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Psychologically informed physical fitness practice in schools: A field experiment

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ABSTRACT

Objectives: Physical education could play a role in attenuating the decline in physical activity during the childhood-to-adolescence transition and inspiring children to adopt a lifelong physical activity habit. While psychological theories (e.g., Self-Determination Theory, Achievement Goal Theory) offer pointers for desirable changes to practice norms, experimental tests of the effectiveness of theory-based interventions in school settings are lacking. In this study, we compared the effects of a "traditional" and a "novel" physical education lesson on affective valence, enjoyment, and perceived satisfaction of the psychological needs for autonomy, competence, and relatedness.

Design: Within-subjects field experiment, with two counterbalanced conditions.

Method: The participants were 148 children (4-6th grade, 52% female). Both lessons consisted of practicing aerobic capacity (running), core (curl-ups), and upper-body (push-ups) strength and endurance. In the "traditional" lesson, practice procedures followed FITNESSGRAM™ test instructions. The "novel" lesson incorporated elements designed to address basic psychological needs (e.g., freedom to select preferred running path, positive interactions among peers) and other evidence-supported modifications (e.g., music and video).

Results: Affective valence declined in the "traditional" lesson but remained stable in the "novel" lesson. Enjoyment and need-satisfaction for competence were higher after the "novel" lesson. These differences occurred despite no significant differences in total accelerometer-assessed moderate-to-vigorous physical activity and the intensity of the aerobic components.

Conclusions: Easily implementable, theory-based modifications to physical education practices could improve the experiences derived by students. In turn, experiencing physical education as more pleasant, enjoyable, and need-supportive could raise the odds of long-term physical activity participation.

1. Introduction

Physical activity in children can confer benefits across multiple domains of health (Macdonald-Wallis, Jago, Page, Brockman, & Thompson, 2011; Macdonald-Wallis, Jago, & Sterne, 2012; Sallis & Owen, 1999). Therefore, the promotion of physical activity in this population has garnered attention from researchers and health organizations. Of particular public-health interest (and concern) is the fact that the decline in physical activity begins when children enter primary school (Vincent & Pangrazi, 2002) and accelerates during the primary-to-secondary school transition (Pearson, Haycraft, Johnston, & Atkin, 2017). In the United States, 42% of children aged 6–11 years are estimated to do the recommended 60 or more min of moderate- or greater-intensity physical activity on at least five days per week, whereas only 8% of those aged 12–15 years meet this recommendation, even when every min of activity is counted (Troiano et al., 2008).

Because children spend a significant proportion of their waking hours in school, physical education (PE) is broadly seen as a potential vehicle for promoting physical activity in children, especially among children who may not have exposure to physical activity in the home environment (Fairclough & Stratton, 2006). For many children, PE also serves as the first time that physical activity begins to take on a structured format (NASPE, 2013), in contradistinction to the short bursts of free play toward which children naturally gravitate (Bailey et al., 1995). However, given the increase in sedentary time that coincides with the primary-to-secondary school transition, it is possible that current PE curricula may not be optimal in promoting physical activity. Over the years, several authors have decried certain aspects of PE practice, contending that, although such practices have become established as normative, they may be suboptimal from pedagogical and

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psychological standpoints (Cale & Harris, 2009; Cale, Harris, & Chen, 2007; Hopple & Graham, 1995; Ladwig, Vazou, & Ekkekakis, 2018; Rowland, 1995; Wiersma & Sherman, 2008).

1.1. Fitness testing and fitness-testing practice

Arguably one of the most controversial aspects of PE curricula, with staunch advocates and critics, is physical-fitness testing (Corbin, Pangrazi, & Welk, 1994; Rowland, 1995). Supporters contend that, when properly implemented, fitness testing can serve a variety of useful functions within a PE program, such as educating children about health-related fitness, promoting physical activity, and inspiring long-term (ideally, lifelong) participation (Corbin et al., 1994; Welk, 2008). On the other hand, critics have identified certain elements as possibly "turning off" many children to physical activity. For example, Ernst, Beighle, Corbin, and Pangrazi (2006) wrote that fitness testing may become counterproductive when performance is used as a criterion for grading. This practice communicates to children the message that physical fitness, rather than physical activity, is the focal outcome of PE. Moreover, the inability to achieve fitness standards may be perceived by children as lack of competence, which may, in turn, reduce motivation for physical activity (Silverman, Keating, & Phillips, 2008).

Another challenge is that many children may not comprehend and internalize the rationale for fitness testing. Hopple and Graham (1995) interviewed 4th and 5th graders about their thoughts on the mile run just after completion. Many of the children reported not understanding why they were doing the activity, in addition to finding it to be a painful and unenjoyable experience. Furthermore, students in the same study recalled seeing some of their peers attempting to skip fitness testing either through notes from doctors or through fabricating excuses to see the school nurse. More recently, when rating their attitudes toward fitness testing, both boys and girls gave the item "enjoyment" the lowest rating (Mercier & Silverman, 2014). Indications that children try to avoid fitness testing should raise concerns about the way testing is implemented in practice (Wiersma & Sherman, 2008).

Finally, lack of adequate practice prior to testing may exacerbate problems associated with fitness testing. Keating and Silverman (2004) noted that the most prevalent form of preparation for fitness testing was through information provided by teachers to students. Only about half of the teachers who administered fitness tests allowed students to practice the components of the tests in advance. However, giving students the opportunity to familiarize themselves and practice the tasks included in fitness-testing batteries is an essential part of preparing students for testing. According to Corbin (2009), practice helps students (a) "understand concepts such as pacing," (b) "use good technique," (c) "eliminate mistakes that may result in loss of repetitions," and (d) most importantly for the present investigation, "prepare […] for a more satisfying experience" (p. 25).

It has been suggested that the methods used to implement fitness testing and practice can determine their psychological impact (Welk, 2008). Adopting different approaches can either nurture the interest and motivation for physical activity or lead to frustration and avoidance (Haerens, Aelterman, Vansteenkiste, Soenens, & Van Petegem, 2015). Yet, despite calls to critically reconsider fitness-testing procedures and fitness practice, little empirical research has been conducted investigating how modifications to either the testing itself or fitness practice can improve the experiences of students. Given their highly standardized nature, altering the procedures of fitness tests would require validating them anew. Therefore, for the purposes of the present study, we focused on fitness practice as a context that may be more readily amenable to change. The guiding rationale was that, based on psychological theory and extant evidence (as described in the next section), it may be possible to introduce changes to current practice that may result in making fitness practice a more positive experience for students, strengthening their perceptions of competence and enhancing their motivation for physical activity.

1.2. Constructs theorized to lead to high-quality physical education experiences

In recent years, interest in the role of pleasure and enjoyment in encouraging physical activity behavior has surged. Correlational evidence indicates that positive affect and enjoyment are associated with aspects of intrinsic motivation (Schneider & Kwan, 2013) and physical activity behavior (Cox, Smith, & Williams, 2008; Nasuti & Rhodes, 2013), both cross-sectionally and prospectively (Janssen et al., 2017). According to the principle of psychological hedonism, in general, people tend to engage in activities that bring them pleasure, while avoiding activities that bring displeasure (Ekkekakis & Dafermos, 2012; Kahneman, 1999). The recently proposed Affective-Reflective Theory (ART; Brand & Ekkekakis, 2018) proposes that repeated experiences of displeasure associated with exercise can establish a negative "automatic affective valuation" of the stimulus-category of "exercise" (which may include related constructs, such as PE, physical activity, bodily movement). This negative valuation is inherently linked to an instinctual urge to avoid exercise. In adults, as long as self-control resources have not been depleted by factors such as psychosocial stress, this urge to avoid may be overridden by reflective cognitive processes, such as appraisals of the importance of exercise for health. However, in children, the underdeveloped prefrontal cortex makes it unlikely that reflective processes can inhibit the urge to avoid that stems from a negative affective valuation (Martin & Ochsner, 2016). Therefore, creating a positive affective valuation through consistently pleasant experiences associated with PE and physical activity would be paramount in facilitating a tendency to remain active.

Furthermore, according to Self-Determination Theory (SDT; Deci & Ryan, 2002; Ryan & Deci, 2017), in order for individuals to be intrinsically motivated, the environment should satisfy the basic psychological needs of autonomy (i.e., feeling in control, nurturing inner endorsement, and experiencing ownership of one's behaviors and choices), competence (i.e., feeling effective, progressing, and mastering achievement-oriented tasks), and relatedness (i.e., feeling supported, accepted, and creating close bonds with significant others). Accordingly, teachers can influence the motivation of their students by supporting or thwarting the three psychological needs, depending on whether the instructions they provide, the interpersonal involvement they create, and the lesson structure they use are facilitative or controlling (Chatzisarantis & Hagger, 2009; Haerens et al., 2013; Standage, Duda, & Ntoumanis, 2006; Tessier, Sarrazin, & Ntoumanis, 2010). A need-supportive PE environment promotes self-determined motivation (Tessier et al., 2010) and intentions for physical activity outside of school (Lim & Wang, 2009), whereas a need-thwarting teaching style in PE has been related to maladaptive motivational outcomes and amotivation (Haerens et al., 2015).

Another parameter that may play a crucial role in whether the environment promotes mastery and achievement-oriented goals is the emphasis placed on cooperation versus competition. Drawing from the tenets of Achievement Goal Theory (AGT; Ames, 1992; Nichols, 1989) individuals tend to evaluate their competence and define success based on task- and/or ego-related criteria. Therefore, whether individuals find themselves in a climate that places emphasis on task- or ego-related criteria can prove consequential. A task-involving motivational climate, shaped by adults (e.g., coaches, teachers) and peers, will likely nurture positive social interactions, cooperation among peers, and personal improvement in sports and physical activities. Within such a climate, children perceive success by focusing on self-referenced criteria, such as maximum and collaborative effort, mastery, and learning, with mistakes and failures viewed as part of the learning process (Duda et al., 2013). Perceptions of competence are not threatened by how well others are performing; rather, *positive* peer interactions are a crucial component of a task-involving peer motivational climate (Vazou, Ntoumanis, & Duda, 2005). Accordingly, such a climate is predicted to be associated with positive affect, intrinsic motivation, and enjoyment

(Harwood, Keegan, Smith, & Raine, 2015; Jõesaar, Hein, & Hagger, 2011; Vazou, Ntoumanis, & Duda, 2006). In contrast, in an ego-involving motivational climate, perceptions of success are derived from interindividual competition and demonstrations of superior ability. In competitive ego-involving peer climates, children identify intra-team rivalry and outperforming others as salient factors (Vazou et al., 2005). Accordingly, competitive ego-involving motivational climates have been found to be related to negative affect and anxiety, and inversely related to factors that promote motivation, such as positive affect and perceptions of autonomy and relatedness (Harwood et al., 2015; Vazou et al., 2006).

The few studies that have investigated how to successfully modify the motivational climate and create a need-supportive environment in PE have provided useful suggestions on how PE teachers should interact with students, including giving contingent feedback, being sympathetic, and offering encouragement (Chatzipanteli, Digelidis, & Papaioannou, 2015; Chatzisarantis & Hagger, 2009; Haerens et al., 2013; Tessier et al., 2010). However, there is still a dearth of pragmatic experimental investigations examining the effects of specific changes to how PE is delivered on the quality of the experience that students derive. A previous attempt to experimentally manipulate the PE environment and the perceived goal content highlighted the practical challenges involved in such interventions under ecologically valid conditions (Gillison, Standage, & Skevington, 2013). The experimental manipulations used in this study consisted of different scripts that were read to students once at the beginning of a lesson that involved fitness practice (circuit training) and again half way through the lesson. Specifically, Gillison et al. (2013) attempted to create intrinsic and extrinsic goal content conditions (by reading scripts that emphasized staying fit and healthy versus appearing physically attractive and avoiding weight gain, respectively) and autonomy-supportive versus controlling social context conditions (by using phrases such as “we are asking” and “you can choose” versus “you should” and “you have to,” respectively). Beyond the points of emphasis and the wording of these scripts, however, manipulations of the structure of the lessons were minimal (e.g., telling students in the autonomous condition that they could choose their partners and activities, and that they were allowed to take breaks). While the scripts were successful in creating different perceptions of extrinsic goal content and perceived autonomy-support, they were unsuccessful in changing perceptions of intrinsic goal content. Consequently, the effect of the experimental conditions on motivation, affect, effort, and enjoyment were nonsignificant, and the effects on other outcomes (lesson value and intentions) were contrary to hypotheses.

Besides the foci of the Gillison et al. (2013) study, namely goal content and social context, several other psychological constructs have also been identified as potentially relevant to the motivation, positive affect, and enjoyment of students (Salmon, Brown, & Hume, 2009). However, the efficacy of theory-driven interventions targeting such constructs has yet to be formally assessed. The SAAFE framework (Supportive, Active, Autonomous, Fair, and Enjoyable) was developed to guide the planning and promotion of quality physical activity sessions in youth (Lubans et al., 2017). The satisfaction of the three basic psychological needs (per SDT), the promotion of a task-involving climate (per AGT), the introduction of task variety, as well as the use of self-selected motivational music were recognized as some of the possible ways of promoting enjoyment and motivation. Collective application of the SAAFE principles in multicomponent school-based interventions is yielding promising evidence regarding the promotion of physical activity, although the effects on motivational outcomes remain unclear (e.g., Cohen, Morgan, Plotnikoff, Callister, & Lubans, 2015; Lubans et al., 2016).

Novelty and variety of exercise tasks have been found to positively predict positive affect, enjoyment, and subjective vitality (Dimmock Jackson, Podlong, & Magaraggia, 2012; Sylvester et al., 2016), especially when need satisfaction was low (Sylvester, Curran, Standage, Sabiston, & Beauchamp, 2018). Furthermore, perceived variety has been found to be positively related to competence, autonomy, and relatedness (Sylvester et al, 2014). Among children, experimenting with varied and novel activities has been identified as a strong motivator for physical activity, along with enjoyment, parental support, and a nurturing climate that deemphasizes competitive sport participation (Allender, Cowburn, & Foster, 2006).

Studies examining the effects of choice and increased autonomy in PE lessons among adolescent girls have showed that girls who were offered choices during fitness activities were more intrinsically motivated compared to no-choice groups (Prusak, Treasure, Darst, & Pangrazi, 2004; Ward, Wilkinson, Graser, & Prusak, 2008). Conversely, when choices were withdrawn, self-determination declined. Furthermore, among young adults, even a slight manipulation of the perception of autonomy while selecting exercise intensity has been found to influence affective responses (Vazou-Ekkekakis & Ekkekakis, 2009). Similarly, experimental studies among youth have shown that self-selected, rather than externally imposed, exercise intensity results in more positive affective responses (Hamlyn-Williams, Freeman, & Parfitt, 2014; Stych & Parfitt, 2011). The apparent “decoupling” of affect from exercise intensity under self-paced (autonomy-supportive) conditions allows individuals to continue to experience pleasure even at intensities that would otherwise have been experienced as unpleasant (Benjamin, Rowlands, & Parfitt, 2012).

The use of music and video is another strategy commonly used to facilitate positive affective responses during exercise. A large literature on adults has shown that music, and especially the combination of music and video, permit the maintenance of pleasure during exercise even when intensity is within the vigorous range (i.e., above the ventilatory threshold; Hutchinson, Karageorghis, & Jones, 2015; Jones, Karageorghis, & Ekkekakis, 2014). Research among children is surprisingly limited but extant studies have shown that music can decrease perceptions of exertion and feelings of annoyance during exercise, presumably because the pleasant audiovisual stimulation competes with unpleasant bodily symptoms generated by vigorous exercise (De Bourdeaudhuij et al., 2002; Deforche & De Bourdeaudhuij, 2015).

1.3. The present study

Despite the emergence of theory-based recommendations aimed at promoting motivation, enjoyment, and physical activity in youth, studies testing the practicality and effectiveness of the recommended constructs in pragmatic settings are scarce. Therefore, in the present study, we postulated that theory-based, empirically supported, and readily implementable and scalable psychological interventions can be introduced to fitness-practice lessons to enhance their enjoyability and motivational potential. We conceived the present study as an ecologically valid field experiment (using a within-subjects design). Specifically, the purpose of this study was to compare the effects of a “traditional” and a workload-matched “novel” PE lesson, during which students practiced cardiovascular and muscular fitness, on the outcomes of (a) affective valence (i.e., pleasure-displeasure), (b) enjoyment, and (c) satisfaction of the basic psychological needs for autonomy, competence, and relatedness. In the “novel” lesson, we (a) replaced exposure to interpersonal comparisons with positive, cooperative interactions between students, (b) introduced variety, (c) encouraged autonomy and individual preferences, and (d) included upbeat and engaging music and videos. We hypothesized that, despite matching the amount of physical activity performed in the “traditional” lesson, the “novel” lesson would elicit more positive affective valence, higher enjoyment, and stronger need satisfaction compared to the “traditional” lesson.

2. Methods

2.1. Research design

A within-subjects experimental design was used, with participants engaging in both the "traditional" and "novel" lessons. The order of the conditions was randomized and counterbalanced to control for order effects.

2.2. Participants

The participants were 148 children from five PE classes, from 4th (37.2%), 5th (33.8%), and 6th (29.1%) grade (52% female; $M_{age} = 10.39$, $SD = 0.98$ years; $M_{BMI} = 18.59 \pm 3.98$), who attended two schools in central Iowa (within 50 miles from each other). Power analysis for a 2 (conditions) x 2 (time points: pre, post) design, using G*Power 3 (Faul, Erdfelder, Lang, & Buchner, 2007), indicated that a sample size of 140 was required to achieve 80% power. In the absence of a prior relevant study, a conservative approach was followed, targeting a "small" condition by time interaction (partial $\eta^2 = 0.01$, $f = 0.10$), with alpha of 0.05, and a correlation of 0.65 between the pre and post measurements. The University Institutional Review Board approved all measures and procedures. All students in the recruited classes participated in the lessons as part of their regular PE. Data were not collected from students who opted out or whose parents opted out. No participants dropped out or stopped during the lessons.

2.3. Measures

Physical activity. The SenseWear Armband (SWA) monitor (BodyMedia, Pittsburgh, PA) was used to measure physical activity during the lessons. The SWA is a wireless pattern-recognition device that integrates data from motion and heat sensors with demographic variables to estimate min of physical activity and energy expenditure (Arvidsson, Slinde, Larsson, & Hulthen, 2007). The device has been shown to provide accurate estimates of physical activity and energy expenditure in children (Calabro, Stewart, & Welk, 2013). For the present study, the SWA was set to 1-min epochs.

Affective valence. The Feeling Scale (FS; Hardy & Rejeski, 1989), as adapted for children by Hulley et al. (2008), was used to measure affective valence before and after the lessons. The FS is an 11-point single-item bipolar scale, asking children "How do you feel right now?" Scores range from −5 ("Very bad") to +5 ("Very good"). In the adaptation of the FS by Hulley et al. (2008), the numerical scale and verbal anchors were accompanied by generic drawings ranging from a sad face (−5) to a happy face (+5). In the present study, the faces were redrawn to be gender-specific.

Enjoyment. A version of the Physical Activity Enjoyment Scale (PACES; Kendzierski & DeCarlo, 1991), shortened and simplified for children (S-PACES; Paxton et al., 2008), was used to measure enjoyment at the end of the lessons. The S-PACES consists of the seven negatively worded items from the original PACES (Motl et al., 2001), rated on a 5-point scale ranging from 1 ("disagree a lot") to 5 ("agree a lot") and reverse-scored. Examples of items include "It was not fun at all" and "I disliked it." The alpha coefficient of internal consistency in the present sample was $\alpha = 0.89$ for the "traditional" lesson and $\alpha = 0.95$ for the "novel" lesson.

Situational Need Satisfaction. The 12-item Activity Feelings State Scale (AFS; Reeve & Sickenius, 1994) was used to measure situational satisfaction of the needs for competence, autonomy, and relatedness. Children were asked to respond to the stem "participating in this PE lesson made me feel … ", followed by such items as "free to decide for myself what to do" (example from the Autonomy scale), "competent" (example from the Competence scale), or "involved with close friends" (example from the Relatedness scale). Children rated each item on a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). The alpha coefficient of internal consistency in the present sample was .83 and .86 for Autonomy, 0.74 and 0.69 for Competence, and 0.73 and 0.66 for Relatedness, in the "traditional" and the "novel" lesson, respectively.

2.4. Procedure

The lessons were delivered by the second author aided by trained research assistants. A total of three visits took place at each school. During the first visit, the study was explained to the students and consent forms were collected. The second and third visits consisted of the two ("traditional" and "novel," in counterbalanced order) 30-min fitness-practice lessons. The lessons took place in the school gymnasia and were scheduled on the same day of the week and the same time of day (during regular PE hours), one week apart, to account for diurnal effects.

Upon entry into the gymnasium, an electronic tablet was distributed to each child for the completion of the consent forms and, for students who provided consent, the self-report measures. In addition, at that time, the SWA monitors were placed on the upper arms of participants. The FS was completed before the start and immediately after each lesson. Enjoyment (S-PACES) and need satisfaction (AFS) were measured upon completion of each lesson.

Instructions, demonstrations of the activities, and feedback were identical for both lessons. Care was used in all verbal communications to avoid references to the lessons that could imply that they were intended to be different from each other. Further, besides generic encouragement (e.g., "keep trying") and neutral informational cues (e.g., "you have 20 s left"), no specific positive or negative feedback was provided. Upon completion of each condition, students could pick stickers of their choice as reward.

"Traditional" lesson. The "traditional" lesson included practice of fitness testing, based on the 4th edition of the FITNESSGRAM (Plowman & Meredith, 2013). The tasks that were selected were (1) the PACER, (2) curl-ups, and (3) push-ups (described below). Each activity was selected due to its focus on a different aspect of physical fitness. The PACER is a test of cardiovascular fitness, whereas the curl-up task is a measure of core muscular strength and endurance, and the push-up task is a measure of upper-body muscular strength and endurance. The push-up was chosen over the pull-up because, unlike pull-ups, children can typically do at least one (and, usually, more than one) repetition (Plowman & Meredith, 2013). The lesson was structured as follows: (a) first PACER for 5 min, (b) 1 min of curl-ups, 1 min of core body stretching, 1 min of curl-ups (for a total of 3 min), (c) 1 min of push-ups, 1 min of upper-body stretching, 1 min of push-ups (for a total of 3 min), (d) second PACER for 5 min, and (e) 1 min of whole-body stretching, in this order. No scoring of performance was recorded during the tasks.

Aerobic exercise (PACER). A black line and cones at the two ends of the gymnasium were used to mark the 20-m distance used for the task. The children were asked to line up at the start and to begin running from one side to the other following the auditory signal. Consistent with the PACER protocol, running became progressively faster and students were asked to keep up with the cadence (as this was a practice lesson, students were instructed to continue running for 5 min, even if they could not keep up with the cadence).

Curl-ups and push-ups. Mats were arranged in two lines and children were facing one another. A member of the research team demonstrated the proper form for both tasks. Consistent with the FITNESSGRAM protocol, the practice for both tasks followed an auditory cadence. For push-ups, children were instructed to do two push-ups with the cadence, and then hold on a plank position for three counts of the cadence.

"Novel" lesson. The "novel" lesson focused on the same fitness components (aerobic fitness, abdominal and upper body strength and endurance), had the same duration, was practiced in the same order, and was designed to result in the same overall amount of physical

activity as the "traditional" lesson. However, the "novel" lesson incorporated modifications designed to encourage cooperative peer interactions, variety, personal choices, and individual preferences.

Aerobic exercise. Aerobic practice was accompanied by upbeat music (with a steady tempo of 136 beats per min) and video projected on one of the walls of the gymnasium. The video included scenes from popular cartoon movies (e.g., Madagascar, Despicable Me, Toy Story, Kung Fu Panda). Two 5-min music and video mixes were produced, one for each aerobic-practice period. Children were asked to find a preferred spot near the video projection. When the music and video began, children were instructed to initially run in place and then to proceed to run around the gymnasium in any direction they chose, and, while still running, to interact with their peers by jumping and giving "high-fives." During this process, research team members modeled alternatives to running that included jumping jacks, scissor jumps, kick-punches, and high knees. Children were given the freedom to switch to the new move or to continue the previous one.

Curl-ups and push-ups. These two tasks, adapted from the suggestions of Wiersma and Sherman (2008), were practiced in stations, alternating between curl-ups, push-ups, and stretching (for a total of 6 min). As with the "traditional" lesson, both tasks were described and demonstrated to students in advance. For the curl-up task, beach balls were distributed. Two children, facing each other, passed the ball back and forth with every curl-up. The push-up task was designed as a tag game. The object of the game was to do two push-ups in sync with the push-up cadence and to try to tap the hand of the partner, without getting tapped, for the remaining three counts of the cadence.

2.5. Statistical analyses

Descriptive data are presented as means and standard deviations. To compare the amount of physical activity between the two lessons ("traditional" versus "novel"), a repeated-measures analysis of variance (ANOVA) was conducted. To examine the effect of the experimental manipulation on affective valence, a 2 (condition: "traditional" versus "novel") by 2 (time: pre, post) repeated-measures ANOVA was conducted. Lastly, repeated-measures ANOVAs ("traditional" versus "novel") were conducted for enjoyment and the satisfaction of each of the three psychological needs. Effect sizes (Cohen *d*) for differences between means were also calculated.

3. Results

3.1. Physical activity

A repeated-measures ANOVA examining the difference in the amount of physical activity, expressed as the product of metabolic equivalent units (METs) and duration (i.e., MET·min), between the two lessons ("traditional" versus "novel") showed that the lessons did not differ significantly ($M_{TRADITIONAL}$ = 145.65, SD = 56.51 MET·min; M_{NOVEL} = 139.85, SD = 46.43 MET·min), $F(1,127) = 2.324$, $p = 0.130$. Likewise, the mean intensity (in METs) during the practice of the aerobic activities, which was at the boundary of "vigorous" and "near-maximal" intensity, also did not differ between conditions ($M_{TRADITIONAL}$ = 8.38, SD = 1.15 METs; M_{NOVEL} = 8.34, SD = 0.97 METs), $F(1,127) = 0.366$, $p = 0.366$.

3.2. Affective valence

The 2 × 2 repeated-measures ANOVA showed a significant main effect of condition, $F(1,124) = 8.27$, $p = 0.005$, $\eta^2 = 0.06$, a significant main effect of time, $F(1,124) = 7.23$, $p = 0.008$, $\eta^2 = 0.06$, and a significant condition × time interaction, $F(1,124) = 17.705$, $p < 0.001$, $\eta^2 = 0.125$. As depicted in Figure 1, although FS scores did not differ between the two conditions at the pretest (means approximately corresponding to the anchor "good"; $M_{TRADITIONAL}$ = 3.06, SD = 1.69; M_{NOVEL} = 2.87, SD = 1.83; $t = 1.29$, $p = 0.200$; $d = 0.12$), there was a significant decrease at the end of the "traditional" lesson (to between "fairly good" and "good"; $M = 1.96$, $SD = 2.97$, $d = -0.46$; $t = 3.89$, $p < 0.001$; $d = 0.42$), whereas scores in the "novel" lesson remained stable (at "good"; $M = 2.87$, $SD = 2.25$; $t = -0.11$, $p = 0.910$, $d = 0.00$).

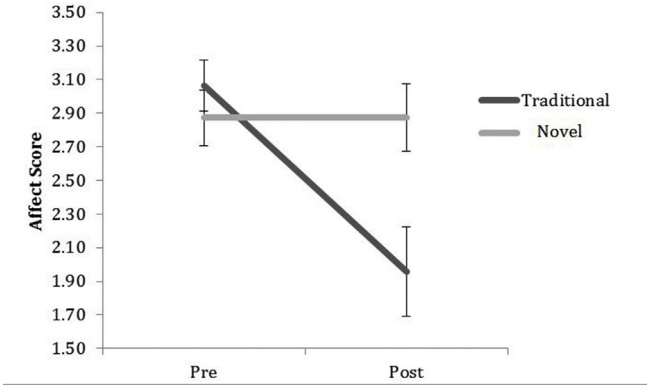

Figure 1. Affect results, illustrating the Time × Group interaction. *Note.* Error bars represent standard errors.

3.3. Enjoyment

The repeated-measures ANOVA showed a significant main effect of condition, $F(1,130) = 6.589$, $p = 0.011$, $\eta^2 = 0.05$. As seen in Figure 2, students reported higher levels of enjoyment ($d = 0.20$) after the "novel" lesson ($M = 4.13$, $SD = 0.84$) than after the "traditional" lesson ($M = 3.94$, $SD = 1.04$).

3.4. Situational Need Satisfaction

Repeated-measures ANOVAs for the needs of competence, autonomy, and relatedness showed a significant main effect of condition only for the satisfaction of the perceived need for competence, $F(1,100) = 5.93$, $p = 0.017$, $\eta^2 = 06$. As shown in Figure 3, while the difference reached significance only for competence ($d = 0.23$), students also reported marginally higher levels of satisfaction of the need for autonomy ($d = 0.11$) and relatedness ($d = 0.06$) after the "novel" lesson compared to the "traditional" lesson.

4. Discussion

In most domains of life, early experiences can have lasting consequences. This is also likely the case with PE experiences, memories of

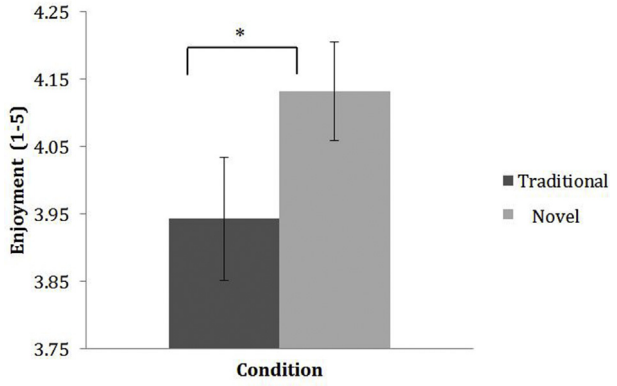

Figure 2. Enjoyment results, illustrating the main effect for Condition. *Note.* $p < 0.05$.

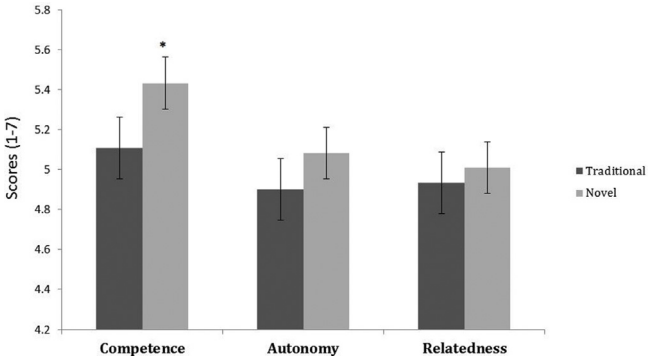

Figure 3. Perceived need satisfaction results, illustrating the main effect for Condition. *Note*. $p < 0.05$.

which have been found to be associated with motivational variables in adulthood (Ladwig et al., 2018). Therefore, for the promotion of long-term (ideally, lifelong) physical activity, it seems essential to deliver PE of the highest quality, as defined by current psychological theorizing and empirical evidence. It is probably uncontroversial to suggest that current practice norms in PE settings still lag behind this goal. In other words, although psychological theory has identified aspects of the experience that could be enhanced, and empirical evidence has supported the effectiveness of certain theory-based interventions, these advances have not yet translated to a meaningful shift in PE practice norms. Perhaps, one reason for the delay in bringing research evidence into practice (i.e., the so-called knowledge-translation gap) may be that the extant research lacks ecological validity or the interventions lack practicality and fail to take into account pragmatic or logistical constraints.

In this context, the aim of the present study was to assess the gains in an important class of motivational factors (i.e., pleasure, enjoyment, psychological need satisfaction) that could be achieved by introducing easy-to-implement, free or low-cost, theory- and evidence-supported modifications to daily PE practice. As our model PE class, we focused on fitness practice that can help students prepare for standardized fitness testing and can improve important aspects of physical fitness (e.g., cardiovascular endurance, muscular strength).

Based on theory and empirical evidence, we postulated that the elements of interpersonal competition and the demanding, regimented, and monotonous nature of activities typically used for physical fitness practice may be perceived as unpleasant or unenjoyable (as reported by Gillison et al., 2013, "teacher and pupil consultation ahead of the trial confirmed fitness-based classes were the least inherently enjoyed of a range of different PE activities", p. 344). Therefore, we designed an alternative format, with the goal of offering an equivalent stimulus for fitness gains (i.e., similar modes of practice, amounts, and intensities of physical activity) while satisfying the basic psychological needs of students and producing a pleasant and enjoyable overall experience. Our "novel" lesson replaced competition cues with positive, cooperative, mastery-involving peer interactions, encouraged variety and individual preferences, and introduced engaging music and video. We kept the number of changes small, the cost low, and the need for teacher training, space reconfiguration, and availability of physical infrastructure to a minimum. We did so in order to offer a practical, easy path to implementation.

Consistent with indications from previous studies, the "traditional" lesson led to a significant, medium-sized ($d = 0.42$) pre-to-post decrease in affective valence scores whereas the "novel" lesson prevented the decline in affective valence and was rated as significantly more enjoyable ($d = 0.20$, i.e., "small" effect) and competence-supportive ($d = 0.22$, i.e., "small" effect) than the "traditional" lesson. To our knowledge, this is the first theory-based experimental study that manipulated the structure of a fitness-practice PE lesson and demonstrated that fitness practice can be perceived as a more positive experience for all children without compromising the volume of physical activity provided. Another recent study (White, Rothenberger, Hunt, & Goss, 2016) similarly showed significant increases in positive affect among children over a seven-week intervention with structured gym games (e.g., tag) compared to traditional aerobic exercises (e.g., treadmill running, ergometer cycling), despite heart rate being 23 bpm higher on average during the gym games.

The relationships of affective valence and enjoyment with physical activity have been demonstrated in a growing number of studies involving adult participants (Ekkekakis & Dafermos, 2012; Rhodes, Fiala, & Conner, 2009; Rhodes & Kates, 2015) and appear to be reliably reproducible in children and adolescents as well (Burdette & Whitaker, 2005; Nasuti & Rhodes, 2013; Schneider & Cooper, 2011; Schneider, Dunn, & Cooper, 2009). For example, among adolescents (14–16 years old), individuals reporting improvements in valence (22%) during a 30-min bout of moderate-intensity exercise averaged 54.25 daily min of accelerometry-assessed moderate-to-vigorous physical activity, those who reported no change (22%) averaged 46.94 min, and those who reported declines (56%) averaged 39.83 min (Schneider et al., 2009). Therefore, it is reasonable to assume that repeated experiences of higher pleasure and enjoyment during PE, especially over months or years, could result in a stronger tendency to be physically active during the critical period of childhood and adolescence. Moreover, although this notion remains to be tested, it seems reasonable to suggest that the promotion of pleasure and enjoyment may be particularly effective as the main target of motivational interventions during childhood and adolescence, a period when the knowledge or appreciation of the health and fitness benefits of physical activity may have limited motivational implications. Emerging dual-process theoretical models (e.g., Brand & Ekkekakis, 2018; Conroy & Berry, 2017) propose that physical activity behavior may be more likely to reflect affect-driven urges, rather than deliberative decisions, especially when executive processes are compromised by such factors as stress (in adults) or incomplete cortical development and maturation (in children and adolescents).

Giving children the autonomy to self-regulate the intensity of their activities in the "novel" lesson may have contributed, in part, to their more positive overall experience. Among adults, it has been shown that imposing even a 10% higher level of exercise intensity over what participants would have self-selected can lead to significant declines in pleasure (e.g., Ekkekakis & Lind, 2006; Vazou-Ekkekakis & Ekkekakis, 2009). Likewise, providing autonomy and choices during PE fitness activities has been shown to be effective in increasing intrinsic motivation among adolescents (Prusak et al., 2004; Ward et al., 2008). It has also been suggested that high-quality PE programs promoting an intensity that "feels good" have the potential to increase both enjoyment and physical-activity intensity among adolescents, especially for those with low baseline levels of enjoyment (Schneider, 2014; Schneider & Cooper, 2011). Conceivably, these effects may be similar in children but direct empirical tests are still lacking.

In addition, the use of music and video may have contributed to the positive experience reported by children in the "novel" lesson. Among adults, the combination of music and video has been shown to be marginally more effective than music-only conditions in improving affective responses to exercise and reducing perceptions of exertion, even when the intensity is above the ventilatory threshold (Hutchinson et al., 2015; Jones et al., 2014). Moreover, the presence of music has been shown to lead adult participants to self-select a higher level of exercise intensity while continuing to report consistently positive affective valence (Hutchinson et al., 2018).

Finally, play-like elements of the "novel" lesson may have improved enjoyment as they were likely conducive to activity that emulated the natural movement patterns of children, which are characterized by intermittency (Bailey et al., 1995). It should be emphasized that play is the only natural form of physical activity among children, as evidenced in the young of all mammalian species (Burghardt, 1984). In contrast,

prescribed, regimented, and highly structured forms of activity, such as those that have become the backbone of PE curricula, represent a relatively recent development. Play is a behavior that was preserved throughout mammalian and hominid evolution, despite its high energetic cost, because it is theorized to confer crucial benefits for development: (a) motor training, (b) socialization, and (c) cognitive development (Burghardt, 1984).

In the present study, we successfully manipulated perceived competence. Presumably, this was achieved by restructuring the activities to remove elements of competition between peers (i.e., practicing the fitness tasks without students focusing on the performance of others and evaluating their ability in relation to others). Importantly, students perceived their competence to be higher after the "novel" lesson, compared to the "traditional" lesson, even though the intensity was vigorous (as measured objectively by accelerometers) and did not differ between the two lessons. Perceived competence is positively associated with enjoyment and physical activity behavior (Fortier, Duda, Guerin, & Teixeira, 2012; Teixeira, Carraca, Markland, Silva, & Ryan, 2012). Perceived competence based on self-referenced criteria and elements of positive peer interactions within a task-involving peer motivational climate have been found to be strong predictors of enjoyment and adaptive motivational outcomes in youth (Joesaar, Hein, & Hagger, 2011; Vazou et al., 2006). White, Olson, Parker, Astell-Burt, and Lonsdale (2018) showed that adolescents recalled experiencing more positive affect in leisure-time physical activity and PE when they felt a sense of accomplishment, personal improvement, and belonging with their peers, whereas peer evaluations or comparisons to classmates with higher ability contributed to recalling negative emotions.

The results of the present study also showed that children perceived the "novel" lesson to be slightly more autonomy- and relatedness-supportive; however, these effects were too small ($d < 0.20$) to reach statistical significance. The "novel" PE lesson provided more variety and allowed students to choose who to work with, where to be in space relative to their peers, and to positively interact with their peers through encouragement (e.g., "high-fives") and playful actions (e.g., tag game during push-ups). However, those elements of choice and positive peer interactions were not reflected in the measures of situational satisfaction of the needs for autonomy and relatedness, respectively. There are several possible explanations for these weak effects. Among procedural explanations, it is possible that the interventions were not as practical as intended (e.g., were not adequately comprehended or could not be satisfactorily applied in practice). However, anecdotal observations were inconsistent with this possibility, as the students expressed no confusion and exhibited no difficulty following the instructions. Among psychometric explanations, it is conceivable that the inherent susceptibility of self-report measurements to random error among children (9–11 years old) might have attenuated the strength of any effects. This possibility is partially supported by the observation that coefficients of internal consistency indicated approximately 50% of reliable variance in the assessments of Competence (alpha coefficients of 0.74 and 0.69, suggesting 48%–55% reliable variance) and Relatedness (alpha coefficients of 0.73 and 0.66, suggesting 44%–53% reliable variance), though not Autonomy (alpha coefficients of 0.83 and 0.86, suggesting 69%–74% reliable variance). A remaining possibility points to the context-generic nature of the AFS (Reeve & Sickenius, 1994); it is possible that autonomy (e.g., "free to decide for myself what to do," "doing what I want to be doing") and relatedness items (e.g., "involved with close friends," "emotionally close to the people around me") not specifically referring to the context of PE might have been too general, or their relevance might have been too obscure, to reflect the effects of our intervention. These possibilities should be given consideration in future studies.

In interpreting the results of the present study, readers should take into account its limitations. This was a study of an acute intervention, involving only two experimental sessions. A long-term intervention would be necessary to support any claims about the efficacy of the "novel" fitness-practice lesson in enhancing physical activity behavior. Furthermore, the findings summarized here should be considered applicable only to students in 4th to 6th grades, participating in lessons that consist of fitness practice. Additional grades and variety of lesson plans or fitness-testing practices, delivered by PE teachers over a longer period, should be examined in the future. Lastly, because the "novel" lesson was conceived as a multicomponent intervention combining multiple theory- and evidence-supported elements (music, video, games, interactions with peers, etc.), it is not possible to parse out which component was most influential in changing affective valence, enjoyment, or perceived competence.

As the epidemic of physical inactivity continues unabated, it is becoming increasingly important to translate novel, theory-based, and evidence-supported interventions into practice. In this study, we have provided evidence for the effectiveness of a PE class model that requires minimal specialized teacher training, need for prior reconfiguration of gymnasium space, and availability of physical infrastructure to implement. We have concluded that modifying the way that a PE class period consisting of fitness practice is structured is conducive to improving affective valence, enjoyment, and perceived competence among schoolchildren. Importantly, the superiority of the "novel" lesson over the "traditional" lesson was demonstrated despite a comparable overall amount of physical activity and intensity during the aerobic component of the lesson. The "novel" lesson tested in this study represents only one of many possibilities for designing more pleasant and enjoyable PE classes. Physical educators may wish to consider implementing some or all of the elements we proposed here, or to experiment with other changes that reflect the same theoretical postulates (i.e., minimizing or eliminating comparisons between students, emphasizing positive peer interactions, encouraging autonomy, introducing music and video).

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