Closing the intention-behavior gap in physical activity: the moderating effect of individual differences in the valuation of physical effort

For correspondence:
maltagli@usc.edu
boris.cheval@ens-rennes.fr

Silvio Maltagliati[1], David A. Raichlen[1,2], Ryan E. Rhodes[3], Boris Cheval[4,5]

[1]Human and Evolutionary Biology Section, Department of Biological Sciences, University of Southern California, CA, US

[2]Department of Anthropology, University of Southern California, CA, US

[3]School of Exercise Science, Physical and Health Education, University of Victoria, Victoria, BC, Canada

[4]Department of Sport Sciences and Physical Education, École normale supérieure de Rennes, Bruz, France

[5]VIPS[2] Laboratory, University of Rennes, France

Please cite as: Maltagliati, S., Raichlen, D., Rhodes, R.E., Cheval, B. (2024). Closing the intention-behavior gap in physical activity: the moderating effect of individual differences in the valuation of physical effort. *SportRxiv*.

Abstract

Objective. In most psychological models, intention is viewed as a proximal antecedent of physical activity. However, despite its importance, intention often fails to translate into actual behaviors. The Theory of Effort Minimization in Physical Activity (TEMPA) has suggested that the valuation of physical effort may explain the intention-behavior gap. The purpose of this study was to examine whether individual differences in approach and avoidance tendencies toward physical effort moderate the strength of the association between intention and action.

Methods. Data were collected from 401 Canadian participants using two online surveys separated by one week. Intention strength and individual differences in the tendencies to approach and avoid physical effort were first assessed. Moderate and vigorous physical activity were self-reported seven days later.

Results. Linear regression models showed that approach tendencies ($\beta = .11$, $p = .007$), avoidance tendencies ($\beta = -.11$, $p = .005$) moderated the association between the intention to be physically active and physical activity. As expected, the association between intention and physical activity was stronger as approach tendencies toward physical effort increased, but weaker as avoidance tendencies increased. Results of secondary analyses suggested that the moderating effect of approach and avoidance tendencies was observed only for vigorous physical activity, but not for moderate physical activity.

Conclusion. Consistent with TEMPA, this study suggests that individual differences in the valuation of physical effort represent a moderator of the intention-behavior gap in physical activity. Incorporating these individual differences into physical activity promotion may help to close the intention-behavior gap.

Keywords: Exercise, motivation, personality, physical exertion.

Introduction

Intention is widely recognized as a proximal antecedent of physical activity behavior in psychological models (Feil et al., 2023). For example, the theories of reasoned action and of planned behavior (Ajzen, 1985, 1991; Ajzen & Fishbein, 1980), which are popular and among the most widely used social cognitive models, incorporate attitudes, subjective norms, and, in the case of the theory of planned behavior, perceived behavioral control to explain intention. Intention, in turn, is considered as the most immediate precursor of behavior (Biddle et al., 2007). While empirical data support that intention is necessary to engage in a certain behavior, it also shows that it is not sufficient to always guarantee the initiation of physical activity behavior (Rhodes & Bruijn, 2013). For example, in the meta-analysis by Feil et al. (2023), results showed, on the one hand, that less than 5% of the sample actually engaged in physical activity without reporting an intention to be physically active, underscoring that intention is a necessary condition for behavioral initiation. On the other hand, among individuals who had the intention to engage in physical activity, approximately one in two failed to translate this intention into action, highlining the insufficiency of intention alone.

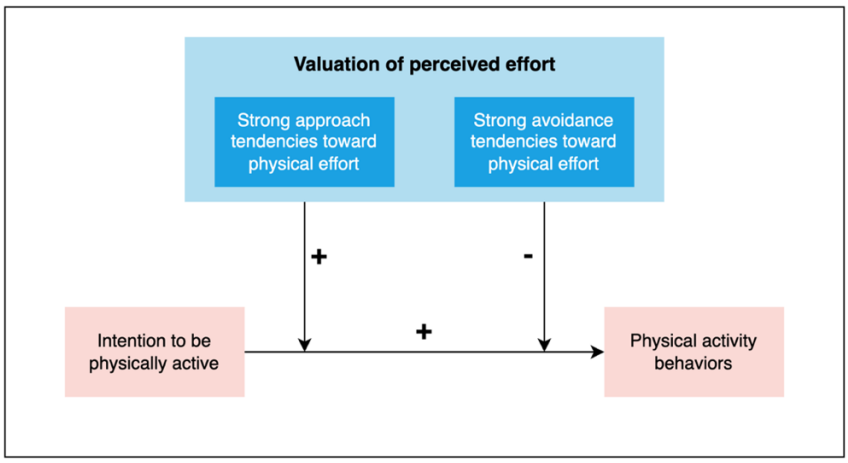
This intention-action gap is not without consequences. Today, it is estimated that one person dies every six seconds worldwide from causes related to physical inactivity, amounting to approximately 5.3 million deaths annually (WHO, 2020). Better understanding, and ultimately addressing, this inability to translate intention into action is imperative if we want to have any chance of mitigating the global pandemic of physical inactivity (Kohl et al., 2012) and achieving the target of a 15% reduction in physical inactivity by 2030 (WHO, 2019). Numerous factors have been proposed to capture the circumstances under which intention effectively translates into actual behavior, including variables such as a high intention stability, a high intention commitment, a low goal conflict, positive affective attitudes, and a strong perceived behavioral control (Rhodes et al., 2022). Likewise, several theoretical approaches such as the HAPA (Schwarzer & Luszczynska, 2008), the I-Change (De Vries, 2017), the COM-B (Michie et al., 2011), or the M-PAC (Rhodes, 2017) have been developed to identify key constructs that may favor the translation of intention into action. In line with this research perspective, the Theory of Effort Minimization in Physical Activity (TEMPA)

(Cheval & Boisgontier, 2021) has been considered as another approach able to shed light on the intention-behavior discordance.

TEMPA argues that the tendency to minimize physical effort may represent a key moderator of the intention-behavior gap, but has been largely underappreciated so far (Cheval et al., under review). In short, TEMPA posits that humans have a strong tendency to minimize physical effort – making sedentary behavior opportunities particularly appealing and a by-default behavioral response (Cheval, Cabral, et al., 2021; Cheval et al., 2020; Cheval et al., 2017; Cheval et al., 2018; Falck et al., 2024) – which may hinder the successful translation of physical activity intention into behavior. This suggestion is consistent with other models, such as the M-PAC, which also considers automatic approach-avoidance tendencies as key drivers of intention-behavior discordance (Rhodes, 2017). Crucially, TEMPA proposes that if individuals have a general tendency to minimize physical effort, individual differences in this tendency should be expected, as observed for cognitive effort (Cacioppo et al., 1996). Specifically, according to TEMPA, these individual differences in the perception of physical effort are central to understanding the regulation of physical activity behavior. It is hypothesized that an stronger tendency to approach rather than to avoid physical effort, would increase the participation in physical activity by facilitating the translation of intention to engage in physical activity into actual behavior (Cheval et al., 2024) (Figure 1).

Figure 1.

Hypothesized relationships of the moderating effects of approach and avoidance tendencies toward physical effort on the intention-action association.



Until recently, however, there has been a lack of a scale to measure individual differences in the valuation of physical effort, hindering our ability to directly test the hypothesis proposed by TEMPA. The recent development of the Physical Effort Scale and avoidance tendencies toward physical effort has filled this gap (Cheval et al., 2024). This eight-item scale can be used to capture the tendency to approach physical effort, the tendency to avoid physical effort, and the relative tendency to approach (vs avoid) physical effort. The reliability of the scores of PES has been established for examining individual differences in the valuation of physical effort, and their validity has been supported by their associations with self-reported physical activity behavior (Cheval et al., 2024). However, at the time of writing, this measure has not been used to test the assumptions of TEMPA.

Building on the recent development of the PES, the objective of the present study was to directly test, for the first time to our knowledge, whether individual differences in the tendencies to approach and avoid physical effort are moderators of the intention-behavior gap in the physical activity domain. In line with TEMPA (Cheval & Boisgontier, 2021), we hypothesized that the association between intention and physical activity would be stronger as automatic approach tendencies toward physical effort increased (H1). On the contrary, we expected a weaker association as automatic avoidance tendencies toward physical effort increased (H2). Finally, consistent with the aforementioned hypotheses, we expected a stronger relationship between intention and physical activity as the relative tendency to approach (vs avoid) physical effort increased (H3).

Of note, additional analyses were performed – adjusting for age and sex, using a Metabolic Equivalent Task (MET)-based score instead of time spent in moderate-to-vigorous physical activity, and examining time spent in moderate and vigorous physical activity separately. The latter analysis was planned because, based on Ekkekakis's previous work on the relationship between affective responses and effort intensity (Ekkekakis, 2003), one might expect that the role of approach-avoidance tendencies toward effort on the intention-behavior relationship might depend on the intensity of the enacted behavior, with a stronger influence for vigorous than for moderate physical activity intensity.

Methods

Procedure and participants

The study was approved by the Research Ethics Board of the University of Ottawa, Canada (H-07-22-8284). Participants were students recruited from the research participation pool of a Canadian university in exchange for partial course credits. All participants followed the procedure online and were asked to complete the study on a computer in a quiet environment. They first completed a ~15-minute questionnaire assessing their intention to be physically active and their approach-avoidance tendencies toward physical effort. Seven days later, they were invited to complete the second part of the study, in which they self-reported their physical activity levels over the past week.

In total, 409 English-speaking participants entered the questionnaire and provided complete answers on the variables of interest at both time points. Eight participants who reported implausible levels of physical activity (i.e., > 25 hours of moderate-to-vigorous physical activity per week) were excluded. Thus, 401 participants were included in the present analyses, with women making up 71% of the sample and a mean age = 20 ± 5 years (Table 1).

Measures

Dependent variable: Seven days after having completed the first questionnaire, participants' level of physical activity was measured by a modified version of the International Physical Activity Questionnaire (Craig et al., 2003). This version of the questionnaire has been used in previous studies, with levels of physical activity being associated with health-related outcomes (Cheval, Sivaramakrishnan, et al., 2021) and showing significant relationships with motivational factors (e.g., autonomous motivation) (Maltagliati et al., 2021). In this questionnaire, participants were asked to report the amount of time (in hours and minutes) they spent practicing moderate physical activity, vigorous physical activity, walking and sitting during their leisure time over the last seven days. Time spent practicing moderate-to-vigorous physical activity was considered as the main variable of interest to, but analyses were also conducted for moderate and vigorous physical activity separately. Indeed, original studies validating this scale found that the association between the PES scores could be stronger for vigorous physical than for moderate physical activity (Cheval et al., 2024).

Independent variable: Intention strength was measured on the first questionnaire using two items (Ajzen, 2006; Rhodes & Rebar, 2017). Participants were asked to indicate the extent to which they agreed with the following statements: "*Over the next seven days, I intend to engage in at least 30 daily minutes of moderate-to-vigorous physical activity on most days of the week, during my free time*" and "*Over the next seven days, I am determined to engage in at least 30 daily minutes of moderate-to-vigorous physical activity on most days of the week, during my free time*". Answers were reported on a Likert scale ranging from "I completely disagree (1)" to "I completely agree (7)". Internal consistency was good, with Cronbach's $\alpha = .87$.

Moderating variables: Approach and avoidance tendencies toward physical effort were measured in the first questionnaire using the English version of the PES (Cheval et al., 2024). Participants received the following instructions: "*This questionnaire relates to physical effort, which is usually associated with increased heart rate and breathing. Please read each of the following statements carefully and indicate the extent to which you agree or disagree with that statement. There are no right or wrong answers*". Four items were used for each dimension (e.g., "*I usually like activities that require physical effort*" for the approach dimension ; "*Exerting physical effort does not appeal to me*" for the avoidance dimension). Answers were given on a five-point Likert scale ranging from "I completely disagree" (1) to "I completely agree" (5). Previous studies have confirmed the reliability and validity of this scale for predicting self-reported PA in Canadian students (Cheval et al., 2024; St-Denis et al., work in progress). In the present study, the reliability of both subscales was high, with Cronbach's $\alpha = 0.90$ for the approach tendencies and Cronbach's $\alpha = 0.92$ for the avoidance tendencies. Additionally, following Cheval et al., (2024), a relative approach (vs avoidance) score was computed by subtracting the mean avoidance score from the mean approach score – with a higher score indicating stronger approach versus avoidance tendencies toward physical effort.

Statistical analyses

To examine the potential moderating effect of approach and avoidance tendencies toward physical effort on the association between intention and physical activity, we computed linear regression models. In separate models, interactive terms were entered between intention and approach tendencies (Model 1), between intention and avoidance

tendencies (Model 2), and between intention and relative approach (vs avoidance) score (Model 3). Simple slope analyses – were first performed to decompose the potentially significant interactions. We then performed region of significance analyses using the Johnson-Neyman method (Bauer & Curran, 2005) to estimate the threshold of PES-related scores at which the association between intention and physical activity was significant versus non-significant. Statistical assumptions associated with linear regressions (i.e., normality of the residuals, linearity, multicollinearity, and undue influence) were checked for all the models.

In a first set of additional analyses, the same models were further adjusted for participants' gender and age. Only participants who identified themselves as "male" or "female" were included in the analyses, resulting in a sample of 394 participants. Second, we converted time spent in moderate-to-vigorous physical activity into a Metabolic Equivalent Task (MET)-based score (MET-based score = time spent in moderate physical activity × 4 + time spent in vigorous physical activity × 8) and used this score at the outcome (Craig et al., 2003). In a third set of additional analyses, the same models were re-run with moderate and vigorous physical activity being specified as different dependent variables. Finally, to account for the non-normal distribution of the physical activity variable (i.e., 17 % of participants reported having engaged in zero minutes of physical activity, resulting in a dispersed right-skewed distribution) and the non-normal distribution of the residuals in the linear models, zero-inflated models with a Poisson distribution were computed. In short, these models predicted the odds of engaging (versus not engaging) in more than zero minutes of physical activity using a binomial function (first step) and estimated the effects of predictors on physical activity levels among participants who engaged in more than zero minutes of physical activity using a logit link function (second step) (Green, 2021) – see also an example of application in the domain of physical activity (Maltagliati et al., 2024).

All variables were scaled (i.e., mean of 0 and standard deviation of 1) before conducting abovementioned analyses. All analyses were performed using the R software (version 4.4). In accordance with good research practices (Boisgontier, 2022), scripts and data are available at the following link: https://zenodo.org/records/10706945

Results

Descriptive statistics are reported in Table 1 (see also descriptive statistics stratified by gender in Table S1). Participants reported a mean of 298 ± 300 minutes of moderate-to-vigorous physical activity, with ~60% of the sample meeting the World Health Organization recommendations (i.e., at least 150 minutes of moderate-to- vigorous physical activity per week).

Table 1. Demographic information and descriptive statistics.

	Mean (SD)	**Range**
Demographic information		
Sex (N, % of women)		
Female	286 (71%)	–
Male	108 (27%)	–
Prefer not to disclose	1 (< 1%)	–
These options do not apply	6 (1%)	–
Age	20 (5)	18; 52
Faculty or school		
Social Sciences	83 (21%)	–
Health Sciences	125 (31%)	–
School of Management	47 (12%)	–
Sciences	76 (19%)	–
Arts	58 (14%)	–
Engineering	10 (2%)	–
Law	2 (<1%)	–
Descriptive statistics		
Intention to be active	4.9 (1.6)	1; 7
PES – Approach tendencies	3.6 (0.9)	1; 5
PES – Avoidance tendencies	2.4 (0.9)	1; 5
PES – Relative approach (vs avoidance) tendencies	1.3 (1.8)	-4; 4
Moderate-to-vigorous PA (in min)	298 (300)	0-1380
Moderate PA (in min)	145 (165)	0-1200

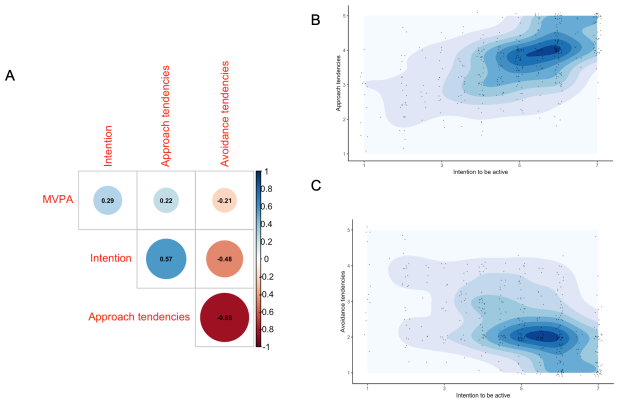
Vigorous PA (in min)	152 (195)_	0-870

Notes. SD: standard-deviation; PES; Physical Effort Scale; PA: Physical activity.

The mean scores for the PES were respectively of 3.6 ± 0.9 for approach tendencies and 2.4 ± 0.9 for avoidance tendencies on the five-point Likert scale. The relative approach (avoidance) tendency was of 1.3 ± 1.8 on a score potentially ranging from -4 to +4. Bivariate correlations are shown in Figure 2A. To illustrate the distribution of intention with approach tendencies toward physical effort and intention with the avoidance dimension, two-dimensional plots are displayed in Figure 2B and 2C (see also Figure S2).

Figure 2.

Bivariate correlation table (A) and two-dimensional density plots (B, C).



Notes. MVPA: moderate-to-vigorous physical activity. All correlations are significant, with $p < .001$ (A). In the two-dimensional density plots (B, C), different density ranges of the data are displayed, with darker color corresponding to a greater density of observations in the data.

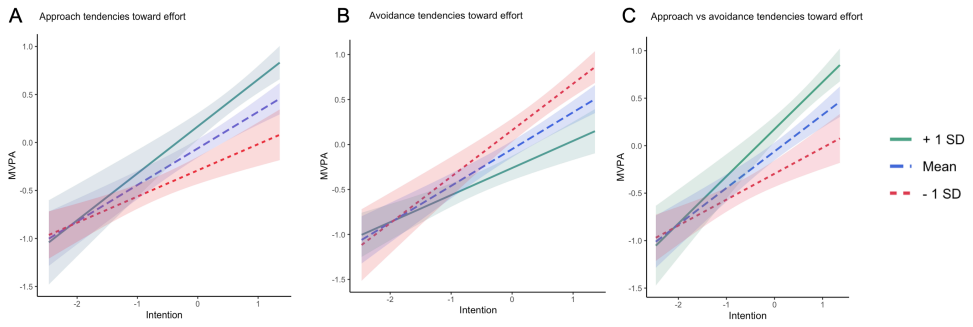
As expected (H1, H2, H3), in Models 1, 2 and 3 (Table 2), approach tendencies (β = .11, 95CI = .03; .18, $p = .007$), avoidance tendencies (β = -.11, 95CI = -.18; -.03, $p = .005$) and the relative approach (vs avoidance) tendencies toward physical effort (β = .11, 95CI = .04; .19, $p = .005$) moderated the association between the intention to be physically active and moderate-to-vigorous physical activity. Simple slope analyses further showed that the association between intention and physical activity was stronger when approach tendencies were high (+1 SD, $b = .49$, 95CI = .35; .63, $p < .001$), compared to low (-1 SD, $b = .27$, 95CI

= .15; .39 p = .005, Figure 3A). On the contrary, the association between intention and physical activity was weaker when avoidance tendencies were high (+1 SD, b = .30 95CI = .18; .42, p = .001), relative to low (-1SD, b = .52, 95CI = .37; .66, p < .001, Figure 3B). Consistent with these observations, when using the relative approach (vs avoidance) tendencies score as moderator, results showed that the association between intention and physical activity was stronger when this score was high (+1 SD, b = .50, 95CI = .36; .63, p < .001), relative to low (-1SD, b = .27, 95CI = .15; .39, p = .005, Figure 3C).

Regarding region of significance analyses using the Johnson-Neyman method, results showed that the association between intention and physical activity was significant when the approach tendencies toward effort were above ~1.9 on the five-point Likert scale (i.e., mean scaled sample score - 1.96 SD) and not significant below this threshold (Figure 4A). For the avoidance tendencies, the association between intention and physical activity was significant when the avoidance tendencies toward effort were below ~4.4 on the five-point Likert scale (i.e., mean scaled sample score + 2.17 SD) and non-significant above this threshold (Figure 4B). Finally, consistent with these results, when using the relative approach (vs avoidance) tendencies score as the moderator, the association between intention and physical activity was significant when this relative score was above -2.2 on a range of -4 to + 4 (i.e., mean scaled sample score -1.97 SD) and non-significant below this threshold (Figure 4C).

Figure 3.

Simple slopes for the associations between intention and approach tendencies (A), avoidance tendencies (B) and approach-avoidance tendencies (C) on moderate-to-vigorous physical activity.



Notes. MVPA: Moderate-to-vigorous physical activity; SD: standard-deviation. All variables were scaled.

Table 2.

Results from linear models using moderate-to-vigorous physical activity as the dependent variable.

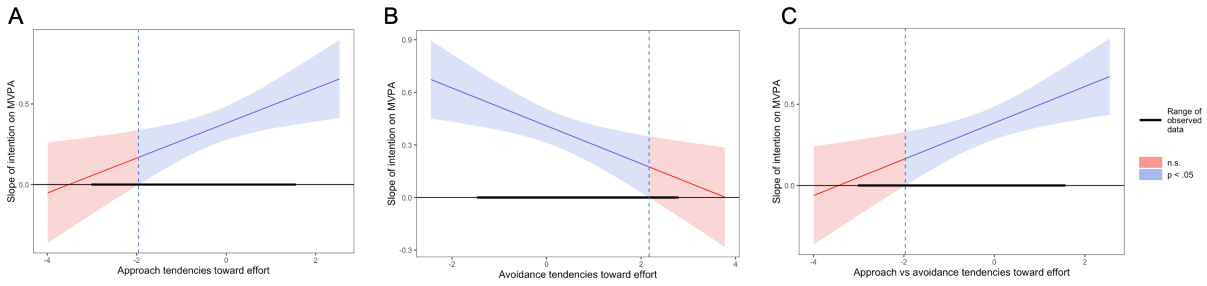
	Model 1: PES score: Approach tendencies			**Model 2 : PES score: Avoidance tendencies**			**Model 3: PES score: Approach vs avoidance tendencies**		
Variables	β	95CI	*p*	β	95CI	*p*	β	95CI	*p*
Intercept	-0.06	-0.16 – 0.03	.204	-0.05	-0.14 – 0.04	.271	-0.06	-0.15 – 0.03	.202
Intention	0.38	0.28 – 0.49	<.001	0.41	0.31 – 0.51	<.001	0.39	0.28 – 0.49	<.001
PES score	0.23	0.13 – 0.33	<.001	-0.21	-0.31 – -0.11	<.001	0.23	0.13 – 0.33	<.001
Intention × PES score	0.11	0.03 – 0.19	.007	-0.11	-0.18 – -0.03	.005	0.11	0.04 – 0.19	.004
R^2		0.28			0.28			0.28	

Note. PES: Physical Effort Scale ; 95CI = 95% confidence interval.

The results remained unchanged after further adjustment for age and gender in the first set of additional models (Table S2) and when using a MET-based score in the second set of models (Table S3). In the third set of additional models, when moderate physical activity was used as the dependent variable, neither approach tendencies, nor avoidance tendencies, nor the global score for approach-avoidance tendencies significantly moderated the association between intention and moderate physical activity (Table S4). However, when using vigorous physical activity was used as the dependent variable, results were similar to the main analysis: approach tendencies, avoidance tendencies, and the relative approach (vs avoidance) tendencies score significantly moderated the association between intention and vigorous physical activity (Table S5, Figure S1). Finally, in zero-inflated models (Table S6), neither the approach tendencies, nor avoidance tendencies, nor the relative score significantly moderated the association between intention and odds of engaging (vs not engaging) in more than zero minutes of moderate-to-vigorous physical activity (first step of the models). However, as in the main analysis, approach tendencies, avoidance tendencies, and the relative score moderated the association between intention and levels of moderate-to-vigorous physical activity among participants engaging in more than zero minutes of moderate-to-vigorous physical activity (second step of the models).

Figure 4.

Region of significance of the association between intention and depending on moderate-to-vigorous physical activity, depending on approach tendencies (A), avoidance tendencies (B) and approach vs avoidance tendencies (C).



Note. MVPA: Moderate-to-vigorous physical activity; n.s: non-significant. All variables were scaled (mean = 0, standard-deviation = 1).

Discussion

Main findings

This study examines whether individual differences in approach and avoidance tendencies toward physical effort can act as potential moderators of the intention-behavior gap in physical activity. As hypothesized, results revealed that the strength of the association between intention and physical activity behavior increased as approach tendencies toward physical effort increased and as avoidance tendencies toward physical effort decreased. This moderating effect was observed for vigorous-intensity physical activity, but not for moderate-intensity activity. Overall, these findings support the idea that individual differences in the valuation of physical effort are a relevant moderator of the intention-behavior gap in physical activity, as suggested by TEMPA (Cheval & Boisgontier, 2021). In the remainder of the discussion, we contextualize our findings within the existing literature and then consider the limitations and strengths of this study.

Comparison with other studies

The observation that the association between intention and physical activity is contingent on individual differences in the processing of physical effort is consistent with a study that focused on the *automatic* approach (vs avoidance) tendencies toward physical activity and sedentary behavior stimuli, as measured by a reaction-time task (Cheval et al., 2015). Specifically, results from this study showed that intention predicted the engagement in a device-based measure (i.e., accelerometer) of physical activity over one week only among participants with low or moderate, but not high, automatic approach tendencies toward sedentary behavior (Cheval et al., 2015) – an effect that was particularly pronounced among individuals with a high trait of impulsivity (Cheval et al., 2016). Although this study did not directly measure individual differences in the valuation of physical effort itself, it suggests that differences in tendencies to approach stimuli associated with sedentary behavior, which may represent the by-default behavioral response due to their low-effort dimension (Cheval, Cabral, et al., 2021; Cheval et al., 2020; Cheval et al., 2017; Cheval et al., 2018; Falck et al., 2024), may serve as a relevant moderator of the intention-behavior link. Taken together, these results corroborate individual differences in both automatic (i.e., as assessed by a reaction time task) and reflective (i.e., as assessed by a self-report questionnaire) tendencies to

approach and avoid effort-related behaviors may be an important, but relatively unexplored, moderator of the intention-behavior gap.

Although to our knowledge this study is the first to provide direct empirical support for the moderating role of approach-avoidance tendencies on effort, previous work examining the moderating role of personality traits had indirectly found empirical support for this idea. For example, extraversion, a personality trait that provides a predisposition for the exertion of one's resources, has often been found to be a moderator of intention-behavior associations, although the evidence remains mixed (Rhodes et al., 2022; Rhodes & Wilson, 2020). In parallel, neuroticism, a personality trait that has been paired with the avoidance of physical effort, has been found to be associated with physical activity (De Moor & De Geus, 2018; De Moor et al., 2012). Therefore, it may also play a moderating role in the relationship between intention and physical activity. Overall, it is reasonable to hypothesize that scores on the PES may represent a mediator of the association between personality traits and physical activity. Future studies may be interested in testing this possibility.

Results of the region of significance analyses further showed that if the strength of the association between intention and physical activity increased as approach tendencies toward physical effort increased and avoidance tendencies decreased, it should also be noted that the association between intention and physical activity became non-significant only at rather extreme values of approach and avoidance scores. For example, the intention-physical activity association was not significant when approach tendencies were below 1.9 on the five-point Likert scale (corresponding to 12 participants in the sample, ~3% of the sample) and above 4.4 on the avoidance dimension (corresponding to 7 participants in the sample, ~2% of the sample) (Figure S2). Using relative approach (vs. avoidance) tendencies score ranging from -4 to +4, the association was not significant when the score was below -2.2 (corresponding to 14 individuals of the full sample, ~3%). Thus, it appears that individual differences in the tendency to approach and avoid physical effort can explain the inability to translate intention into action, but only for a small portion of the population who exhibit very low approach tendencies toward physical effort and/or very high avoidance tendencies toward physical effort. These findings may have clinical implications for exercise prescription, as they suggest that approach-avoidance tendencies toward effort may be a useful screener for targeting individuals at highest risk of not translating their intention into action.

However, at least two factors need to be considered when interpreting these results. First, the sample consists of young who are healthy and self-report high levels of physical activity, which may have reduced the range on the scale at which the association between intention and physical activity was not significant. Second, as discussed above, approach-avoidance tendencies toward effort represent only one driver of the intention-behavior discordance, as several other candidates have been identified in the literature, such as intention stability or perceived behavioral control (Michie et al., 2011; Rhodes, 2017; Rhodes et al., 2022; Schwarzer & Luszczynska, 2008). In addition to these features, it should also be noted that the measure of physical activity used in the main analysis combines moderate-intensity physical activity with vigorous-intensity physical activity, which may influence the main effect and/or moderating effect of approach-avoidance tendencies on physical activity. To test this possibility, we performed a secondary analysis examining the spent in moderate and vigorous physical activity separately. Results of these secondary analyses showed that the moderating effect of both approach and avoidance tendencies toward physical effort emerged only for self-reported vigorous-intensity physical activity, but not for self-reported moderate-intensity physical activity. Regarding the range of the scale at which the association between intention and physical activity was not significant, we found that the association between intention and vigorous physical activity was significant when the approach tendencies toward effort were above ~2.4 on the five-point Likert scale (i.e., mean scaled sample score - 1.40 SD) and not significant below this threshold (Figure 4A). For the avoidance tendencies, the association between intention and physical activity was significant when the avoidance tendencies toward effort were below ~4.0 on the five-point Likert scale (i.e., mean scaled sample score + 1.67 SD) and not significant above this threshold (Figure 4B). Finally, consistent with these results, when the relative approach (vs avoidance) tendencies score was used as a moderator, the association between intention and physical activity was significant when this relative score was above -1.5 on a range of -4 to + 4 (i.e., mean scaled sample score -1.45 SD) and non-significant below this threshold (Figure 4C).

These results are consistent with the assumptions of TEMPA (Cheval & Boisgontier, 2021), which suggests that the perception of effort associated with a given behavior constitutes an antecedent of a given physical activity behavior. They also provide indirect support for other theoretical perspectives such as M-PAC (Rhodes, 2017), hedonic theory

(Williams, 2019; Williams et al., 2019), or affective-reflective theory (Brand & Ekkekakis, 2018), which argue that high-intensity physical activities may elicit negative affective responses, which in turn may reduce the likelihood of performing this effortful behavior. Thus, the perception of effort associated with moderate-intensity physical activity may not be strong enough to prevent individuals from successfully translating their intention into action, even among individuals with a low tendency to approach effort and/or a high tendency to avoid effort. In line with this rationale, our study found that the association between intention and moderate-intensity physical activity was significant regardless of individual differences in the propensity to approach or avoid physical effort (Table S2). In other words, individual differences in the valuation of physical effort may represent an important moderating factor, but only for activities that require a substantial amount of effort – such as vigorous-intensity physical activity. These observations align with the work by Ekkekakis and colleagues that has robustly demonstrated that exercise of vigorous intensity are associated with negative affective responses that may in turn prevent individuals from engaging in such activities (Ekkekakis et al., 2008). Nevertheless, it is important to note that our results should be here interpreted with caution as the distinction between physical activity of moderate and vigorous intensity may not be reliably captured using a self-reported questionnaire.

Clinical implications

TEMPA proposes that the promotion of physical activity must consider individual differences in tendencies to approach and avoid physical effort. The present study provides evidence that individual differences in approach-avoidance tendencies may indeed affect individuals' ability to translate their intention into action, especially for vigorous physical activities. Accordingly, the PES may be used as a screening tool to identify individuals at risk of not translating their conscious intention into actual behavior. Alternatively, although no empirical evidence is currently available in the context of physical effort, it could be argued that interventions could be conducted to reduce the tendency to avoid effort and promote a tendency to approach physical effort, as has recently been done in the context of cognitive effort (Clay et al., 2022). In the meantime, we believe that policy makers should consider these tendencies to minimize effort in order to develop more effective interventions. These interventions could jointly target other individual factors, such as the cognitive function that are needed to counteract the so-called law of the least effort (Cheval, Cabral, et al., 2021;

Cheval et al., 2018), but also environmental factors, in order to create an environment that tips the balance in favor of active (versus sedentary) lifestyles (Cheval et al., 2019; Cheval et al., 2017).

Limitations and strengths

The study includes at least two limitations. First, we used a self-reported measure of physical activity, which may not accurately assess the actual level of physical activity (Prince et al., 2008). This self-reported measure also poses challenges, as previously highlighted and briefly reiterated here, because 1) it may artificially increase the association between intention and physical activity and 2) it may not accurately measure the intensity of physical activity. Future studies should consider incorporating device-based estimations of physical activity (e.g., combining heart rate-derived and accelerometer-derived measures) to better evaluate physical activity intensity and, in turn, better identify when approach and avoidance tendencies might influence the strength of the intention-behavior association. Second, since the data were obtained from a cohort of young, healthy, physically active (i.e., participants self-reported, on average 298 minutes of moderate-to-vigorous physical activity), and well-educated individuals, the generalizability of our findings to other samples needs to be confirmed. For example, for this sample, physical activities of a moderate intensity may be paired with a relatively low level of perceived effort, which may explain why the individual differences in the perception of effort may be unrelated to the intention-action link for moderate-intensity physical activity. On the contrary, as people get older, this range of intensity may be perceived as more effortful, and thus, the individual differences may become relevant in this population to explain the intention-action gap. Future work could focus on determining whether the non-significant moderating effect of individual differences in the valuation of physical effort on the association between intention and moderate-intensity physical activity would also be observed in an older or less physically active sample.

The study has however at least four strengths. First, it was based on a newly developed scale, the PES, which has shown sound psychometric properties (Cheval et al., 2024). Second, this is the first study to directly test the hypothesized moderating effect of individual differences in the valuation of physical effort on the association between intention and physical activity. Third, we used a statistical analysis that allowed a fine-grained analysis of the moderating results, estimating, for each dimension of the scale, the range of values at

which it can be expected to observe a (non-)significant association between intention and physical activity. Finally, results of the secondary analyses that disaggregated self-reported physical activity of moderate and vigorous intensity allow to demonstrate that the moderating role of the individual differences in the valuation of physical effort may also depend on the type of physical activity being considered.

Conclusion

Our findings support the hypothesis that individual differences in the tendencies to approach and avoid physical effort act as moderators of the association between intention and physical activity behavior. These results are consistent with TEMPA (Cheval & Boisgontier, 2021), suggesting that individuals with a weak tendency to approach physical effort and/or a strong tendency to avoid physical effort may struggle translating their laudable intention to be physically active into actions, especially the most vigorous ones.

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