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Task-efficacy predicts perceived enjoyment and subsequently barrier-efficacy: Investigation of a psychological process underpinning schoolchildren's physical activity

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Abstract

Self-efficacy and perceived enjoyment have been recognized as important psychological correlates of children's physical activity (PA). However, research investigating the psychological process underpinning self-efficacy and perceived enjoyment has generated "contradictory" findings – with some regarding self-efficacy as an antecedent of enjoyment while the others arguing for the reverse. To mitigate this confusion, we have embraced the largely overlooked distinction between task- and barrier-efficacy in PA research and have examined the proposal that task-efficacy enhances perceived enjoyment and, subsequently, increases barrier-efficacy and PA. In a sample of 331 eight-to-ten years old schoolchildren (169 boys), task-efficacy manifested an indirect effect on accelerometer-based measures of MVPA and total PA via perceived enjoyment and subsequently barrier-efficacy. Perceived enjoyment served as a mediator of task-efficacy on MVPA but not total PA. Barrier-efficacy appeared to be a consistent mediator underlying schoolchildren's PA regardless of PA intensity. The findings suggest that 1) the distinction between task- and barrier-efficacy warrants consideration in children's PA promotion and 2) the psychological drivers of more vigorous types of PA differ compared to lower intensity PA. Future research would do well to explore the key psychological factors underpinning less vigorous types of PA to inform the development of effective PA interventions for those who have difficulties engaging in MVPA.

Keywords: physical activity, accelerometer, enjoyment, efficacy, schoolchildren

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Physical activity (PA) in the early years of life contributes to a wide range of lasting benefits, such as enhanced cognitive development (Carson et al., 2016), reduced obesity-related diseases and insulin resistance (Dwyer et al., 2009), and less binge drinking- and smoking-relevant health issues (Kwan, Cairney, Faulkner, & Pullenayegum, 2012). Given these exclusive benefits, it is unsurprising that substantial research attention has examined various potential determinants of PA among children to offer implications for promoting PA behaviors in the early years of life (see Lubans, Foster, & Biddle, 2008). In this context, reviews of systematic reviews have suggested that among the different conceptual correlates of PA (Bandura, 1986, 2004), psychological factors such as self-efficacy and perceived enjoyment are the most proximal influence of children's PA (e.g., Biddle, Atkin, Cavill, & Foster, 2011; Sterdt, Liersch, & Walter, 2014). Evidence also supports both self-efficacy and perceived enjoyment as mediators of various school-level PA interventions (e.g., Dishman, Jackson, & Bray, 2014; Dishman et al., 2004; Dishman, Motl, Saunders, et al., 2005) and the mechanisms underlying the relationship between other social-environmental factors (e.g., social, parental, peer support) and children's PA (e.g., Chen, Sun, & Dai, 2017; Lewis, Marcus, Pate, & Dunn, 2002; Silva, Lott, Mota, & Welk, 2014).

However, although the independent role of self-efficacy and perceived enjoyment in children's PA is relatively clear, the causal relationship between PA self-efficacy and perceived enjoyment is, to some extent, mysterious. Specifically, evidence exists not only for self-efficacy as an antecedent of perceived enjoyment but also for supporting the effect being the opposite direction. For example, among a sample of Australia students (Jackson, Myers, Taylor, & Beauchamp, 2016), researchers found that the influence of self-efficacy on student PA achievements at school operated through increased levels of perceived enjoyment. In a

Chinese sample of young adolescents (Hu, Cheng, Lu, Zhu, & Chen, 2016), researchers randomized participants to a low or high self-efficacy condition to engage in moderate-intensity PA and found high compared to low self-efficacy group reported higher levels of perceived enjoyment in doing prescribed exercising activities. Findings are consistent among non-Latina White and Latina samples when using similar research designs (e.g., Jerome et al., 2002), suggesting that individuals with higher PA self-efficacy in the early years of life perceive PA to be more enjoyable and thus may adopt a more active life.

On the other hand, evidence also supports the effect in the opposite direction. In an examination of a US PA intervention for low active individuals (Lewis, Williams, Frayeh, & Marcus, 2016), results revealed that self-efficacy at the sixth month mediated the effect of baseline enjoyment on the 12-month PA, but enjoyment at the sixth month did not manifest similar effects. In another laugh-based PA program (i.e., LaughActive) designed to improve PA via enhancing enjoyment (Greene, Morgan, Traywick, & Mingo, 2017), researchers found that self-efficacy mediated the relationship between perceived enjoyment and PA over 12-week time. These findings suggest that perceived enjoyment is essential for obtaining PA self-efficacy, which subsequently contributes to PA.

Although some studies regard PA self-efficacy as an antecedent of PA enjoyment while the others argue for the opposite direction, one largely overlooked aspect in self-efficacy and PA research is the distinction between task- and barrier-efficacy (Bandura, 2004). According to Bandura's social cognitive framework (Bandura, 1986, 1997, 2004), task-efficacy refers to one's perceived *ability to execute* a specific behavioral task, and barrier-efficacy is conceptualized as one's belief in the *capacity to overcome obstacles* in performing a certain behavioral task. Although having emerged over decades, such a distinction has yet to be widely considered in PA research.

Indeed, the task-/barrier-efficacy distinction explains the "contradictory" findings in PA literature. Specifically, research demonstrating different directions of the relationship between self-efficacy and perceived enjoyment in PA have used measures that assess distinct aspects of efficacy yet claim to be homogeneous under the umbrella term of "self-efficacy". To expand, intervention studies supporting PA self-efficacy as an antecedent of perceived enjoyment have typically adopted measures established from McAuley and Mihalko's (1998) *Exercise Self-efficacy Scale* (e.g., Hu et al., 2016; Hu, Motl, McAuley, & Konopack, 2007; Jackson et al., 2016; Jerome et al., 2002), with a predominating focus on the confidence in completing certain PA tasks (e.g., "I am able to continue to exercise three time per week at moderate intensity, for 30+ minutes, for most days of the next week"). As such, the studies using McAuley's Exercise self-efficacy scale typically suggest that PA task-efficacy enhances level of perceived enjoyment. In contrast, intervention studies supporting the effect of perceived enjoyment on PA self-efficacy have used measures established from Marcus et al.'s (1992) *Self-efficacy Inventory* (e.g., Dishman, Motl, Sallis, et al., 2005; Greene et al., 2017; Lewis et al., 2016), with a particular emphasis on the confidence in overcoming PA obstacles (e.g., "I am confident I can participate regular exercise when I am in a bad mood"). As such, the studies using Marcus et al.'s Self-efficacy inventory particularly suggest that PA enjoyment contribute to one's barrier-efficacy.

Given the use of different instruments tackling distinct aspects of self-efficacy, the use of the homogeneous term "self-efficacy" in the relevant PA research is ironic because in reality they have precisely referred to either task- or barrier-efficacy. Therefore, a more insightful and accurate conclusion that one could draw from existing literature maybe that one's perceived ability to complete certain PA tasks (i.e., task-efficacy) enhances enjoyment in PA, whereas one's perceived enjoyment improves the perception of one's capacity to overcome difficulties in participating PA (i.e., barrier-efficacy).

However, researchers have not examined the proposition and thus resulting in a dearth of knowledge in the understanding of psychological process underpinning the distinct aspects of self-efficacy and perceived enjoyment in the context of PA. The lack of such knowledge makes it difficult for intervention and education programs to effectively tackle both self-efficacy and enjoyment for PA promotion.

To bridge such a gap in knowledge, we conducted the first examination of a sequential mediation model involving task-efficacy, perceived enjoyment, and barrier-efficacy in schoolchildren's PA (see *Figure 1* for illustration). In the present study, we assessed schoolchildren's self-report PA task- and barrier-efficacy and enjoyment, and asked the participants to wear an accelerometer for a week to allow the objective assessment of PA. Research has suggested that schoolchildren tend to self-report higher PA than objectively measured by accelerometer (Wang, Baranowski, Lau, Chen, & Zhang, 2016). As such, the adoption of an accelerometer-based PA assessment, instead of relying on self-report PA, is vital to the current study. We hypothesized that task-efficacy would predict higher perceived enjoyment and, subsequently, enhanced barrier-efficacy and increased PA. We also expected that both enjoyment and barrier-efficacy would mediate task-efficacy's effect on PA, and barrier-efficacy would mediate the effect of enjoyment on PA. The findings will advance the understanding of our highlighted psychological process underpinning schoolchildren's PA and provide valuable implications to inform PA intervention and education programs.

Methods

Participants

Power analysis for detecting mediating effects using MedPower (Kenny, 2017) indicated that 252 participants were required to detect a relatively small indirect effect (i.e., partial r for all paths = .20) with sufficient power (i.e., $1-\beta = .80$) at .05 alpha level. We invited 387 third-fifth grade healthy schoolchildren from a public primary school in Hong

Kong to a briefing session, of which 331 (*M* age = 9.49; *SD* = .78; 169 boys) decided to participate and provided consents (see also Procedures). 304 participants (*M* age = 9.47; *SD* = .77; 158 boys) achieved accelerometer wear-time criterion (see *Measures*) and thus were included for data analysis.

Measures

Physical activity

We measured participant PA using the ActiGraph GT3X+ accelerometer over a continuous seven-day period (i.e., five schooldays and two weekend days). We set the wear-time validation to at least 480 minutes/day for three school days and one weekend days, with any continuous 20-minute period of zero accelerometer counts considered as non-wear time. We used Evenson et al.'s (2008) cut point for moderate-to-vigorous physical activity (MVPA), i.e., ≥ 2296 accelerometer counts per minute, to estimate participant time spent on MVPA. Research involving similar samples and designs has provided support to the cut-off point we employed to estimate MVPA (e.g., Chan, Ha, Ng, & Lubans, 2019; Esliger, Copeland, Barnes, & Tremblay, 2005; Wang et al., 2016). In order to examine whether the conceptualized model predicts MVPA and total PA consistently, we generated average daily MVPA and total PA time for analyses. Such an approach can offer insights to address recent research calls for more attention to overall PA time rather than solely higher-intensity PA (e.g., Pedisic et al., 2019).

PA task-efficacy

We adopted six items from McAuley et al.'s *Exercise Self-efficacy Scale* (McAuley & Mihalko, 1998) into Chinese using the translate-back-translate method. Cronbach's α achieved .94 for the translated scale. Participants received instructions to facilitate their differentiation of light, moderate, or vigorous PA and reported their confidence in participating PA at different intensities for either 30 or 60 minutes per day on at least five

days out of the following seven continuous days (e.g., "How confident are you that you can perform 30 minutes moderate PA per day on at least five days out of the following seven continuous days"). The rating scale ranges from 1 (0%, not confident at all) to 10 (100%, very confident) on each item. We generated mean scores for PA task-efficacy (M = 6.82; SD = 2.23).

PA barrier-efficacy

We used six-items that are relevant to schoolchildren from Lee et al.'s Chinese version Barrier-efficacy Scale (Lee et al., 2009). Participants assessed their confidence in engaging in regular PA when facing difficult situations (e.g., bad weather, busy with homework, tired; "How confident are you to do PA in bad weather?"). Participants rated from 1 (0%, not confident at all) to 10 (100%, very much confident) on each item. We generated mean scores for PA barrier-efficacy (M = 4.75; SD = 2.61). Cronbach's α in this study was .85.

PA enjoyment

We used Liang et al.'s seven-item PA Enjoyment Scale designed for Chinese schoolchildren (Liang, Lau, Huang, Maddison, & Baranowski, 2014). Participants rated their feelings when doing PA (e.g., "When I am active, I feel bored") from 1 (not at all) to 5 (very often). We reversed item scores so that higher scores reflected better enjoyment and generated the mean scores for further analyses (M = 3.75; SD = .73) Cronbach's α in this study achieved .85.

Procedures

With ethical approval, 387 third-fifth grade healthy schoolchildren from a public primary school in Hong Kong were invited to a study briefing session, whereas individual and parental consent were obtained from 331 attendees. Following the completion of the informed participant and parent consent, we provided a survey pack for participants to

complete, including all the self-report questionnaires described in the Measures section and brief demographic information such as age and sex. We then gave each participant an ActiGraph GT3X+ accelerometer to wear continuously for seven days (i.e., five school days and two weekend days). In line with a previous study using similar participants (e.g., Wang et al., 2016), a simple activity diary was provided for participants to record any non-wear time (e.g., sleeping, bathing, swimming, etc) with assistance from parents. The use of the diary was designed to improve participant compliance in wearing the accelerometer and was not for data analysis. On completion of the study, we thanked and fully debriefed our participants and the teachers who offered administrative support during the course of study.

Statistical analysis

We used SPSS 25.0 for preliminary analyses. Specifically, we checked univariate extreme values (i.e., three standard deviations away from means) and employed Cook's distance (Cook & Weisberg, 1982) and leverage (Stevens, 2002) to screen multivariate outliers that may cause concerns in our regression models. We followed the recommended cut-off value of greater than 1 Cook's distance and larger than 3*(k+1)/n leverage (whereas k is the number of predictors in the model and n reflects the sample size) as the criterion for multivariate outliers. We then performed descriptive analyses for each study variable and analyzed the zero-order correlations between each pair of variables.

We used PROCESS macro for SPSS (Hayes, 2013) to test the direct and indirect effects in our conceptualized model (see *Figure 1*). PROCESS is a robust tool that has been widely applied for path analyses (Preacher & Hayes, 2008). While offering standardized regression coefficients (β) for both direct and indirect effects, PROCESS can also provide unstandardized regression coefficients (B) and the R^2 value for the total effect model in mediation analysis. Hayes (2013) suggested that the use of unstandardized regression coefficients is vital to the interpretation of mediation or indirect effect. In our study, for

example, the unstandardized regression coefficients (B) would offer insights into how many minutes of increased PA is accounted by a one-unit increase in PA task-/barrier-efficacy and enjoyment scores. Thanks to an anonymous reviewer's suggestion, we would report standardized regression coefficients (β) in the Results and provide unstandardized regression coefficients (B) alongside the β in Tables 2-3. Additionally, PROCESS provides bootstrap adjusted standard errors (SE) and confidence intervals (CI). Lower and upper bound 95% CIs that do not encompass zero indicates significance at the .05 alpha level.

Results

Preliminary analyses

No univariate or multivariate outliers were found. Children's age was not related to either MVPA or total PA. Boys spent more time in MVPA. Among PA enjoyment and task- and barrier-efficacy, barrier-efficacy appeared to be the strongest correlate with both MVPA and total PA. Perceived enjoyment manifested a stronger correlation with MVPA compared to total PA. Table 1 displays detailed descriptive statistics and zero-order correlations among study variables.

Main analyses

We fit our data to the sequential mediation model (Model 6) in PROCESS, using 5,000 bootstrap samples. We analyzed our specified mediation model, as illustrated in Figure 1 separately for MPVA and total PA. Considering the PA differences by sex and age found in preliminary analyses and studies involving similar samples (e.g., Gao, Wang, Lau, & Ransdell, 2015; Wang et al., 2016), we included participant sex and age for statistical control. Tables 2-3 display both the unstandardized and standardized direct and indirect effects on each hypothesized path in our specified models.

MVPA

The model accounted for 10.18% variance in MVPA, F (3, 300) = 11.34, p = .001. Task-efficacy manifested significant positive direct effects on perceived enjoyment (β = .17, p = .003) and barrier-efficacy (β = .32, p < .001), but not in MVPA (β = .04, p = .339). Perceived enjoyment demonstrated positive direct effects on both barrier-efficacy (β = .24, p < .001) and MVPA (β = .20, p < .001). Barrier-efficacy also significantly contributed to MVPA (β = .59, p < .001). Importantly, all our identified indirect effects were significant. To expand, perceived enjoyment (β = .03, SE = .02, 95% CI [.01, .07]) and barrier-efficacy (β = .19, SE = .04, 95% CI [.12, .26]) mediated the relationship between task-efficacy and MVPA. Barrier-efficacy also mediated the relationship between perceived enjoyment and MVPA (β = .18, SE = .04, 95% CI [.10, .25]). Furthermore, the indirect effect of task-efficacy via perceived enjoyment and subsequently through barrier-efficacy on MVPA was positive and significant (β = .02, SE = .01, 95% CI [.01, .04]).

Total PA

The model accounted for 3.24% variance in total PA, F (3, 300) = 3.34, p = .020. The direct effect of task-efficacy was not significant on total PA (β = .04, p = .423). Meanwhile, perceived enjoyment failed to demonstrate a significant direct effect on total PA (β = .07, p = .099) while barrier-efficacy remained significant (β = .63, p < .001). Further, perceived enjoyment failed to mediate the effect of task-efficacy on total PA (β = .01, SE = .01, 95% CI [-.01, .04]). However, barrier-efficacy mediated both the relationship between task-efficacy and total PA (β = .20, SE = .04, 95% CI [.13, .27]) and the relationship between perceived enjoyment and total PA (β = .19, SE = .04, 95% CI [.11, .27]). Importantly, the indirect effect of task-efficacy via perceived enjoyment and subsequently through barrier-efficacy on total PA was positive and significant (β = .03, SE = .01, 95% CI [.01, .05]).

Discussion

The present study provides the first examination of the psychological process involving perceived enjoyment and the distinction between task- and barrier-efficacy underpinning children's PA. The findings support the notion that task-efficacy's impact on children's PA operates via the perception of enjoyment (i.e., perceived enjoyment) and the confidence to overcome obstacles (i.e., barrier-efficacy) in participating PA. The findings also reveal that barrier-efficacy is a consistent mechanism underlying schoolchildren's MVPA and total PA, while perceived enjoyment underpins MVPA but not total PA. Both task-efficacy and perceived enjoyment are important sources for barrier-efficacy.

Task- vs barrier-efficacy: An essential concern in PA promotion

Although self-efficacy has been regarded as one of the central psychological factors in children's PA (Bandura, 2004; Biddle et al., 2011), its conceptualization in most PA research is overly simplistic. Specifically, when using the umbrella term of "self-efficacy", studies refer to either the confidence to complete certain PA tasks (i.e., task-efficacy; Hu et al., 2016, 2007; Jerome et al., 2002; Jonason & Jackson, 2016; McAuley & Mihalko, 1998) or the confidence in overcoming obstacles in doing PA (i.e., barrier-efficacy; Dishman, Motl, Saunders, et al., 2005; Greene et al., 2017; Lee et al., 2009; Lewis et al., 2016). However, PA research has typically ignored the distinct roles of the two different aspects of self-efficacy. It is noteworthy that the task-/barrier-efficacy distinction is not merely meaningful at a theoretical level – it also provides important applied implications. Our data have demonstrated that it is barrier-efficacy that manifests direct impact on children's PA; in contrast, task-efficacy only exerts small and indirect effects. The results also revealed that task-efficacy accounted for a significant portion of the variance in barrier-efficacy. Taken together, we suggest that PA interventions and education programs for schoolchildren would do well to tackle barrier-efficacy and consider how to optimize task-efficacy in order to overcome barriers to an active lifestyle.

Although task- and barrier-efficacy have received little attention as distinctive concepts in previous PA research, two exceptional studies supplement our findings. In a sample of 230 third-to-fourth grade schoolchildren who were assigned to either a structured or unstructured after school PA program, Rosenkranz, Welk, Hastmann, and Dzewaltowski (2011) examined the impacts of task- and barrier-efficacy on accelerometer-assessed PA. These researchers demonstrated that regardless of structured or unstructured programs barrier-efficacy demonstrated significantly larger effects on schoolchildren's PA compared to task-efficacy. Rosenkranz et al.'s results also suggested that the importance of barrier-efficacy on PA becomes even more profound for those in the unstructured sessions because barrier-efficacy accounted for significant variance in unstructured PA while task-efficacy did not. Our findings are consistent with the aforementioned studies in that barrier-efficacy plays a more vital role than task-efficacy among young schoolchildren and further suggests that barrier-efficacy can be an important factor underpinning the relationship between task-efficacy and PA. As such, future PA interventions and education programs for schoolchildren looking to tackle self-efficacy as an important psychological driver should consider prioritizing the consideration of enhancing barrier-efficacy.

However, the influences of task- and barrier-efficacy on adolescent PA seem to demonstrate a different pattern compared to that of younger schoolchildren. In a sample of 72 adolescents with an average age of 17, Roberts, Maddison, Magnusson, and Prapavessis (2010) examined the role of PA intention, perceived behavioral control, and task- and barrier-efficacy on pedometer-based PA. The results demonstrated that task- but not barrier-efficacy accounted for a significant proportion of variance in PA after controlling for adolescent PA intention and perceived behavioral control. Although Roberts et al.'s findings may be subject to the limitation of a small sample size, it is possible that task-efficacy as an efficacy source becomes increasingly important with age (cf. Bandura, 1997). Such a proposition has yet to

receive research attention and is worthy of further investigation. Regardless, PA researchers and practitioners should prioritize the consideration of different efficacy sources when developing interventions and education programs for younger schoolchildren and adolescents.

Enjoyment in children's PA: The format of PA matters

While enjoyment is considered one of the most proximal psychological correlates of children's PA (Biddle et al., 2011), the notion that enjoyment may exert different influences on MVPA and total PA have been largely overlooked. The present study offers the first evidence that schoolchildren's perceived enjoyment of PA has a direct impact on their time spent engaging in more vigorous types of PA (i.e., MVPA) rather than less vigorous PA (i.e., total PA). Our findings suggest that promoting PA enjoyment may be particularly beneficial to schoolchildren's higher-intensity PA but less efficient in influencing lower-intensity and overall amount of PA. The implication reveals that PA researchers and practitioners should consider the different roles of enjoyment in promoting specific exercise behaviors (e.g., MVPA via engaging a typical sport) in comparison to more general aspects of physically active lifestyle (e.g., active commuting).

The finding that PA enjoyment accounted for a larger proportion of MVPA compared total PA may be explained by the extent to which these types of PA are structured. Rosenkranz et al. (2011) found that schoolchildren's PA enjoyment only predicted their levels of PA in structured PA sessions where children were guided to rigorously designed sport and activities but not in unstructured PA sessions where children were given autonomy to engage PA freely as they wanted. Given our findings that enjoyment exerted a greater influence on PA in MVPA compared to total PA, it is possible that in Rosenkranz et al.'s structured sessions schoolchildren may have received increased opportunities to engage in higher-intensity PA while those in unstructured sessions engage more in lower-intensity or

overall PA. Therefore, future research and practices should optimize enjoyment when looking to enhance more vigorous types of PA but would do well to consider other underpinning factors when aiming to promote overall PA or a generally active lifestyle.

Promoting MVPA and total PA: Different psychological pathways

MVPA has been a major focus of PA research, with its health benefits being well-established (Lee et al., 2012). Nevertheless, emerging evidence uncovers that participating in PA has lasting health benefits regardless of its dose of intensity (Pedisic et al., 2019). Such a finding arouses interest in a relatively overlooked aspect of PA; the time spent in the less vigorous type of activities (e.g., total PA). Indeed, light PA could be more beneficial than that has been previously understood. Compared to MVPA, time spent on less vigorous types of activities or total PA is much longer. As such, total PA can occupy a larger proportion of time within a 24-hour daily cycle so that less time may be spent in other unhealthy behaviors such as sedentary behaviors and excessive sleep (Tremblay et al., 2017). In support of this view, evidence has demonstrated that time spent total PA rather than in more vigorous activity in schoolchildren is associated more with various cardiometabolic biomarkers (Poitras et al., 2016). Additionally, not all individuals can engage in vigorous PA. Vulnerable people, such as the elderly and those with certain diseases or disorders, would find less vigorous types of PA more accessible. Future PA intervention and education programs would benefit from considering these different perspectives.

While promoting total PA or the participation in less vigorous types of PA appears to be an increasingly important realm, our findings reveal that previous knowledge of MVPA promotion may not be immediately transferrable to the promotion of total PA. Specifically, the sequential mediation model we have tested has accounted for over 10% of the variance in schoolchildren's MVPA but only 3% in total PA. These findings suggest that the psychological drivers of less vigorous PA are unlikely to be the same as they are for MVPA,

at least among schoolchildren. Considering the exclusive benefits of PA regardless of its dose intensity (e.g., Pedisic et al., 2019), future research should endeavor to uncover the psychological drivers underpinning one's overall PA. This realm of research will inform interventions and education programs looking to tackle less vigorous forms of PA for optimal health benefits.

Limitations and future research directions

The current study is not without limitations. A major limitation is related to the cross-sectional nature of the study. Indeed, cross-sectional data usually invites concerns regarding the unknown causality and undue confounding effects. However, our proposed sequential mediation model is based on a sound theoretical framework and has received clear support from robust statistical tests. Therefore, the preclusion of causality and concerns of confounding effects are considerably alleviated. Also, our assessment of objective accelerometer-based PA took place at a different time to the self-report questionnaires (i.e., over the next seven days). Such a design offers insights for prediction rather than a pure cross-sectional perspective. Future research would benefit from longitudinal data to replicate and extend our current findings.

Another limitation of this study is the lack of consideration of other psychological correlates of PA such as intrinsic/autonomous motivation (Deci & Ryan, 1985; Edward L. Deci & Ryan, 1985), self-regulation (Pitkethly, Lau, & Maddison, 2018), and self-perception (Sales, Levinger, & Polman, 2017). Indeed, research has demonstrated that a range of psychological factors can contribute to PA behavior (Biddle et al., 2011; Lubans, Foster, & Biddle, 2008). However, considering the relatively young age of our participants, we believed it was important to avoid long questionnaires and to only assess variables that were key to this study (i.e., PA task- and barrier-efficacy, PA enjoyment). Such an approach has overlooked the roles of other important psychological factors and thus might create a biased

388 view of the psychological process underpinning children's PA. Future research should
389 consider testing a more fullness picture of psychological process underpinning PA.
390 Additionally, although the study data support the psychological process that task-
391 efficacy enhances the levels of enjoyment and subsequently improves barrier-efficacy and
392 PA, we acknowledge that PA enjoyment can be a source for both types of PA efficacy.
393 Indeed, Bandura (1997, 2004) suggested that a reciprocal link exists between emotional states
394 and efficacy beliefs. However, our study design is constrained and does not allow us to test a
395 reciprocal relationship between emotional states (e.g., enjoyment) and efficacy beliefs (e.g.,
396 task- and barrier-efficacy). Future research should apply a more rigorously designed
397 longitudinal approach such as a cross-lagged panel design (see Allen, 2017 for a review) to
398 explore and examine any potential reciprocal psychological processes underlying PA.
399 **Conclusion**
400 This research offers important insights into the psychological processes, including
401 perceived enjoyment and the distinction between task- and barrier-efficacy, that underpin
402 schoolchildren's PA. Our findings suggest that 1) barrier-efficacy should be prioritized when
403 considering PA promotion; 2) enjoyment plays a more vital role in more vigorous types of
404 activities, and 3) knowledge of the psychological processes underpinning more vigorous
405 types of activities may be limited in its generalizability to less vigorous types of activities.
406 Future research should explore a complete picture of the psychological processes that
407 underpin children's PA to complement theories and inspire intervention development.
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573

Table 1

Descriptive statistics and zero-order correlations among study variables (n = 304)

Measure	1	2	3	4	5
1. PA Task-efficacy	–	.36**	.17**	.29**	.28**
2. PA barrier-efficacy		–	.29**	.67**	.67**
3. PA enjoyment			–	.37**	.26**
4. MVPA				–	.82**
5. Total PA					–
Mean	6.82	4.74	3.75	20.24	93.48
SD	2.23	2.61	.73	10.49	33.10

Note. PA = Physical Activity; MVPA = Moderate-to-Vigorous Physical Activity; Total PA = Total Physical Activity; SD = Standard Deviation.

* $p < .05$; ** $p < .01$

Table 2

Unstandardized and standardized direct effects of hypothesized paths (n = 304)

Model Components	PA Enjoyment	PA Barrier-efficacy	MVPA	Total PA
Age	-.03 (-.03)	.24 (.07)	.39 (.03)	-.13 (-.01)
Sex (0-girl; 1-boy)	-.09 (-.06)	*.60 (.12)**	1.46 (.07)	-.15 (-.01)
PA Task-efficacy	.06 (.17)	*.37 (.32)***	.20 (.04)	.55 (.04)
PA Enjoyment		*.86 (.24)***	*2.79 (.20)***	3.36 (.07)
PA Barrier-efficacy			2.37 (.59)**	*8.06 (.63)***

Note. Unstandardized estimates were displayed without the parentheses. Standardized estimates were displayed within the parentheses.

PA = Physical Activity; MVPA = Moderate-to-Vigorous Physical Activity; Total PA = Total Physical Activity.

* $p < .05$; ** $p < .01$

Table 3

Unstandardized and standardized indirect effects of hypothesized paths (n = 304)

Mediation Path	Indirect Effect	Bootstrap SE	Bootstrap 95% CI
TE → EN → MVPA	.16 (.03)	.08 (.02)	[.03, .35] (.01, .07)
TE → BE → MVPA	.87 (.19)	.18 (.04)	[.54, 1.25] (.12, .26)
EN → BE → MVPA	2.54 (.18)	.55 (.04)	[1.49, 3.68] (.10, .25)
TE → EN → BE → MVPA	.11 (.02)	.05 (.01)	[.03, .21] (.01, .04)
TE → EN → Total PA	.19 (.01)	.18 (.01)	[-.08, .59] (-.01, .04)
TE → BE → Total PA	2.96 (.20)	.58 (.04)	[1.91, 4.15] (.13, .27)
EN → BE → Total PA	8.63 (.19)	1.84 (.04)	[5.10, 12.35] (.11, .27)
TE → EN → BE → Total PA	.39 (.03)	.16 (.01)	[.11, .76] (.01, .05)

Note. Unstandardized estimates were displayed without the parentheses. Standardized estimates were displayed within the parentheses.
Lower and upper bound 95% CI that do not encompass zero indicates significance at the .05 alpha level.
TE = Task-Efficacy; BE = Barrier-Efficacy; EN = Perceived Enjoyment; MVPA = Moderate-to-Vigorous Physical Activity;
Total PA = Total Physical Activity.

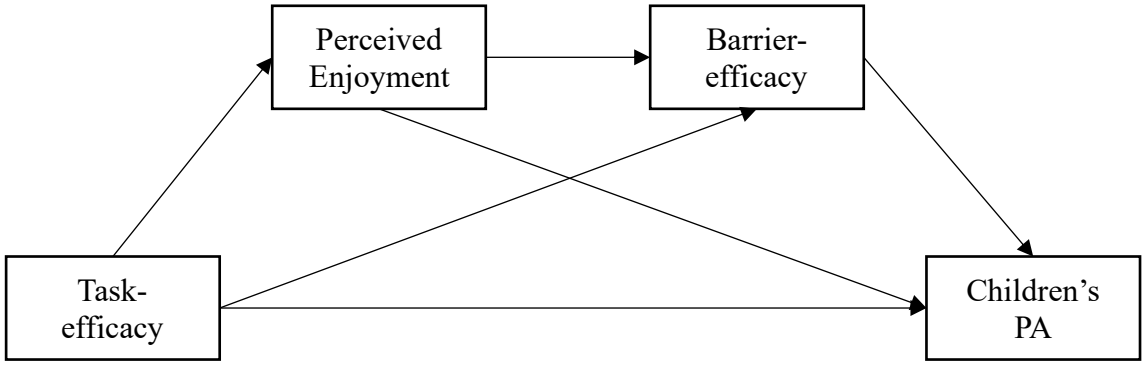

Figure 1. A delineation of the hypothesized multi-mediator model involving task-efficacy, perceived enjoyment, and barrier-efficacy underpinning children's physical activity (PA). Each arrowed path represents a conceptual direct effect.