3%) compared to the adults (64.8%), whereas spouse/boyfriend/girlfriend option was selected more often by the adults (69.1%) than the students (42.9%). These results are intuitive, as undergraduate students are likely to be more dependent on their parents in various aspects (e.g., financial, emotional support) compared to the general adult sample, who may be more likely to have built long-term relationships with their romantic partners and thus are influenced more by them than their parents. These results support Ajzen's (2002) emphasis on the need to elicit salient normative referents prior to assessing subjective norms.

However, several observations deduced from Table 2 challenge the validity of the elicitation procedures based on a subsample as advocated by Ajzen (2002). For instance, though it appears logical that friends ($n = 454$; 84.9%) and parents ($n = 427$; 79.8%) were the most common referents for the combined sample, these results also suggest that some individuals *did not* select friends ($n = 81$; 15.1%) and parents ($n = 108$; 20.1%). All other referents (e.g., siblings, spouse, etc.) were selected by approximately 50.0% of the sample or less, and 96 distinct combinations of selected referents existed. Further, there were several differences between the current results and those by Symons Downs and Hausenblas' (2005) systematic review of TPB-based studies. For

example, spouse/boyfriend/girlfriend was less common in the current study (selected by 50.8% of the sample) than their review (elicited in 18 out of 20 reviewed studies), whereas parents (79.8% vs. 6 studies) and siblings (53.8% vs. 3 studies) were more common in the current study.

Some of the discrepancies between the current findings and those by Symons Downs and Hausenblas (2005) may be due to population differences. For example, it appears logical that the current sample (i.e., university students and adults aged 28.05 years on average) rarely selected children as the salient normative referents (7.5%), whereas studies reviewed in Symons Downs and Hausenblas that included older adults (e.g., age 65 and above) often indicated that children were salient normative referents. However, as explained previously, the current findings showed that a seemingly homogenous sample (e.g., psychology undergraduate students) also had considerable individual variations in the salient normative referents (see Table 2). This implication suggests that the previous studies that elicited salient normative referents with a subsample likely had omitted truly influential social agents for many participants in the overall sample when assessing their subjective norms, which may have distorted their results. In fact, the results from the RSA based on each referent (Supplemental Tables 5-11 and Figures 5-11) clearly show that the relationships among PA intentions, NB, and MC are different from one normative referent to the next. For example, the patterns of normative influences from parents were similar to the results based on overall scores across normative referents (e.g., significant a_1 and a_3 for fixed intentions, significant a_3 for open intentions; Supplemental Table 6), whereas influences from spouse/girlfriend/boyfriend were not as meaningful (Supplemental Table 5).

Despite the novel insights, a few limitations must be considered. First, the main analyses (i.e., traditional moderation, RSA) focused on PA intentions as the outcome variable. Recent literature has discussed that high intentions do not always lead individuals to adopt regular PA behaviors (i.e., PA intention-behavior gap; Rhodes & de Bruijn, 2013). However, the main analyses deliberately focused on intentions because subjective norms are theoretically purported to directly influence intentions rather than behaviors (Fishbein & Ajzen, 2010), and because the goal of the study was to provide an explanation to the weak relationship between subjective norms and PA intentions consistently found in the previous literature that contradicts the theoretical propositions. In addition, despite the recent controversies surrounding the PA intentions-behavior gap, PA intentions are still recognized as an important predictor of PA behaviors (e.g., Rhodes & de Bruijn, 2013), and the current findings also supported this association (i.e., statistically significant prediction at $p < .001$; Supplemental Figures 1-4).

Second, the present study followed Ajzen's (2002) recommendation to achieve *scale compatibility*, which involves using a consistent behavior criterion (e.g., 'engaging in PA for 30 minutes each time, 4 or more times per week') for assessing the antecedent (i.e., subjective norm) and the outcome (i.e., PA intentions). In addition, with the exception of PA intentions assessed via open scaling, all variables were assessed based on Likert-type scales with perceptual anchors (i.e., disagree/agree). McDermott and Sharma (2017) recently demonstrated that self-report assessments, scale compatibility, and Likert-type scales can result in method bias that may artificially inflate the correlations between the variables.

Despite the potential method bias, such variable assessment approaches were adopted to compare the results to the previous studies that commonly employed these approaches. Further, the strength of the current study that provides some protection against the method bias was that the findings regarding the relationship between subjective norms and PA intentions varied based on the analytic approaches. Specifically, although subjective norms assessed via direct measures and indirect measures involving simple multiplication of NB and MC revealed weak support for the relationship between subjective norms and PA intentions, the traditional moderation and RSAs revealed more complex patterns of relationships. As such, it is unlikely that the

significant interaction effects were results of inflated correlations.

5. Conclusion

The current study provided evidence that the weak associations between subjective norms and PA intentions consistently found in the literature may be explained by the methodological shortcomings involving the measurement and analysis of subjective norms. To the authors' knowledge, this was the first study to employ RSA to assess subjective norms, and the overall results can be organized into several recommendations for future studies assessing subjective norms in the context of PA. First, direct measures should be avoided as they omit the elicitation of salient normative referents and ignore individuals' motivation to comply. Second, salient normative referents should be elicited with all participants (rather than a subsample) prior to assessing subjective norms (Symons Downs & Hausenblas, 2005). Configuring electronic surveys may help facilitate this process (i.e., administer the items only in relation to salient referents for each participant). Third, both normative belief and motivation to comply should be assessed. The two scores should not be multiplied together to represent an overall subjective norm score. Instead, analytic methods that can examine the moderation/interaction (e.g., RSA) between the two components should be used. In the present study, RSA provided a clearer picture of the relationships among study variables.

Overall, future researchers should conduct replication studies that incorporate these recommendations in order to continue to reassess the role of subjective norms in PA contexts, and further explore the nuances of the relationships between one's perceived normative pressure and his/her (un)willingness to comply with the pressure in their prediction of PA intentions. Finally, the potentially different mechanisms by which various normative referents influence the individuals should be investigated. Such studies will provide a more robust and sensible test of the role that subjective norms play in predicting individuals' intentions to engage in PA.

Conflicts of interest

No funding details or conflict of interest to disclose

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.psychsport.2019.04.013>.

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