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Reciprocal effects of motivation in physical education and self-reported physical activity

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Running head: PE MOTIVATION AND PHYSICAL ACTIVITY

Reciprocal effects of motivation in physical education and self-reported physical activity

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Abstract

Objectives: The present study tested whether self-reported school and leisure-time physical activity have a reciprocal relationship with Physical Education (PE)-based motivational regulations described by self-determination theory. Participants were 635 11- and 12-year-old school children from the United Kingdom.

Design & Method: A cross-lagged longitudinal design over two time points was employed.

Study hypotheses were analyzed using latent factor reciprocal effects models.

Results: Following temporal invariance tests, data revealed positive relationships between both types of physical activity and subsequent changes in autonomous motivation, but not the oft-stated reverse relationship. No relationships were observed involving introjected regulation. Theoretically aligned relationships between external regulation and changes in physical activity were observed, but no reverse relationships. Both types of physical activity behavior were negatively associated with changes in amotivation in PE, but surprisingly, amotivation in PE positively predicted changes in leisure-time physical activity.

Conclusions: In general, physical activity participation may help children internalize reasons for partaking in PE and foster self-determination. However, the widespread theory that self-determined PE motives can develop school and leisure-time physical activity participation was not compellingly demonstrated.

Keywords: health promotion, time-lagged, self-determined motivation, controlling motivation

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Introduction

There is now strong evidence to suggest that general levels of physical activity in children and adolescents are inadequate to accrue meaningful health benefits. Only 21% of boys and 16% of girls aged 5-15 years in the United Kingdom are meeting guidelines for recommended physical activity levels (Health and Social Care Information Centre, 2014). Schools have been documented as important settings to combat these insufficient levels of activity (Centers for Disease Control & Prevention, 2011). In particular, physical education (PE) classes may help develop healthy physical activity behavior in school and in leisure-time (Office for Standards in Education Children's Services & Skills, 2013). There is, therefore, compelling reason to explore PE-related phenomena with a view to inform the promotion of children's physical activity in various contexts.

Self-determination theory (SDT; Deci & Ryan, 2012) is a well-evidenced framework that focuses on human motivation and has been applied to the study of children's motivation in PE contexts (e.g., Ntoumanis, 2012). A key postulate of the theory distinguishes between types of motivation that vary in their levels of self-determination. Intrinsic motivation represents complete self-determination and refers to performing an activity for its own sake, because the activity is interesting and enjoyable (Deci & Ryan, 2012). In a descending order of self-determination, four different types of extrinsic motivation are also defined within the theory: Integrated regulation (i.e., partaking in an activity because it represents the essence of the self. Note that this motive is generally not considered in child samples, possibly due to an underdeveloped sense of self; Vallerand, 2001), identified regulation (i.e., pursuit of an activity to attain personally meaningful outcomes), introjected regulation (i.e., engaging in a behavior to feel worthy or to avoid feelings of guilt or shame), and external regulation (i.e., engagement to obtain a reward or avoid punishment; Deci & Ryan, 2012). An individual may

also completely lack any reason to participate in an activity and is, therefore, amotivated (Deci & Ryan, 2000). Broadly speaking, autonomous motivation (i.e., intrinsic motivation and identified regulation) in PE has been positively associated with physical activity behavior, whereas controlling regulations (i.e., introjected regulation and external regulation) and amotivation have been unrelated or negatively related to physical activity in cross-sectional (Aelterman et al., 2012), prospective (Standage, Gillison, Ntoumanis, & Treasure, 2012), and longitudinal work using multilevel modeling (McDavid, Cox, & McDonough, 2014; Taylor, Ntoumanis, Standage & Spray, 2010; Taylor, Spray, & Pearson, 2014). That said, introjected regulation has, on occasion, been positively associated with physical activity (e.g., time-invariant individual differences in sixth grade students; McDavid et al., 2014). In fact, this positive relationship has been observed in a meta-analysis of self-determined motivation and physical activity in children and adolescents (Owen, Smith, Lubans, Ng, & Lonsdale, 2014). With the exception of one study that focused on physical activity in physical education classes (Aelterman et al., 2012), physical activity is usually operationalized within broad leisure-time contexts, and measured in a variety of ways (i.e., self-report, pedometer, and accelerometer).

This body of research stems from theory suggesting that autonomous motivation leads to favorable behavior. The hierarchical model of intrinsic and extrinsic motivation, for example, proposes that motivation in any given context leads to behavioral consequences in that context and other related settings (Vallerand, 2001). Therefore, there is an assumption that a temporal or causal sequence exists between motivation in PE and subsequent physical activity. However, most studies testing this process have employed a cross-sectional design (Owen et al., 2014). Equally plausible, therefore, is the reverse process whereby physically active individuals are more likely to become more autonomously motivated in PE classes. A similar argument was put forward, and subsequently tested, regarding psychological need

satisfaction (a separate, but related, motivational concept associated with SDT) and physical activity (Gunnell, Bélanger, & Brunet, 2015). All children have a natural inclination to internalize motives for behavior and this is only prevented under conditions that thwart fundamental psychological needs (Deci & Ryan, 2000). It is reasonable to assume, therefore, that more time spent being active provides greater opportunity for the internalization of associated activities, such as PE class participation, to occur (i.e., increased autonomous motivation, lower controlling motivation and amotivation).

This reciprocal process has been largely ignored in the literature but can be tested using longitudinal data in which motivation and physical activity are evaluated on at least two occasions. Reciprocal effects models have been used to consider alternative processes, such as academic self-concept and achievement (e.g., Marsh, 1990) and motivational quality and burnout (Lonsdale & Hodge, 2011). Statistically significant paths from initial motivation to subsequent physical activity and from initial physical activity to subsequent motivation would indicate the existence of reciprocal effects. This type of autoregressive cross-lagged analysis provides stronger evidence for relationships than cross-sectional results because it accounts for cross-sectional associations between both constructs, as well as the temporal stability of each construct (i.e., intra-individual change is measured). The reciprocal effects hypothesis has significance for theorists who propose that self-determined motivation is a crucial mechanism for physical activity promotion (e.g., Owen et al., 2014). Complementary to this proposal is the potential for physical activity participation to create engaged and self-determined students in PE classes.

A further focus in the present study is the testing of sequential relationships between PE motivation and different periods of physical activity, namely school and leisure-time. Self-determination in PE class has been associated with higher levels of objectively measured (via step counts) physical activity in the PE class (Lonsdale, Sabiston, Raedeke, Ha, & Sum,

2009). Theories that have stemmed from SDT, such as the hierarchical model of motivation (Vallerand, 2001) and the trans-contextual model of autonomous motivation (Hagger & Chatzisarantis, 2015) also describe how motivation in one context can influence behavior in another. As such, motivation in PE has been positively associated with self-reported physical activity in leisure-time contexts (e.g., Barkoukis, Hagger, Lambropoulos, & Torbatzoudis, 2010; Hagger et al., 2009; Taylor et al., 2010). It is currently unknown whether motivation in PE is correlated with a more general consideration of school physical activity which includes recess or lunch-time. In the present study, therefore, leisure-time physical activity (after school hours, evenings, and weekends) and school-based physical activity (PE class, recess, and lunch time) were distinguished. Also, the aforementioned models do not consider whether behavior in one context can influence motivation in another. Evidence exists to suggest that out of school sport participation is associated with stable amotivation in PE, whereas, non-participation is associated with increasing amotivation (Ntoumanis, Barkoukis, & Thøgersen-Ntoumani, 2009). The influence of past behavior on subsequent cognition has been acknowledged in some theoretical frameworks, such as the theory of planned behavior (Hagger, Chatzisarantis, & Biddle, 2001; Rhodes & Courneya, 2003), but has received little attention as an antecedent of self-determination.

To summarize, the present study aimed to test the reciprocal longitudinal associations between individual motivational regulations towards PE and self-reported physical activity. Integrating previous evidence (Aelterman et al., 2012; McDavid et al., 2014; Standage et al., 2012; Taylor et al., 2010; 2014) with theorized internalization processes (Deci & Ryan, 2000) led to the hypothesis that motivation in PE and physical activity would have a mutually dependent relationship. This challenges the unidirectional causal relationship from motivation to behavior that is often assumed. Stronger evidence of this reciprocal relationship was expected between PE motivation and school physical activity, rather than leisure-time

physical activity, because of the proximity of context (PE and school versus PE and leisure-time). Stronger evidence was also expected for the positive relationships involving intrinsic and identified regulation, compared to non-significant or negative relationships involving introjected regulation, external regulation and amotivation. This was hypothesized because autonomous regulations tend to have a greater association with physical activity behavior, compared to controlling regulations or amotivation (Owen et al., 2014).

Method

Participants and Procedures

Secondary school students participated in the study ($N = 635$, including 466 11-year-olds, 150 12-year-olds, 19 unspecified, 58% male) who were sampled from 65 classes in nine secondary schools based in **Wales and central England**. Eighty-eight percent of participants reported their ethnicity as White, one percent as Black, four percent as South Asian, and six percent as Other. None of the sampled participants were included in a separate study that took place within the same broader project (i.e., **Taylor et al., 2014**). Fifteen participants did not report the class that they belonged to, so they could not be included in the analysis because the nested class structure was accounted for. One hundred sixty-nine participants did not complete measures during the second time point, either for logistical reasons or absence from school. However, all analyses conducted in this study used the full sample of 620 participants to avoid a suboptimal listwise deletion strategy (Newman, 2014). On average, participants reported a level of involvement in leisure-time activity that was slightly over the scale midpoint [$M(SD) = 3.25(0.87)$ at time 1 and $3.42(0.87)$ at time 2] and slightly under the scale midpoint for school-based physical activity [$M(SD) = 2.86(0.93)$ at time 1 and $2.83(0.90)$ at time 2].

Following approval from a University Ethical Committee, consensual procedures corresponding with the American Psychological Association regulations were followed with

teachers, parents of prospective participants, and the students. At the beginning of a scheduled PE lesson, students were asked to answer the study questionnaire honestly and were told that there were no correct or wrong answers. Students were asked to complete all measures in November or December 2011 (Time 1) and March or April 2012 (Time 2). A range of activities were taught in the classes over the course of the study, including soccer, athletics, hockey, and basketball.

Measures

PE Motivation. The different types of motivation were measured using the 20 items (four for each subscale) developed by Goudas, Biddle, and Fox (1994), which followed the stem, “I take part in PE. . . .” Example items are “Because it is fun” (intrinsic motivation), “Because I want to learn sport skills” (identified regulation), “Because I would feel bad if I didn’t” (introjected regulation), “Because I’ll get in trouble if I don’t” (external regulation), and “But I think I’m wasting my time in PE” (amotivation). Students responded to all items using a 7-point scale ranging from 1 (*not at all true*) to 7 (*very true*). Lonsdale and colleagues (Lonsdale, Sabiston, Taylor, & Ntoumanis, 2011) provided supportive evidence regarding the factor structure and internal consistency of the measure.

Physical activity. We used six items from the Physical Activity Questionnaire for Older Children (PAQ-C; Crocker, Bailey, Faulkner, Kowalski, & McGrath, 1997) to measure children’s physical activity. The PAQ-C measures 7-day recall of general levels of moderate and vigorous physical activity by utilizing memory cues, such as lunch time and evenings to enhance recall. Three items were used to measure school physical activity (during PE, break time and lunch) and three items for leisure-time physical activity (after school hours, in the evenings and weekends). An example item is, “In the last seven days, on how many evenings did you do sports, dance or play games in which you were very active?” All items from the original PAQ-C were not used because some did not allow for differentiation of school and

leisure-time, which was a purpose of the study. Students then responded on a 5-point scale with higher scores reflecting greater amounts of physical activity. Crocker et al. (1997) demonstrated internal consistency and validity in similar aged samples, however, see the Results section for evidence of factorial validity when using school and leisure-time items as indicators of distinct types of physical activity.

Data Analysis

All analyses were conducted using Mplus software (Version 7.11; Muthén & Muthén, 1998 - 2012). Maximum likelihood estimation with robust standard errors (i.e., MLR estimator in Mplus) and the TYPE = COMPLEX command were used to account for potential clustering effects associated with pupils being nested within different classes (Hox, 2010). Each questionnaire item was used as an indicator of its respective latent factor and missing data was handled using the full information maximum likelihood method (Newman, 2014). The primary indices used for estimating goodness of fit of the models were the Root Mean Square Error of Approximation ($RMSEA < .08$), Comparative Fit Index (CFI) and Tucker-Lewis Index ($TLI \& CFI > .90$, however, values closer to .95 have also been endorsed; Hu & Bentler, 1999).

Prior to the main analysis, preliminary confirmatory factor analysis was carried out to test the factorial structure of the study measures. In particular, previous research has demonstrated consistently high inter-factor correlations between intrinsic motivation and identified regulation (Lonsdale et al., 2011); therefore, this possibility was explored by examining the latent factors correlations between these constructs. The correlations between the two physical activity forms were also inspected to confirm whether the two types were distinguishable.

Next, measurement invariance across time points was tested in line with previous work (Marsh et al., 2010; Marsh, Nagengast, & Morin, 2013). This involved constructing a

baseline configural measurement model (Model 1) in which parameters were allowed to differ across time points, all loadings were freely estimated and factor variances were fixed to 1 (Byrne, 2012). In accordance with guidelines on constructing reciprocal effects models, covariance terms among factors measured at the same time point were freely estimated and the uniqueness term associated with each indicator score at time 1 was allowed to correlate with the same term at time 2 (Marsh, Byrne, & Yeung, 1999).

Increasingly constrained models were then tested. Chi-square difference tests when employing robust maximum likelihood estimation can be overly severe (Brown, 2006), therefore, the main criterion for accepting the constrained model over the previous less constrained model (i.e., invariance) was $\Delta CFI \leq .01$ (Chen, 2007; Cheung & Rensvold, 2002). Additionally, $\Delta RMSEA \leq .015$ was also considered indicative of invariance (Chen, 2007). Model 2 tested weak invariance with factor loadings constrained to be equal over time and the factor variances at the second time point freely estimated. Model 3 tested strong invariance by additionally constraining item intercepts and freely estimating the factor means of the second time point. Model 4 tested a strict invariance model with factor loadings, intercepts, and uniqueness terms constrained to be equal over time. Two further models testing less commonly evaluated aspects of invariance were constructed (see Marsh et al., 2013). Specifically, factor variances and covariances were additionally constrained in Model 5, followed by factor means in Model 6.

Our primary analysis involved structural equation modeling to test the reciprocal effects model (shown in Figure 1), which involved the simultaneous modeling of all relationships involving time 1 motivation – time 2 physical activity and time 1 physical activity – time 2 motivation. The estimation method and fit criteria were the same as the preceding invariance analyses.

Results

Preliminary Analyses

As expected, the inter-factor correlation between intrinsic motivation and identified regulation was high (.98 at time 1 and .99 at time 2). As a result, the two regulations were merged with all eight items loading onto a single ‘autonomous motivation’ factor. This strategy has been used in previous research (e.g., Standage, Duda, & Ntoumanis, 2003). The inter-factor correlations between the two types of physical activity were .44 (at time 1) and .56 (at time 2) suggesting the existence of two related, yet discernible types of physical activity.

Factor loadings in the baseline configural measurement model (Model 1) ranged from .35 to .86. Composite reliability scores and latent factor correlations for all variables are presented in Table 1. All composite reliability values were satisfactory. Latent factor correlations indicated that the motivational regulations largely conformed with the hypothesized simplex structure proposed by SDT researchers (e.g., Ryan & Connell, 1989). In general, positive correlations were observed between autonomous motivation, introjected regulation and the two forms of physical activity. External regulation was weakly and negatively associated with leisure-time physical activity at time 1 and 2. A small negative correlation was observed between external regulation and school physical activity at time 2. Amotivation was moderately and negatively correlated with both types of physical activity at both time points. School and leisure-time physical activity were moderately and positively correlated with each other.

Measurement Invariance

The fit indices for the models testing invariance can be seen in Table 2. Δ CFI and Δ RMSEA did not meaningfully deteriorate following the addition of constraints, signifying invariance in each step. In other words, the latent factors in the present study are measured identically across time points and full measurement invariance is supported (Marsh et al.,

2010; Marsh et al., 2013). As such, the reciprocal effects model was based on full invariance, with the exception that the covariances were freely estimated across time points because time-specific covariances in autoregressive cross lagged models do not have the same meaning across time points.

Reciprocal Effects Model

The estimated reciprocal effects model (Model 7) demonstrated acceptable fit using the same criteria used to assess models testing invariance (see Table 2). Standardized path coefficients are displayed in Table 3. Unsurprisingly, all time 1 measurements were positively and strongly associated with the time 2 measurements of the same construct. Regarding the substantive associations, the motivational regulations in PE at time 1 did not predict time 2 school physical activity, apart from weak evidence found for the negative relationship between school physical activity and external regulation ($p = .07$). Time 1 external regulation in PE negatively predicted time 2 leisure-time physical activity, whereas time 1 amotivation in PE positively predicted time 2 leisure-time physical activity. Both relationships were small-moderate in magnitude. Time 1 introjected regulation was not associated with time 2 leisure-time physical activity.

Inspection of reverse effects demonstrated that time 1 school and leisure-time physical activity positively predicted time 2 autonomous motivation in PE (both relationships were small in magnitude). Neither type of physical activity at time 1 predicted introjected or external regulation in PE at time 2. School physical activity at time 1 negatively predicted amotivation at time 2, and weak evidence was found for a negative relationship between time 1 leisure-time physical activity and time 2 amotivation ($p = .06$; both relationships small in magnitude). Explained variance of the time 2 dependent variables were similar with R^2 statistics ranging from .29 - .35.

Discussion

301 The present study aimed to test the reciprocal effects between motivation in PE, as
302 defined within SDT, and self-reported physical activity. By doing so, the bidirectional and
303 temporal associations between motivation and physical activity were put under rigorous
304 scrutiny. Some conclusions drawn from the data align well with existing theory, but others
305 are counter to postulates of SDT and related models of motivation.

306 Prior to discussing associations between motivation and physical activity, two
307 psychometric conclusions can be drawn from the data. First, high latent correlations between
308 children's responses to intrinsic motivation and identified regulation meant that it was not
309 possible to distinguish between the two motivational regulations. This issue has been raised
310 previously and represents a shortcoming of SDT research and broader motivation science, in
311 general (Lonsdale et al., 2011; Wigfield & Cambria, 2010). Intuitively, one can value and
312 identify with an activity that is not inherently enjoyable or interesting, but this distinction
313 may require considerable reflection or guidance during completion of a questionnaire.
314 Perhaps a greater distinction between situational (enjoyment) and personal (value) interest
315 may be fruitful (Hidi & Renninger, 2006). Alternatively, children's motives may be more
316 simplistic and they largely value what they enjoy or find interesting. Whatever the underlying
317 reason, conceptual and psychometric efforts to solve this issue are required.

318 Second, longitudinal invariance of the motivation measure was demonstrated, which
319 adds to the ongoing process of validity testing of this instrument. This has not been reported
320 elsewhere and demonstrates that the latent factors tapping into the motivational regulations
321 are measured identically across time, albeit a relatively short period of a few months. The
322 physical activity questionnaire also demonstrated longitudinal invariance but it was adapted
323 from its original form, so this is not commented on further. Establishing longitudinal
324 measurement invariance is a fundamental step towards a focus on internalization processes
325 proposed within SDT because we can assume that children's scores at initial measurement

represent the same construct as scores at subsequent measurement points (Vandenberg & Lance, 2000). It would be of further interest to investigate longitudinal measurement invariance across longer periods to establish the impact of cognitive development (Knight & Zerr, 2010).

Most observed relationships between motivation and physical activity were small or small-moderate in magnitude; however, this was to be expected given that intra-individual change in study variables was controlled for. Surprisingly, no evidence was found to suggest that autonomous regulation was associated with increases in either type of physical activity. This was not expected considering previous longitudinal work (McDavid et al., 2014; Taylor et al., 2010; 2014). The most obvious explanation is the different type of analysis used in the present study. The reciprocal effects models used here represent considerable rigor by controlling for measurement error, cross-sectional associations and temporal stability of each construct. The second, perhaps less obvious explanation given the weight of evidence to the contrary, is that motivation in PE does not influence school or leisure-time physical activity. Although a primary objective of PE is to encourage life-long physical activity, there are considerable contextual differences between PE and many contexts in which physical activity takes place, such as the mandatory nature of PE and the organized curriculum focused on teaching and learning. These differences make any strong trans-contextual associations less likely, for instance, it is not unreasonable to imagine an adolescent despising PE class, but enthusiastically engage in softball at weekends. In addition, PE classes are one of many influences on physical activity behavior. It is possible that any one focus of intervention (e.g., motivation in PE class) may have limited success in isolation but a multi-component intervention targeting several influences may be successful (e.g., school and family; van Sluijs, McMinn, & Griffin, 2007).

The lack of relationship between autonomous regulation and changes in physical activity becomes more thought-provoking when considering that reverse effects were found in the present study. Participants who reported high levels of school and leisure-time physical activity reported increases in autonomous regulation in PE. This relationship is significant because a dominant assumption within SDT-based research and associated theoretical frameworks, such as Vallerand's (2001) hierarchical model, is that motivation leads to subsequent behavioral consequences. This evidence questions that assumption and the largely cross-sectional research that it is based on (Owen et al., 2014). Researchers using this framework in applied and field studies should begin to consider the reverse process. This is the first empirical demonstration that participating in physical activity may allow children to internalize motives for similar activities, such as PE class engagement. This hypothesis is further substantiated with the lack of evidence found in the present study to suggest that physical activity facilitates low self-determined motives (i.e., introjected or external regulation). Moreover, students with higher school physical activity subsequently reported greater decreases in amotivation. There was also a trend to suggest that high leisure-time physical activity similarly led to decreases in amotivation in PE. Put simply, engaging in physical activity may allow children to find reason for engaging in PE class and foster self-determined motives, such as enjoyment, interest and value. Without such engagement, these opportunities would be missed.

In contrast to autonomous motivation, there was no relationship between introjected regulation in PE and changes in school or leisure-time physical activity. Some positive relationships between introjected regulation and broad physical activity behavior have been noted previously, however, these are usually observed when considering individual differences (e.g., McDavid et al., 2014; see Owen et al., 2014 for a review). Longitudinal examination of intra-individual change has typically unearthed non-significant relationships

between introjected regulation in PE and physical activity (McDavid et al., 2014; Taylor et al., 2010). Given that controlling for initial levels or measuring within-person changes provides stronger evidence for motivational processes, compared to cross-sectional analysis of individual differences, we can begin to conclude that the desire to avoid guilt or maintain self-worth in PE does not drive changes in physical activity behavior. The negative affective experiences associated with introjected regulation, such as heightened anxiety, are likely to attenuate any energizing properties of the motivation itself (Edmunds, Ntoumanis, & Duda, 2006; Thøgersen-Ntoumani & Ntoumanis, 2006; Gillison, Standage & Skevington, 2011).

In accordance with tenets of SDT, the results indicate that external regulation has a detrimental impact upon children's physical activity levels in school or leisure-time. Null relationships among external regulations and physical activity have been observed previously in longitudinal designs (e.g., Taylor et al., 2010; 2014), but this study provides extra detail by examining the school and leisure-time distinction and controlling for initial levels of physical activity. Children's motivation is, to some degree, an inherently natural intrapersonal phenomenon; however, the teacher can also play an important role (i.e., the organismic dialectical approach fundamental to SDT; Deci & Ryan, 2000). Use of coercion and threat has been reported by PE teachers for many reasons (e.g., teaching norms, administrative pressure; Taylor, Ntoumanis, & Smith, 2009). A dual approach to minimizing external regulation could be to curtail these strategies from teachers but also to develop values in children that help reduce their orientation towards external, avoidance-based motives.

No evidence was found linking amotivation in PE to changes in school physical activity. Unexpectedly, however, amotivation in PE was positively associated with increases in leisure-time physical activity. Although rare, this theoretically abnormal finding has occurred previously (Taylor et al., 2014). The use of multilevel modeling to distinguish within-person changes and the use of latent factors in a reciprocal effects model have both

lead to the same conclusion, hence, this observation requires closer inspection in future work. For example, on average the sample used in the present study reported low levels of amotivation in PE. A broader sample representing the full range of amotivation would be hard to obtain but would shed light on trans-contextual consequences of amotivation in PE. The underlying reasons behind amotivation may also regulate this relationship (Ntoumanis, Pensgaard, Martin, & Pipe, 2004; Taylor et al., 2014). Interpersonal reasons for an absence of motivation in PE (e.g., dislike of classmates) may lower activity in class but may not transfer to leisure-time because the social milieu differs. In contrast, intrapersonal foundations for a lack of motivation (e.g., “I don't like sweating in PE”) may facilitate trans-contextual influence (e.g., “I don't like sweating at weekends either”). Although the mechanisms describing the transfer of motivation from PE to leisure-time have been described in detail by Hagger and colleagues’ conceptual framework (Hagger & Chatzisarantis, 2015; Hagger, Chatzisarantis, Barkoukis, Wang, & Baranowski, 2005; Hagger, Chatzisarantis, Culverhouse, & Biddle, 2003; Hagger et al., 2009), the transfer of amotivation has not. It is likely that the processes undergirding cross-contextual transfer of motivation will differ from those of an absence of motivation. This work could be guided by previous attempts to sub-categorize types of amotivation (Legault, Green-Demers, & Pelletier, 2006) or the inter- versus intra-personal foundations described above.

Limitations and Future Directions

These results provide insight into mutual relationships between PE experiences and physical activity behavior; however, there are also limitations to address and further questions to investigate. Physical activity was measured used self-report to obtain a relatively large sample of students over two-time points. The self-report measure has been advocated previously (Biddle, Gorely, Pearson, & Bull, 2011); however, replication of the proposed relationships using accelerometry would be useful to obtain more precise estimates of activity

and remove potential effects of recall and response bias (Prince et al., 2008). Associations between motivation and accelerometer-derived physical activity may be lower (compared to self-reported physical activity) because accelerometers capture incidental activity as well as purposeful ‘motivated’ activity. Encouragingly, however, autonomous motivation has been positively correlated with accelerometer-based moderate and vigorous physical activity in a youth football sample (Fenton, Duda, Quested, & Barrett, 2014).

Our results underscored the importance of reverse effects, whereby physical activity behavior may influence autonomous motivation and amotivation, potentially via the internalization process. Certain contextual conditions have been suggested to facilitate or forestall internalization (e.g., autonomy supportive versus controlling contexts; Pelletier, Fortier, Vallerand, & Brière, 2001). A three-year longitudinal study in Greek PE demonstrated perceptions of competence buffered against decreases in identified regulation and increases in external regulation (Ntoumanis et al., 2009), which may provide clues into contextual factors that facilitate internalization (e.g., competence enhancing feedback). It would be fruitful to replicate this approach and ask whether specific conditions in physical activity contexts are associated with *increases* in autonomous motivation over time, and whether any observed changes influence subsequent physical activity behavior. Any such longitudinal work may wish to consider greater number of time points than the present study to enable a more nuanced analysis of temporal change using multilevel growth modeling techniques (see Singer & Willett, 2003). Longitudinal work capturing critical periods of adolescent development, including school transitions and periods of accelerated biological growth would also be beneficial (see Taylor et al., 2014; Sherar, Cumming, Eisenmann, Baxter-Jones, & Malina, 2010).

To summarize, the present study describes several reciprocal effects exploring the relationship between motivation in PE and school and leisure-time physical activity. The

hypothesis that motivation in PE and physical activity would have a mutually dependent relationship was evidenced to some degree but not to the extent expected. Relationships were not stronger when considering school physical activity, relative to leisure-time physical activity. Overall, engagement in physical activity may help children internalize PE engagement and foster self-determination, but the prevailing assumption that self-determined motivation can enhance school and leisure-time physical activity was not convincingly observed.

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662 Table 1

663 *Raykov's Rho Coefficients and Latent Factor Correlations of all Study Variables*

Variable	Raykov's Rho		Latent Factor Correlations (correlations at time 1/time 2)				
	Time 1	Time 2	1.	2.	3.	4.	5.
1. Autonomous Motivation	.906	.923					
2. Introjected Regulation	.695	.699	.54/ .50		—		
3. External Regulation	.792	.859	-.23/ -.26	.53 .57		—	
4. Amotivation	.801	.878	-.52/ -.62	.08 ($p = .26$) .03 ($p = .64$)	.54 .57		—
5. School Physical Activity	.729	.743	.42/ .46	.29 .26	.02 ($p = .80$) -.13 ($p = .05$)	-.17 ($p = .01$) -.33	
6. Leisure Time Physical Activity	.771	.772	.29/ .33	.09 ($p = .19$) .21 ($p = .01$)	-.19 -.11 ($p = .05$)	-.23 -.26	.44 .56

664 *Note.* Unless otherwise specified, associated p values with correlations are $< .001$. All scales were responded to on a 1-7 scale with the

665 exceptions of school and leisure time physical activity (1-5). All latent variables had a mean of 0 and a standard deviation of 1.

666 Table 2

667 *Fit Indices for all Models*

Model	Fit indices			
	χ^2 (df)	CFI	RMSEA (90% CI)	TLI
1. Configural baseline model	1930.846(1182)	.934	.032(.029-.035)	.926
2. Weak invariance (Factor loadings constrained)	1966.949(1202)	.933	.032(.029-.035)	.926
3. Strong invariance (Factor loadings and item intercepts constrained)	2010.892(1222)	.931	.032(.030-.035)	.925
4. Strict invariance (Factor loadings, intercepts, and residual variances constrained)	2050.829(1248)	.930	.032(.030-.035)	.925
5. Factor variance- covariance invariance	2089.766(1269)	.928	.032(.030-.035)	.925
6. Factor mean invariance	2132.154(1275)	.925	.033(.030-.035)	.922
7. Reciprocal effects model	2035.583(1236)	.930	.032(.030-.035)	.925

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670 Table 3

671 *Standardized Path Coefficients in the Reciprocal Effects Model*

Dependent Variable: β (95% Confidence Intervals); p value						
Independent Variable	T2 Autonomous motivation	T2 Introjected Regulation	T2 External Regulation	T2 Amotivation	T2 School physical activity	T2 Leisure-time Physical Activity
T1 Autonomous motivation	.52(.46 - .58); $p < .001$	—	—	—	-.00(-.21 - .20); $p = .99$	.13(-.04 - .29); $p = .13$
T1 Introjected regulation	—	.59(.54 - .65); $p < .001$	—	—	.15(-.07 - .37); $p = .18$	.13(-.06 - .31) $p = .18$
T1 External regulation	—	—	.54(.47 - .61); $p < .001$	—	-.15(-.31 - .01); $p = .07$	-.18(-.35 - -.02); $p = .03$
T1 Amotivation	—	—	—	.50(.41 - .59); $p < .001$	-.04(-.20 - .13); $p = .65$	.13(.01 - .28); $p = .04$
T1 School physical activity	.10(.00 - .19); $p = .04$	-.04(-.15 - .08); $p = .52$	-.07(-.18 - .03); $p = .16$	-.12(-.22 - -.03); $p = .01$	.49(.42 - .57); $p < .001$	—
T1 Leisure-time physical activity	.08(.00 - .15); $p = .05$	.06(-.04 - .15); $p = .25$	.02(-.10 - .13); $p = .80$	-.09(-.18 - .00); $p = .06$	—	.46(.39 - .54); $p < .001$

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Figure 1

The reciprocal effects model

Note. Factor indicators, error terms, and covariance paths not shown