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ORIGINAL ARTICLE

Affective Judgment and Physical Activity in Youth: Review and Meta-Analyses

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Abstract
Background A recent meta-analysis on affective judgment and physical activity in adults yielded a medium effect-sized relationship. Despite narrative reviews and topic interest, a meta-analysis in youth has not yet been conducted.
Purpose This study aims to appraise the overall effect of affective judgment on physical activity in youth via meta-analyses and explore moderators of this relationship.
Methods Literature searches were conducted between 1990 and 2011. Fixed and random effects meta-analysis with correction for sampling, measurement, and publication bias were employed.
Results Fifty-six correlational studies and 14 interventions met the inclusion criteria. Among correlational studies, the corrected summary r was 0.26 (95 % CI 0.18–0.32). Significant moderators were gender, measure of physical activity, and recruitment context. Among intervention studies, Cohen's d was 0.25 (95 % CI 0.11–0.40).
Conclusions The results are close to a medium effect size which is larger than other meta-analytic physical activity correlates among youth. The construct should be included in our contemporary theories for understanding and intervening upon youth physical activity.

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Introduction

The benefits of regular physical activity in youth have been well documented and are plenty including reduced levels of adiposity, blood pressure and lipids, cardiovascular risk factors, injury, and mental health concerns like depression; increased bone health; and strength and fitness outcomes [1–3]. Unfortunately, only a small fragment of Canadian and US youth are engaging in levels of physical activity that would bring about health benefits and are meeting current physical activity guidelines [4–6]. These guidelines recommend that children and youth perform a minimum of 60 min of moderate to vigorous physical activity every day, vigorous intensity activities at least 3 days a week, and bone strengthening activities at least 3 days a week [7, 8]. Given the many benefits, the low levels of activity, and that physical activity tracks reasonably well from childhood to adolescence and into adulthood [9], promoting regular physical activity in children is an important public health concern.

When devising physical activity interventions, it is fundamental to work within theoretical frameworks [10–12]. To this end, several theories versed in the cognitive tradition have been used extensively in physical activity. Although these prominent theoretical frameworks have shown utility among youth [10, 13], there are some criticisms; one of which is the (deficit in) employment of an emotional or affective component [14]. Affect (core affect, specifically) refers to "…the most elementary consciously accessible affective feeling"; it is the neurophysiological state of simply feeling good or bad, drowsy, or energized [15, 16]. In an exercise/physical activity context, affect is often measured acutely—during the activity or immediately before or after the activity [17]. For the purposes of this review, we defined the affective component of the included studies as affective judgment: the overall pleasure/displeasure, enjoyment, and feeling states *expected* from enacting an activity or from *reflection* on past activity [18, 19]. Although core affect is likely one of the main contributors of affective judgment, the cognitive appraisal of affective judgment may also comprise the overall physical activity experience, which includes, but is not limited to, the environment (physical and social) within which one will be physically active.

Most theoretical models of physical activity do incorporate some aspect of affective judgment, though not usually as its own construct, exclusively. For example, the theory of planned behavior distinguishes between social (normative) and personal outcome judgments (attitude) [20]; social cognitive theory distinguishes among social, physical, and self-evaluative outcome judgments [21]; while the transtheoretical model and health belief model denote specific constructs for positive and negative outcome judgments [22, 23]. Recent research with the theory of planned behavior and physical activity has highlighted the importance of a distinction between affective and instrumental outcome expectation constructs [19, 24–27]. The self-determination theory of Deci and Ryan [28] highlights the importance of affective judgment in their intrinsic regulation construction and more generally in autonomous motivation; the theory has gained momentum in the adult and youth physical activity domain over the last few years [29–31]. Further, behavioral choice theory [32] highlights affective judgment in the construct of reinforcing value and this model has also gained research attention in child physical activity over the last several years [33, 34]. Finally, hedonic theory posits that people will more readily engage in behaviors that bring them pleasure and avoid those that bring displeasure [35].

Besides the theoretical rationale for an affective construct, there is evidence among adults that affect is a key correlate of physical activity. Positive affective responses to acute bouts of exercise have been found to predict future physical activity participation [36, 37] as well as to moderate the intention–behavior relationship [38]. Affect and self-efficacy have been found to be linked, in that they shift together during and immediately after an acute bout of activity [39], and are both important for action and maintenance of exercise behavior [40]. Further, affect can be used to regulate exercise intensity, while still achieving an intensity of activity that is health promoting [41].

Bearing in mind the broader construct of affective judgment, a recent meta-analysis which included 82 correlational studies on affective judgment and physical activity reported a summary r of 0.42, reflecting a robust medium effect size [42, 43]. This effect size was larger than reported effect sizes of most other physical activity correlates in adults, such as the built environment [44], sociodemographic [45], personality [46], and the largest, self-efficacy ($r=0.35$) [43, 47]. Considering the link between self-efficacy, affect, and physical activity—and that in adults the effect size for affective judgment was larger than that for self-efficacy—further insight on the role of affective judgment is of value.

In children and adolescents especially, whose motivation to engage in physical activity is likely not because of the distant, long-standing health benefits, accounting for affective judgment as a determinant to being physically active may be even more critical than it is in adults. Its potential importance has been considered in the youth physical activity literature, but its relationship with physical activity remains inconsistent. For example, Biddle et al. [48] reviewed nine systematic reviews on non-intervention physical activity research in youth. Of the nine reviews included, four evaluated the impact of enjoyment [49–52]. Physical activity preference was a positive physical activity correlate among children, but not adolescents in the review by Sallis et al. [51]; however, enjoyment was positively associated with physical activity among adolescent girls in another review [49]. Hinkley et al. [50] reported too few data to draw any conclusions and van der Horst et al. [52] reported no association. Given the interest in the topic and the decidedly uncertain and mixed results, a quantitative summation of the results via a meta-analysis with moderator analyses seemed necessary.

The aim of this review and meta-analysis was to determine the relationship between affective judgment and physical activity in youth (5–18 years old) by reviewing cross-sectional, longitudinal, and experimental studies that employed an affective judgment component within a physical activity context. The second aim was to explore potential moderators. Potential moderators analyzed from correlational studies were: measure used to assess affective judgment, measure of physical activity, country where the study was conducted, recruitment location, physical activity context, quality of the study, theory employed, and participant age and gender. Potential moderators analyzed from intervention studies were country, gender, age group, quality of the study, measure of affective judgment, measure of physical activity, intervention location, and method of intervention dissemination. Similar to the results from the meta-analysis (with correlational studies) that was conducted in adults, it was hypothesized that affective judgment in youth would also be within a meaningful effect size. Further, there was interest in exploring gender as a moderator because past reviews had reported that females participated in more physical activity if they had a high affective judgment score [49].

Method

Eligibility Criteria

A study was considered for this review if it met the following inclusion criteria: (a) a measure of leisure time physical activity as the dependent variable. Physical activity was defined as "body movement produced by the skeletal muscles which results in a substantial increase over the resting energy expenditure" [53]; (b) a measure of affective judgment. For the purposes of this paper, affective judgment was defined as a judgment on a past or future affective state resulting from engagement in physical activity behavior. This judgment would take into account how one felt or would feel about the whole physical activity experience (i.e., the activity, the environment, the company, etc.), and was measured using a tool that assessed cognitively appraised affect [21]. Core affect (a mood or emotional episode at a specific or present time), and transient pre–post, or during exercise affective states (usually measured via the Feeling Scale [54] or the Profile of Mood States [55]) were not included because they do not incorporate a judgment of the activity; and (c) involved participants with a mean age between 5 and 18 years old.

Excluded studies were those which (1) examined attitude or outcome judgments as an omnibus construct (i.e., did not analyze affective judgment separately from other attitudes); (2) did not measure affect as a judgment construct (e.g., transient pre–post or during exercise affective states); (3) included a measure of physical activity or affective judgment that was not quantitative (e.g., results from a focus group discussion); (4) did not include an analysis of physical activity with affective judgment; (5) were written in a language other than English; or (6) focused on special, medical populations (see Electronic Supplementary Material (ESM) Appendix A).

Search Strategy

Literature searches were conducted from January 1990 to June 2011 in ISI Web of Science, SPORTDiscus, PsycINFO, PubMED, and MEDLINE (see ESM Appendix A). A combination of keywords were used, including physical activity, exercise, enjoyment, liking, fun, pleasure, affective attitude, "Physical Activity Enjoyment Scale or PACES", "motives for participation", intrinsic motivation, social cognitive theory, theory of planned behavior, self-determination theory, correlates, and intervention. The search was executed by one author and one research assistant. Reference lists of included studies were manually cross-referenced. The search strategy and eligibility criteria followed a protocol used by Rhodes et al. [35].

Screening

Citations were screened by two reviewers (GN and GR) using predefined inclusion criteria. Studies were initially screened based on the title and abstract. Relevant abstracts were then selected for a full read of the article. Potential studies for adjudication were examined by two reviewers (GN and RR); and after discussion, it was determined whether or not the study was to be included in the review. Consensus was reached in 100 % of the cases.

Data Abstraction

Data were abstracted using a predefined data abstraction form. The abstracted data included authors, country, sample (number, age, gender, and subpopulation), study design and setting (recruitment location and physical activity context), measurement tools (affective judgment and physical activity), reliability of the tools, theory, reported effect size, outcomes, and intervention (dose, length, groups, and location). Coding and data entry were conducted using a word table and later imported into the Comprehensive Meta-Analysis (CMA) version 2 software program [56].

Analyses

Correlational Studies

Correlational studies assessing the relationship between affective judgment and physical activity were grouped in total and coded by country/continent (Australia, Asia, Canada, USA, UK), quality (high, moderate, and low), design (longitudinal and cross-sectional), recruitment location (school and community/other), physical activity context (physical education, extracurricular physical activity/non physical education), measure used for affective judgment (semantic differential, intrinsic motivation, study-created measure by the researchers), measure used for physical activity (direct: accelerometer, pedometer, heart rate; validated self-report; other), and gender (female only, male only, same sex [female only and male only], mixed) based on a priori classification of possible moderators. If a study reported both a longitudinal and cross-sectional effect size, the longitudinal finding was used for the analyses. If a study used more than one physical activity variable, the variable that best reflected the definition of "meeting physical activity guidelines during leisure time" was chosen. For example, if participants answered the following questions: "how active are you during physical education?" and "how active are you after school?" results from the latter were chosen. When a study measured affect with more than one tool, the tool that reflected only enjoyment, over a larger construct was chosen. For example, if a study used both the PACES and the

Intrinsic Motivation Inventory, the PACES was chosen. This is because the PACES measures positive affect associated with involvement in physical activity, whereas the Intrinsic Motivation Inventory assesses enjoyment as well as perceived competence, value, pressure, and perceived choice, therefore encompassing a broader construct than solely affect. Only the effect size which was the most inclusive was reported for each sample. For example, some studies reported effect sizes for males only, females only, and both sexes. When a study reported an effect size for all three categories, only the effect size for both sexes was used. This was done to ensure that no particular individual was included twice. The sample size imputed in these calculations was based on the sample used to calculate the coefficient of interest (e.g., effect size r).

Risk of bias/study quality for the correlational studies was assessed using a checklist tool which has been used in the past [43]. The tool uses similar scoring to the Cochrane Collaboration's instrument for assessing risk of bias [57] and a checklist created by Downs and Black [58]. The instrument included five questions answered with a yes (1) or no (0) format. High quality (i.e., low risk of bias) was considered with a score of five, moderate quality was considered with scores of 3–4 and low quality (i.e., high risk of bias) was considered with scores of 0–2 (see ESM Appendix B).

Effect sizes for each study were calculated before and after correcting for the attenuation of measurement error. Correction for attenuation of measurement error procedures were based on the reliabilities of the measures as presented in the study or from prior published literature with the same instrument. In cases with single items or unreported reliabilities, we used $r$xy=0.70 based on a conservative, yet acceptable judgment of reliability [59]. In cases where coefficients had already been corrected for the attenuation of measurement error (e.g., structural equation models), no additional correction procedures were used.

Quantitative evidence synthesis was subsequently performed [60]. Fixed- and random-effects models of meta-analyses were performed using both the uncorrected and corrected r [61] to obtain overall effect sizes. Along with the weighted average effect sizes, we computed the 95 % confidence intervals. If the confidence interval does not include zero, then the effect size is statistically significant at the $p<0.05$ level. To determine heterogeneity of the effect sizes, we calculated both the Q statistic and I^2. Q tests the hypothesis that the observed variance in effect sizes is no greater than that expected by sampling error alone, while I^2 quantifies the dispersion. For interpretation, we considered I^2 values of 25=low, 50=moderate, and 75=high [62]. For moderator analyses, we used Q_B to explore the impact of categorical variables on the effect size. Moderator analyses were performed using corrected rs with fixed and random effects models[1]. Rosenthal's [63] *classic fail-safe N* and Duval and Tweedie's [64, 65] *Trim and Fill* procedures were used to assess the extent of publication bias. All data were analyzed in January 2012 using Comprehensive Meta-Analysis [56].

Experimental Studies

The grouping of experimental studies was considered with coding schemes similar to the correlational studies; in addition to age group, location of the intervention, and dissemination of the intervention. Quality of study was coded using a tool similar to that used with the correlational studies (see ESM Appendix C). Studies were appraised both quantitatively and qualitatively for three reasons: (1) due to the small number of available experimental studies; (2) not all experimental studies that met eligibility criteria were included in the quantitative analysis; and (3) for a more in-depth understanding of the results of the interventions given their heterogeneity. Studies were appraised quantitatively using Cohen's d. Moderator analyses were performed with random effects models. Studies were also appraised qualitatively and were themed based on setting and whether or not affect was targeted in conjunction with other constructs. Specific subthemes were explored if at least three studies could be grouped within it.

Results

The literature search yielded a total of 10,332 potentially relevant citations. After screening procedures, 46 articles were included as a result of the search and an additional nine were extracted from manually searching the reference lists of the included articles (see Fig. 1). A total of 55 studies were included in this review, of which, 40 studies were correlational (yielding 56 independent samples; see Table 1) and 15 were interventions (14 independent samples; see Table 2).

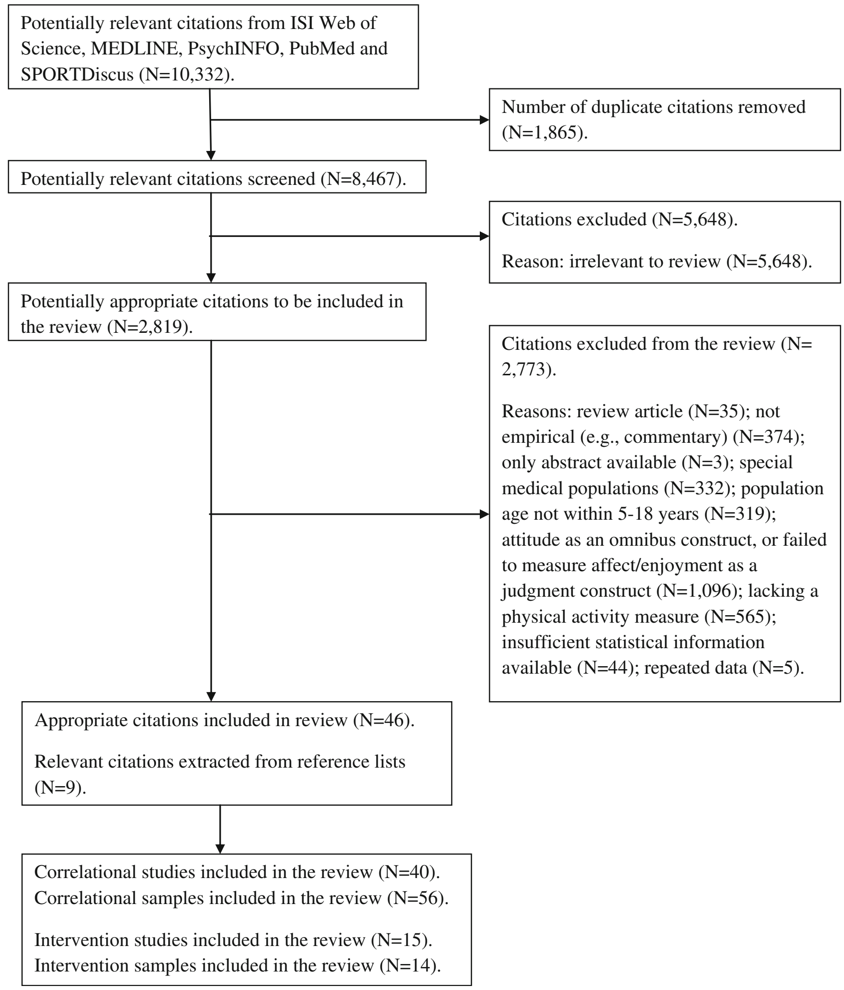
Correlational Studies

Study Characteristics

Within the 40 correlational studies, 94 effect sizes were reported. Two studies reported effect sizes for the overall sample, as well as for each gender category within the sample [66, 67]. Seven studies employed more than one tool to measure affective judgment [68–74] and six studies employed more than one tool to measure physical activity

[1] Results from both models were incorporated into Table 4 but only results from the random effects model were discussed.

Fig. 1 Results of the literature search, 1990–2011



[51, 75–79][2]. Three studies reported cross-sectional and longitudinal effect sizes for the same sample [69, 80, 81]. In order to ensure that each sample was represented only once, 56 effect sizes (one for each independent sample) were included in the meta-analysis [66–105]. See Table 3 for study characteristics.

Overall Effect Size, Heterogeneity, and Moderators

Using the uncorrected effect size from each study, the fixed-effects model yielded an overall effect of r=0.23 (95 % CI= 0.22–0.24) and the random-effects model an overall effect of r=0.20 (95 % CI=0.15–025). Thirty-five reliability coefficients (α) were reported for tools used to measure affective judgment, and the average α was 0.84. After correcting for measurement error, the fixed-effects model yielded an overall effect of 0.32 (95 % CI=0.30–0.33), and the random-effects model r=0.26 (95 % CI=0.18–0.32), indicating a medium effect size [42]. The random effects model, using the corrected r value was used for all subsequent analyses. Significant heterogeneity was detected among studies, Q (56)=2,034.85, p<0.001. Furthermore, I^2 (97.30) indicated that 97 % of the observed variance was explained by true systematic effect size differences (as opposed to error) between studies. Both of these statistics suggest the need to explore possible moderating variables. Gender, measure of physical activity, and recruitment location emerged as significant moderators. Study quality, country, physical activity context, measure of affective judgment, and design did not significantly moderate the affective judgment–physical activity relationship. See Table 4 for results from moderator analyses.

Gender emerged as a significant moderator (p<0.005). In order to delve further into gender, two additional gender

[2] Of the seven studies that used more than one measure of affective judgment, three pooled the results from the affective judgment measures. Four studies reported results from more than one affective judgment measure. Two of these employed the Intrinsic Motivation Inventory and Physical Activity Enjoyment Scale and similar to the results from our moderator analysis on affective judgment measure, there was almost no difference in the results from the two measures (0.36 vs. 0.38 and 0.43 vs. 0.42). It is unlikely that using the within-study average affective judgment results from the other two studies would have drastically affected the meta-analytic results of 56 independent samples.

Table 1 Correlational studies of affective judgment and physical activity

Study, country	Sample (number, gender, mean age)	Theory, design	Affective judgement measure, α	Physical activity measure	Results	Corrected *r*	Quality score/5
Bergh et al. [82], Norway	*N*=1,129 mix 11 Years	x-s	PA enjoyment, 0.70	Accelerometer	MVPA: n.s.	0.00	4
Gillison et al. [83], UK	*N*=310 mix 14.9 Years	Longitudinal, but x-s analysis of affect and PA	BREQ-2, 0.87	LTEQ	r=0.24 (p<0.001)	0.29	5
Lawman et al. [84], USA	*N*=1,422 mix 11.3 Years	x-s	PACES, 0.90	Accelerometer	MVPA: r=0.07 (p<0.1)	0.07	4
Lyu and Gill [85], South Korea	*N*=546 mix Range=11–14 years	SDT x-s	Intrinsic Motivation Inventory, 0.93	Effort in PE	r=0.518 (p<0.01)	0.58	4
Rosenkranz et al. [79], USA	*N*=230 mix 9.5 Years	x-s	Study created, 0.72	Accelerometer	Structured PA: r=0.21 (p<0.05) Unstructured PA: n.s.	Unstructured: 0.06[a]	3
Zhang et al. [86], USA	*N*=286 mix 13.4 Years	SDT x-s	Intrinsic motivation Inventory, 0.84	Self-reported PA	r=0.43 (p≤0.05)	0.43	3
Cox and Ullrich-French [74], USA	*N*=249 mix 12.6 Years	SDT x-s	Intrinsic motivation Inventory (for PE), 0.94; Sport Enjoyment Scale 0.94	PAQ-C	r=0.35 (p<0.01)	0.35	3
García Bengoechea et al. [77], Canada	*Group 1N*=1,641 mixAge range=12–13 *Group 2N*=1,518 mixAge range=14–15	x-s	PE enjoyment: study created	Participation in unorganized and organized PA, study created	*Group 1*Organized PA: OR=2.33 (p<0.001) unorganized PA: OR=1.58 (p<0.001) *Group 2* Organized school PA, OR=3.54 (p<0.001); unorganized school PA, OR=3.90 (p<0.001); organized out-of-school PA, OR=3.98 (p<0.05); unorganized out-of-school PA, OR=2.55 (p<0.001)	Unorganized, 0.18[a]; unorganized out of school, 0.36[a]	2
García Calvo et al. [87], Spain	N=492 M 14.3 Years	SDT Longitudinal baseline, 1 year	Sport Motivation Scale, 0.76	Players vs. drop outs	r=−0.11 (n.s.)	−0.13	3
Heitzler et al. [88], USA	*N*=720 mix 14.7 Years	x-s	PACES, 0.93	Accelerometer	MVPA: r=0.15 (p<0.05)	0.16	4
Kelly et al. [78], USA	*N*=1,180 F 12.0 Years	x-s	PACES, 0.90	Accelerometer	*MVPA* Hispanic, n.s.; Black, n.s; White, r=0.07 (p<0.1) *VPA*; Hispanic, r=0.17 (p<0.05); Black, n.s.; White, r=0.17 (p<0.05)	MVPA[a]: Hispanic, 0.11; Black, −0.03; White, 0.07	4
Lee et al. [89], Singapore	*N*=1,814 mix 14.1 Years	SCT, TPB x-s	PACES, 0.91	3-Day PAR	Male, r=0.23 (p<0.001) Female, r=0.19 (p<0.001)	0.26 0.21	4
Liukkonen et al. [90], Finland	*N*=338 mix Age range, 11–12	SDT and achievement goal theory x-s	Sport Enjoyment Scale, 0.89	Effort during PE; study created	r=0.58 (p<0.01)	0.85	3
Pang and Ha [67], Hong Kong	*N*=335 mix 10.7 Years	Expectancy value x-s	Chinese Subjective Task Value inventory, 0.90	PA questionnaire for children	r=0.47 (p<0.001) Males only, β=0.23 (p<0.01) Females only: n.s	All, 0.55[a]	4
Raudsepp et al. [81], Estonia	*N*=236 F 12.7 Years	TPB longitudinal baseline, 1 year	Affective attitude, 0.74	3-Day PAR	Past PA, r=0.16 (p<0.05) Future PA, r=0.22 (p<0.05)	Future, 0.26[a]	5
Taylor et al. [91], UK	*N*=178 mix Mean age=13.8	Longitudinal baseline, 1 month, 2 months	PE enjoyment, 0.90–0.92	PA questionnaire for children	b=0.29 (p<0.01)	0.33	3

Table 1 (continued)

Study, country	Sample (number, gender, mean age)	Theory, design	Affective judgement measure, α	Physical activity measure	Results	Corrected r	Quality score/5
Taymoori et al. [92], Iran	N=515 M 14.3 Years	Health promotion model x-s	PACES, 0.87	Child and adolescent activity log	r=0.54 (p<0.01)	0.58	4
Goldfield [93], Canada	N=30 mix 10.4 Years overweight/ obese	SCT x-s	Children's adequacy in and predilection for PA	Accelerometer previous day PAR	n.s.	−0.25	1
Lubans and Morgan [66], Australia	N=119 Mix 14.2 years	x-s	PACES 0.91	Pedometer	All: r=0.24 Males, r=0.37 (p<0.05) Females, n.s.	All, 0.28[a]	4
Ullrich-French and Cox [70], USA	12.8 Years	SDT x-s	Academic self-regulation questionnaire: motivation in PE, 0.92 sport enjoyment scale 0.94	PA questionnaire for children	Intrinsic motivation, r=0.36 (p<0.01) Enjoyment, r=0.38 (p<0.01)	Enjoyment, 0.41[a]	4
Wright and Li [73], USA	N=87 mix 14.8 Years	x-s	Intrinsic motivation inventory; student attitude toward PE, 0.73	Effort during PE	r=0.36 (p<0.05)	0.51	3
Yli-Piipari et al. [71], Finland	N=429 mix 13 Years	SDT x-s	Sport motivation scale, 0.93; sport enjoyment scale, 0.96	Self-report PA	MVPA for high and low motivation groups: $t(427)$=3.66 (p<0.001)	0.26	3
Zhang [72], USA	N=286 mix 13.4 Years	x-s	Intrinsic motivation for PE; PACES	PA Questionnaire for children	Intrinsic motivation, r=0.43 (p<0.01) Enjoyment, r=0.42 (p<0.01)	Enjoyment, 0.51[a]	3
Barr-Anderson et al. [94], USA	N=1,511 F 12.0 Years	x-s	Enjoyment of PE	Accelerometer	MVPA, β=0.006 (p=0.011)	0.007	4
Cox et al. [105], USA	N=344 mix 12.4 Years	SDT longitudinal baseline, 1 year	Enjoyment of PE, 0.94	PA questionnaire for children	r=0.33 (p<0.01)	0.41	4
Gao [95], USA	N=307 mix 13.4 Years	x-s	Intrinsic motivation inventory, 0.76	Pedometer	r=0.41 (p<0.01)	0.53	3
Barr-Anderson et al. [96], USA	N=2,791 F 12 Years	Socioecological x-s	PACES; intrinsic motivation, 0.88	Structured PA involvement	PA enjoyment, n.s; PE enjoyment, OR=1.97 (p=0.004)	PA enjoyment, 0.00[a]	3
Deforche et al. [76], Belgium	N=89 mix 14.6 Years	Theory of reasoned action; health belief model x-s	Pleasure; not liking, 0.79	Modified Baecke questionnaire	PA and pleasure, n.s.; sport and pleasure, r=0.44 (p<0.01); sport and not liking it, β=−0.38 (p<0.001); leisure time PA with not liking it, r=−0.47 (p<0.001)	PA and pleasure, 0.04[a]	3
De Bourdeaudhuij et al. [97], Belgium	N=6,078 mix 14.7 Years	x-s	Enjoyment	PA self-report	Normal weight, r=0.41, β=0.16 (p<0.05); overweight, r=0.39, β=0.18 (p<0.05)	Overweight, 0.59 Normal weight, 0.56	2
Ntoumanis [68], England	N=302 15 Years	SDT longitudinal	Negative effect in PE, 0.80; intrinsic motivation, 0.86	Enrolment in optional PE	Negative effect, r=−0.15 (p<0.05); intrinsic motivation, r=0.30 (p<0.05)	Intrinsic motivation, 0.32[a]	2
Fairclough [98], UK	N=73 mix 13.1 Years	x-s	Intrinsic motivation inventory	Heart rate (minutes MVPA)	Females, r=−0.4 (p<0.05) Males, n.s.	Females, −0.45 Males, 0.00	4
Morgan et al. [99], USA	N=214 mix 12.1 Years	SCT x-s	PA enjoyment, 0.58	Accelerometer	Males, r=0.134 Females, r=0.071	Males, 0.18 Females, 0.09	3
Prochaska et al. [100], USA	N=414 mix 9.5 Years	x-s	PE enjoyment	Organized sport participation	β=0.15 (p<0.005)	0.21	2
Sallis et al. [99], USA	N=781 mix (subsample for accelerometer: N=200 mix)		Parent report, enjoyment of PE; enjoyment of PA and student self-report	Parent report of child PA; accelerometer	Significant results from parent report: *Female PE enjoyment* grades 1–3, r=0.31 (p<0.05); grades 4–6, r=0.40 (p<0.001); grades 7–9, r=0.23	PA enjoyment Young females, 0.18; older females, 0.12; Young males, 0.69; older males, 0.25[a]	3

Table 1 (continued)

Study, country	Sample (number, gender, mean age)	Theory, design	Affective judgement measure, α	Physical activity measure	Results	Corrected r	Quality score/5
					($p<0.05$) *female PA enjoyment* grades 4–6, $r=0.42$ ($p<0.001$); grades 7–9, $r=0.33$ ($p<0.001$); grades 10–12, $r=0.28$ ($p<0.01$). *Male PA enjoyment*: grades 4–6, $r=0.51$ ($p<0.001$); grades 7–9, $r=0.39$ ($p<0.001$); grades 10–12, $r=0.32$ ($p<0.01$). Significant results from accelerometer: *Young males PA enjoyment*: $r=0.64$ ($p<0.001$)		
Carrol and Loumidis [102], UK	N=879 mix Age range: 10–11	Motivation theory x-s	Preadolescent attitudes towards PE, 0.87	PA outside school	High activity group (vs. low and no activity groups) reported higher enjoyment. $F(2,856)=2.98$ ($p<0.05$)	0.11	3
Bungrum et al. [75], USA	N=520 mix Age range, 13–18	SCT x-s	Enjoyment, 0.87	Previous day PAR	*MVPA* Males, $r=0.25$ ($p<0.001$); females, $r=0.14$ ($p<0.05$) *VPA* Males: $r=0.29$ ($p<0.001$); females, $r=0.25$ ($p<0.001$)	MVPA[a] Males, 0.32; females, 0.18	
Sallis et al. [69], USA	N=732 mix Grades 4–5	SCT longitudinal baseline, 20 months	PA attitude, 0.75; PE attitude, 0.53, after-school activity attitude, 0.82	Previous day PAR parent report accelerometer	Significant results only: *Males* change in PA and BL PA attitude, $r=0.108$ ($p<0.05$) *Males* (*skin folds* ≥75th%). Change in PA and 20 months PE attitude, $r=-0.251$ ($p<0.05$)	Change in PA and PA attitude[a]; males, 0.10; females, 0.14	3
Sallis et al. [69], USA	N=1,504 mix	x-s	PE enjoyment	7-Day PAR	Males		5
					Grades 4–6, $r=0.148$ ($p<0.05$)	0.20	
	Grades 4–12				Grades 7–9, $r=0.149$ ($p<0.05$)	0.20	
					Grades 10–12, $r=0.153$ ($p<0.05$)	0.21	
					Females		
					Grades 4–6, n.s.	0.00	
					Grades 7–9, $r=0.224$ ($p<0.01$)	0.31	
					Grades 10–12: $r=0.275$ ($p<0.001$)	0.38	
DiLorenzo et al. [80], USA	N=242 mix 11.2 Years	Social learning theory longitudinal baseline, 3 years	Enjoyment	PA interview	Baseline, females: $F(1,52)=1.73$ ($p=0.19$). Baseline, males: $F(3,53)=9.42$ ($p=0.003$) at 3 years, n.s.	At 3 years[a]; females, 0.00; males, 0.00	3
Zakarian et al. [104], USA	N=1,634 mix 15.9 Years	Social learning theory x-s	PE attitude	PA self-report	Vigorous PA and dislike of PE: males, $r=-0.16$ ($p<0.001$); females, $r=-0.20$ ($p<0.001$)	Males, 0.23; females, 0.29	2

x-s cross-sectional, *study created* measure created by the researchers, *PA* physical activity, *PE* physical education, *TPB* theory of planned behavior, *SCT* social cognitive theory, *SDT* self-determination theory, *BCT* behavioral choice theory, *SET* socioecological theory/model, *TTM* transtheoretical model, *PAR* physical activity recall, *MVPA* moderate–vigorous physical activity

[a] If more than one effect size was reported for the sample, this was the effect size used for the meta-analysis, which was most inclusive, best reflected "meeting physical activity guidelines" and "enjoyment", and measured adherence (if available)

Table 2 Intervention studies of affective judgment and physical activity

Study, country	Sample (number, gender, mean age)	Theory, measurement points, design	Affective judgment measure, α	Physical activity measure	Findings	Quality rating /8
Schneider and Cooper [113], USA	N=122 F 15 Years	Hedonic theory BL, 5 and 9 months; 9-month intervention Randomized: (1) Input into activities, health education, internet-based self-monitoring; exemption from mile run, activities modified for low-active females (n=53) (2) Control—regular PE curriculum (n=59)	PACES, 0.91	3-Day PAR	Enjoyment as moderator. Girls with low enjoyment at BL increased vigorous activity: F (2,117)=6.67; p<0.01	3
Dudley et al. [112], Australia	N=38 F 16.5 Years	SCT BL, 3 months 11 weeks intervention Randomized: (1) Six 90-min sessions; developed after student discussion (n=17) (2) Control—regular program (n=21)	PACES	Accelerometry during PE	n.s.	6
Sirriyeh et al. [118], UK	N=120 mix 17.3 Years	TPB BL, 2 weeks; 2 weeks intervention Randomized: (1) One affective text message/day (n=31) (2) One instrumental text message/day (n=30) (3) One affective-instrumental text/day (n=31) (4) Control—one neutral text message/week (n=28)		IPAQ	Inactive participants who received affective messages increased PA more than other groups: (p<0.018)	7
McNeil et al. [107], Canada	N=306 mix 9.1 Years	BL, 5 and 11 months Cluster randomized: (1) Family and (PA) connector met at home (n=101) (2) Family and (PA) connector met at school (n=95) (3) Control (n=99)	CAPE; past enrolment in activities, 0.72	CAPE	Increased PA in intervention groups at 11 months; RR=2.1 (p=0.023); 5 months, n.s.	4
Atlantis et al. [119], Australia	N=31 mix, 11 years	SCT, BCT immediately before and after exposure Randomized (B groups received post-test only): (1) Intervention A—watched cartoon with 3 PA ads (n=7) (2) Intervention B (n=8) (3) Control A—watched cartoon 3 neutral ads every (n=8) Control B (n=7)	activity preference on semantic differential scale	10-min free time observation	n.s.	4

Table 2 (continued)

Study, country	Sample (number, gender, mean age)	Theory, measurement points, design	Affective judgment measure, α	Physical activity measure	Findings	Quality rating /8
Simon et al. [116], France	N=954 mix 11.7 Years	SET BL, every year for 4 years 4-year intervention Cluster randomized: (1) new opportunities for PA at lunch, break, after school (n=479) (2) Control—usual curriculum (n=475)		Modifiable activity questionnaire for adolescents; active transport question	Increased supervised PA: OR=2.34 (p<0.001)	5
Spruijt-Metz et al. [117], USA	N=459 F 12.5 Years	SDT, theory of meanings of behavior BL and 3 months post 5 to 7 days intervention Cluster randomized: (1) Intervention media to increase PA and intrinsic motivation (2) Control—usual curriculum	Exercise Self-regulation questionnaire, 0.76	Previous day PAR	PA: n.s. intrinsic motivation, 0.11 (p<0.05)	6
Fridlund-Dunton et al. [108], USA	N=122 F 15.1 Years sedentary	SCT BL, 4 and 8 months 5 days/week; 2 semesters In-class PA program, health education, internet based self-monitoring (n=63); control, no PA instruction (n=59)	PACES, 0.91	3-Day PAR	Increased vigorous PA: t=3.43 (p<0.01); no enjoyment mediation	5
Goldfield et al. [106] and [128], Canada	N=30 mix 10.4 Years overweight or obese	BCT BL, every 2 weeks during intervention, 8 weeks post 8 week intervention Randomized: (1) TV access contingent on PA; PA feedback (n=14) (2) Control—PA activity feedback (n=16)	Children's adequacy predilection for physical activity, 0.70–0.91	Pedometer outside school; previous day PAR	PA: increase (p<0.05); enjoyment increase, p=0.061	6
Robbins et al. [115], USA	N=77 F 12 Years	TTM, health promotion model BL and 12 weeks 12-week intervention Cluster randomized: (1) PA recommendations, individualized feedback, mail/phone contact with nurse, PA counseling (n=45) (2) Control–PA recommendations (n=32)	PACES, 0.87	Child and adolescent activity log	n.s.	6
Dishman et al. [111], USA	N=1,394 F 13.6 Years	SCT, SET BL and 1 year 1-Year intervention Cluster randomized: (1) Choice-based PE (gender-separate, activities favored by females; de-emphasized competition) (2) Control—regular PE	PACES; factors influencing enjoyment of PE	3-Day PAR	Enjoyment-mediated PA, β(75)=0.06	6

Table 2 (continued)

Study, country	Sample (number, gender, mean age)	Theory, measurement points, design	Affective judgment measure, α	Physical activity measure	Findings	Quality rating /8
Schneider-Jamner et al. [114], USA	N=47 F 14.9 Years sedentary	BL and 4 months 4-Month intervention Cluster randomized: (1) PE class targeting self-efficacy, social support, perceived barriers and benefits, enjoyment, self-monitoring, goal setting, problem solving (n=25) (2) Control—usual PE curriculum (n=22)	PACES	2-Day PAR; Stanford Usual Physical Activity Scale	Lifestyle PA, F=9.025, p=0.005; light PA, F=5.53, p=0.023; moderate PA, F=7.946, p=0.007; total PA, F=4.155, p=0.043	3
Epstein et al. [109], USA	N=30 mix 10.5 Years	BCT 1 laboratory session Randomized : (1) access to 4 PA and 4 sedentary activities (n=10) (2) Access to 4 PA, and least favorite sedentary activity (n=10) (3) Access to 4 PA and favorite sedentary activity (n=10). For all groups, work for active alternatives remained constant; work for sedentary alternatives increased over time	Liking of activities on semantic differential scale	Direct observation in laboratory	Constraints on access to most valued sedentary activities increased choice for PA	5
Epstein et al. [110], USA	N=34 mix 10.0 Years obese	BCT 6 days: 1 adaptation, 1 pre-intervention, 3 intervention, 1 post- Randomized: (1) positively reinforced to not engage in 2 high-preference sedentary activities (n=8) (2) punished for engaging in 2 high-preference sedentary activities (n=9) (3) access to 2 high-preference sedentary activities restricted (n=8) (4) Control—reinforced to attend; no contingencies (n=9)	Liking of activities on semantic differential scale	Direct observation in laboratory of time in each activity	Reinforcement (F=6.53, p=0.016), punishment (F=7.72, p=0.009) more effective than restriction	4

F female, *M* male, *BL* baseline, *PA* physical activity, *PE* physical education, *TPB* theory of planned behavior, *SCT* social cognitive theory, *SDT* self-determination theory, *BCT* behavioral choice theory, *SET* socioecological theory/model, *TTM* transtheoretical model, *PAR* physical activity recall, *IPAQ* International Physical Activity Questionnaire

Table 3 Characteristics of included studies

Characteristic	Samples *N* (%)
Correlational (*N*=56)	
Location	
Asia	5 (9)
Australia	1 (2)
Canada	3 (5)
Europe	14 (25)
USA	33 (59)
Study design	
Cross-sectional	42 (75)
Prospective	14 (25)
Gender	
Female	17 (30)
Male	14 (25)
Mixed	25 (45)
Measure of affective judgment	
Intrinsic motivation	8 (14)
Semantic differential	22 (39)
Study created	26 (47)
Measure of physical activity	
Direct	21 (37)
Validated self-report	19 (34)
Other	16 (29)
Quality rating	
High	7 (13)
Moderate	40 (71)
Low	9 (16)
Physical activity context	
Physical education	7 (13)
Extracurricular physical activity	49 (87)
Recruitment location	
School	14 (25)
Community/other	42 (75)
Interventions (*N*=14)	
Location	
Australia	2 (14)
Canada	2 (14)
Europe	2 (14)
USA	8 (57)
Gender	
Female	7 (50)
Mixed	7 (50)
Age group	
Elementary–middle	8 (57)
High school	6 (43)
Measure of affective judgment	
Intrinsic motivation	1 (7)
Semantic differential	7 (50)
Study-created/other	4 (29)
None	2 (14)
Measure of physical activity	
Direct	2 (14)
Validated self-report	7 (50)
Study created/other	5 (36)
Quality rating	
High	6 (43)
Moderate	8 (57)
Theory	
Behavioral choice theory	3 (21)
Hedonic theory	1 (7)
SCT (on its own or with another construct)	4 (29)
SDT	1 (7)
Socioecological theory	1 (7)
TPB	1 (7)
Transtheoretical model+health belief model	1 (7)
None	2 (14)
Intervention setting	
Home	3 (21)
Laboratory	3 (21)
School	8 (57)
Study design	
Randomized controlled trial	12 (86)
Nonrandom assignment	2 (14)
Number of arms	
2	9 (64)
3	2 (14)
4	3 (21)

SCT social cognitive theory, *SDT* self-determination theory, *TPB* theory of planned behavior

analyses were performed. Results from same sex and mixed-gender samples were extracted from correlational and prospective studies. A total of 58 samples were extracted. Of these, 35 were same-sex samples. Same-sex sample sizes ranged from 33 to 1,511 and using the random effects model, the corrected *r* was 0.176 (95 % CI=0.12–0.24). There were 23 mixed-gender samples. Mixed-gender sample sizes ranged from 30 to 5,563, and the corrected *r* was 0.342 (95 % CI=0.23–0.45). For the second gender analysis, results from male-only and female-only samples were extracted from correlational and prospective studies. A total of 35 samples were extracted. Of these, 19 were female-only samples. Female-only sample sizes ranged from 33 to 1,511, and using the random effects model, the corrected *r* was 0.105 (95 % CI=0.05–0.16). There were 16 male-only samples. Male-only sample sizes ranged from 34 to 919 and the corrected *r* was 0.244 (95 % CI=0.14–0.35).

Table 4 Summary statistics for hypothesized moderators of physical activity and affective judgment; fixed and random effects analyses for correlational studies (using corrected *r* values)

Variable	Q_b	*p*	*k*	Random effects		Fixed effects		SE	Q_w	I^2
				r	95 % CI	*r*	95 % CI			
Overall			56	0.26	0.18/0.32	0.32	0.30/0.33	0.02	2,034.85*	97.30
Country	6.221	0.183	5							
Asia			1	0.45	0.27/0.60	0.40	0.37/0.43	0.04	135.94*	97.06
Australia			3	0.28	0.11/0.44	0.28	0.11/0.44	0.00	0.00	0.00
Canada			14	0.19	0.00/0.36	0.26	0.23/0.30	0.03	36.82*	94.57
Europe			33	0.26	0.07/0.44	0.44	0.42/0.45	0.10	1,080.30*	98.80
USA				0.22	0.16/0.28	0.18	0.17/0.20	0.01	298.79*	89.29
Design	2.371	0.125								
Longitudinal			14	0.18	0.09/0.27	0.18	0.14/0.21	0.01	104.14*	87.52
Cross-sectional			42	0.28	0.20/0.36	0.33	0.32/0.35	0.03	1,841.74*	97.77
Gender	11.148	0.004								
Female			17	0.13	0.06/0.20	0.13	0.11/0.16	0.01	104.11*	84.63
Male			14	0.23	0.11/0.34	0.24	0.21/0.26	0.03	187.64*	93.07
Mixed			25	0.35	0.24/0.45	0.39	0.38/0.40	0.04	1,344.40*	98.21
Measure of AJ	1.794	0.408								
Intrinsic motivation			8	0.22	0.00/0.43	0.32	0.28/0.35	0.07	205.80*	96.60
Semantic differential			22	0.31	0.01/0.43	0.35	0.34/0.37	0.05	1,618.64*	98.70
Study created			26	0.21	0.16/0.26	0.23	0.21/0.25	0.01	107.66*	76.78
Measure of PA	17.136	0.000								
Direct			21	0.12	0.05/0.19	0.08	0.06/0.11	0.01	141.19*	85.83
Validated self-report			19	0.31	0.02/0.38	0.32	0.30/0.34	0.01	175.52*	89.75
Other			16	0.35	0.02/0.47	0.43	0.41/0.44	0.09	1,045.33*	98.57
Quality rating	0.947	0.623								
High			7	0.22	0.13/0.31	0.22	0.17/0.27	0.01	19.84*	69.76
Moderate			40	0.25	0.17/0.33	0.22	0.20/0.23	0.02	1, 066.36*	96.34
Low			9	0.31	0.16/0.45	0.44	0.43/0.46	0.04	504.87*	98.42
PA context	1.718	0.190								
Physical education			7	0.42	0.14/0.64	0.59	0.55/0.62	0.12	212.50*	97.18
Extracurricular PA			49	0.23	0.16/0.30	0.30	0.29/0.31	0.02	1,617.89*	97.03
Recruitment location	0.223	0.038								
School			42	0.29	0.20/0.37	0.34	0.33/0.36	0.03	1,789.16*	97.72
Community/other			14	0.16	0.07/0.25	0.20	0.18/0.23	0.02	128.15*	89.86

AJ affective judgment, *PA* physical activity

*$p<0.001$

Measure of physical activity emerged as a significant moderator ($p<0.001$). Physical activity measures were categorized as direct (e.g., accelerometer and pedometer), $n=21$; validated self-report (e.g., Previous Day Physical Activity Recall), $n=19$; and other (e.g., study created, unvalidated), $n=16$. The point estimate for direct physical activity measure was $r=0.12$ (95 % CI=0.05–0.19), much lower compared to validated self-report ($r=0.31$, 95 % CI=0.24–0.38) and other ($r=0.35$, 95 % CI=0.21–0.47). Recruitment location also emerged as a significant moderator ($p<0.05$). Recruitment locations were categorized as school, $n=42$; and community/other (e.g., hospitals, sports clubs, random community sample), $n=14$. The point estimate for school was $r=0.29$ (95 % CI=0.20–0.37) and $r=0.16$, (95 % CI=0.07–0.25) for community/other.

Testing for Publication Bias

Additional analyses were performed to assess the extent of publication bias. First, *classic fail-safe N* of Rosenthal [63] was found to be 24,307. Therefore, a large number of studies with a mean effect of zero would be necessary before the overall effect found in the present study would become statistically insignificant. Thus, the present findings are robust and likely to be true. In addition, Duval and Tweedie's *Trim and Fill* procedure [64, 65] was used to compute a random-effects estimate of the unbiased effect size. This procedure selectively removes extreme effect sizes from small studies and replaces them with imputed scores to produce a more symmetrical funnel plot about the newly derived overall effect size, which results in a less biased estimate of the overall effect size. No studies needed to be trimmed from our meta-analysis (see ESM Appendix D); therefore, the adjusted point estimate was the same as the observed point estimate. This suggests that our findings are reliable and that publication bias did not contribute to the observed overall effect size. In summary, after correcting for measurement error, the fixed-effects model yielded an overall effect of 0.32 (95 % CI=0.30–0.33), and the random-effects model r=0.26 (95 % CI=0.18–0.32), indicating a medium effect size [42]. Gender, measure of physical activity, and recruitment location emerged as significant moderators.

Experimental Studies—Quantitative Analysis

Study Characteristics

Within the 15 intervention studies, 14 independent samples were included. Two manuscripts reported data from the same sample, for different variables; one for physical activity, the other for affective judgment [34, 106]. See Table 3 for study characteristics. The results from four studies were not included in the meta-analysis because the results were reported in a manner which could not be incorporated into the analysis (they did not include effect sizes or the results were not sufficient to create effect sizes for the study) [107–110]. A total of 10 independent samples were included in the meta-analysis.

Overall Effect Size, Heterogeneity, and Moderators

The random-effects model yielded an overall effect of d= 0.25 (95 % CI=0.11–0.40) indicating a medium effect size [42]. Some heterogeneity was detected among studies, $Q(10)=20.69$, $p<0.01$. I^2 indicated that 56 % of the observed variance was explained by true systematic effect size differences. None of the proposed moderators emerged as significant (see ESM Appendix E).

Experimental Studies—Qualitative Analysis

Interventions by Setting

School Setting—High School Five interventions were implemented in high schools [108, 111–114]. All five studies targeted female-only samples. One study implemented a physical activity program which was not choice based [108], while the other four intervened at the level of the physical education curriculum by de-emphasizing competition, allowing for choice of activities, incorporating student input into activities, promoting fun and enjoyment, and/or keeping in mind students' self-efficacy my modifying activities for low-active girls. Four of these reported an increase in physical activity compared to the control groups [108, 111, 113, 114] and one reported no change [112]. The study which did not change physical activity employed an intervention which was the shortest in duration (six 90-min sessions; compared to interventions that were one or two semesters long). Two of these five studies included mediation analyses. One study found that enjoyment mediated physical activity [111], the other did not [108]. The study that showed no enjoyment mediation implemented an intervention which did not target enjoyment. Overall, implementing a choice-based physical education program among high school females which emphasizes enjoyment and activity choice seems to be effective at changing physical activity participation. Ultimately though, only one of the studies that targeted enjoyment and was effective at increasing physical activity included a mediation analysis. Therefore, it remains uncertain whether or not it was enjoyment that in fact caused the increase in physical activity in the other studies.

School Setting—Elementary/Middle School Three interventions were implemented in elementary or middle schools [115–117]. The mean age in each study was 12 years. Two of the studies were not able to produce change, neither in enjoyment nor in physical activity [115, 117]. By contrast, one study that aimed to change affective judgment by increasing opportunities for physical activity during lunch, and before and after school, was able to increase physical activity [116]. Enjoyment was not measured; therefore, it remains unknown whether or not it was enjoyment of the new physical activity opportunities that mediated this effect. The number of interventions implemented in elementary and middle school settings is limited but it appears as though aiming to change physical activity via classroom media [117] or providing individualized counseling [115] are not as effective as implementing activities which are readily available for use on school grounds [116]. Whether or not enjoyment was a mediator remains unknown.

Home Setting with Family Three interventions took place in the home setting [34, 106, 107, 118]. All three studies were able to increase participation in physical activity compared to a control group. Two of the studies focused on children 9–10 years old [34, 106, 107] and one on older teenagers [118]. The two studies on children incorporated the family, either by facilitating enrolment in enjoyable activities for the child [107] or by ensuring that television was only viewed after engaging in physical activity [34, 106]. Enjoyment was not measured post-intervention in either of these two studies and a mediation analysis was not employed. The intervention which was targeted to older teenagers did not involve the family, rather daily affective text messages [118]. Although a mediation analysis was not employed, the intervention groups received an affective message, an instrumental message, an instrumental message and affective message, or a neutral message. Post-intervention the affective message was more effective at increasing physical activity compared to the other types of messages. Overall, it remains unclear whether or not it was enjoyment that mediated the increase in physical activity in preadolescents. Further, despite limited evidence, affective messaging to older teens may show promise, at least in the short term.

Laboratory Three interventions took place in a laboratory setting and investigated sedentary and physical activity behaviors immediately post-intervention [109, 110, 119]. None were adherence studies. All samples were of mixed gender with a mean age of 10–11 years. These studies all employed Behavioral Economic Theory. This theory takes into account the value placed on other activities that potentially compete with physical activity [33]. Through this theory, we see how one could manipulate an activity's (enjoyment) value by altering access and reinforcement of available activity options; rather than focusing solely on the study–desired (physical) activity option.

Two studies of these studies were effective at increasing the choice to be physically active [109, 110] and one showed no effect [119]. When the available options were sedentary and physical activities, simply promoting physical activity via television advertising had no acute effect on physical activity [119]. Going a step further and accounting for value placed on sedentary activities, Epstein et al. [109] found that only participants who had access to their least favorite sedentary activity chose to be active more often. Further, reinforcement for not, or punishment for engaging in high preference sedentary activities was more effective on choice to be physically active, than restricting high preference sedentary activities [110]. Trying to solely change cognition and attitude without placing contingencies on competing options does not seem to change behavior; however, placing contingencies on preferred sedentary activities has the potential to increase the choice to be physically active over sedentary.

Interventions: Targeting Affective Judgment Alone vs. Alongside Other Constructs

Five of the 14 intervention studies targeted only affect [34, 106, 109, 110, 118, 119]. Of these five, only one did not affect choice to be physically active nor value placed on physically active options [119]. In children, mere advertisement that physical activity can be enjoyable was not effective at changing affective judgment, nor choice to be physically active [119]. In older teens, however, messages targeted to change affect proved more effective [118]. For children and preteens (8–12 years), accounting for value of sedentary activities and placing contingencies on those which would alter their judgment of value and enjoyment of sedentary and physical activities was effective, both in the laboratory setting [109, 110] and at home [34, 106].

Nine studies implemented interventions with a cornucopia of constructs and either included an affective judgment component and/or measured affective judgment. These other constructs included self-efficacy, physical activity opportunities, self-monitoring, counseling, education, and media. Six studies showed positive effects on physical activity [107, 108, 111, 113, 114, 116] and three did not [112, 115, 117]. Of the six studies that reported an increase in physical activity, three included a mediation analysis for enjoyment [108, 111, 114]. One reported no mediation from enjoyment [108], one reported mediation ($\beta(75)=0.06$) [111], and the third reported a main effect of time on enjoyment that was close to being significant at $p=0.053$ [114]. Schneider and Cooper [113] did not employ a mediation analysis, but reported that the intervention showed moderation of enjoyment; such that only females with low enjoyment at baseline increased their physical activity post-intervention.

Overall, these results are supportive of interventions that use a stand-alone affective component to change cognition in older youth, but not younger children. Considering value of sedentary options is worthwhile in younger children. Regarding the cornucopia of interventions, it remains unclear whether or not enjoyment mediated the increase in physical activity because of both the lack of mediation analyses and the mixed results from the few which included mediation analyses.

Discussion

The purpose of this paper was to review studies among youth that have employed an affective judgment construct within a physical activity context in order to appraise its relationship with behavior. The review identified 40 studies with 56 independent samples; as well as 15 interventions studies with 14 independent samples. Of the correlational studies employed in the quantitative meta-analysis, 49 (89 %) were post year2000 and 21 (38 %) were within the last 2 years. This provides strong support for the timeliness of this review and meta-analysis among youth.

We hypothesized that the relationship between affective judgment and physical activity among youth would be within a meaningful effect size, like the results reported for adults (i.e., r=0.42) [43]. The results supported this hypothesis. Among correlational samples, random-effects meta-analysis indicated an r=0.26 (95 % CI=0.18–0.32) for affective judgment and physical activity in youth, which is close to a medium effect size, though smaller than that reported for adults. One possible reason for the smaller correlation among youth may be the difficulty in obtaining a strong correlation due to the range restriction (especially youth in Western cultures who are expected and socialized to be active), compared to adults whose individual differences would likely be larger.

Although the effect size for youth was slightly lower than that reported for adults, it was still close to a medium effect size [42], therefore was still prominent, especially when compared to other correlates of physical activity among youth. For example, the effect size for parental support and modeling behavior on child and adolescent physical activity is small, though pertinent at 0.17 [120]. Effect sizes for the relationship between sedentary behaviors and physical activity are also small, but significant, at −0.129 for television viewing, and −0.141 for video and computer game play [121]. Cognitive constructs that have been associated with youth physical activity include self-efficacy [51, 52, 122, 123], perceived behavioral control [123], intention [51], goal orientation and attitude [52]; however, meta-analytic results for these constructs have not yet been investigated. The results from this meta-analysis highlight the importance of an affective judgment construct when understanding youth physical activity. Many physical activity theories do not formally include affect as its own construct. Clearly, further consideration of the role of affective judgment in physical activity theory is warranted.

One of the reasons why the effect size was smaller in youth than in adults may be the presence of moderators. Interestingly, we found that males had a higher point estimate than females, which was in contrast with Biddle's [48] narrative review. In the intervention research analyzed in this review, there were no male-only studies, but there were seven female-only studies. Four female-only studies reported an increase in physical activity and they were all in high school physical education settings. These findings are similar to those reported by Biddle et al. [49] who also found that gender emerged as a positive correlate of physical activity (among female adolescents). Based on the findings of the present study, it is unknown whether or not gender would have still emerged as a positive correlate within intervention studies if there had been male-only samples. At this point, it is not clear why there was a gender difference, but gender, affect, and physical activity requires sustained research attention.

Recruitment location and measure of physical activity also emerged as significant moderators. Recruitment via schools (r=0.29) yielded a higher point estimate than recruitment via community/other (which included hospitals and sports camps; r=0.16). This may be the result of dealing with a captive audience and an audience whose peers are involved in the same experience. Direct measurement via accelerometers, pedometers, or heart rate (r=0.12) yielded a lower point estimate than both validated (r=0.31) and unvalidated (r=0.35) self-reported measures of physical activity. It has been suggested that direct measurement of physical activity reflects the best available methods of obtaining physical activity data, unbiased by personal judgment or recall, especially in children whose physical activity patterns are a lot more sporadic than adults' [124]. It may be that affective judgment is not as pertinent a correlate of physical activity as direct measurement assessments suggest. Alternatively, the lower point estimate from direct measures may result because affective judgment is linked more-so to purposeful, volitional physical activity, and not total incidental activity captured by direct measures. When youth recall enjoyment of physical activity, they may more readily be recalling volitional, structured, and strenuous physical activities. These physical activities tend to require more cognitive judgment and planning [125] compared to incidental physical activity. Intrinsic motivation is thought to be a consequence of autonomous choices [28], which supports this theorizing. More information is needed in order to tease out what exactly youth are recalling when self-reporting their physical activity.

Also interesting is that five potential moderators were found to be insignificant. Affective judgment and physical activity was invariant to cross-sectional vs. prospective design, study quality, physical activity context, measure of affective judgment, and the country in which the study was conducted. This speaks to the robustness of the affective judgment construct. The meta-analysis on adults also reported similar invariance [43]. Study design (longitudinal or cross-sectional) did not emerge as a significant moderator. This showcases that a longitudinal study, which tends to reflect a more sophisticated (and costly) study design compared to a cross-sectional design, may not be necessary, especially if there is constancy in people's behaviors [126]. Measure of affect was also not significant. Clearly, despite obvious subtle differences between the theories and how they target the affective judgment construct (e.g., studies based on self-determination theory employ the Intrinsic Motivation Inventory, studies based on social cognitive theory employ the PACES, etc.), the measures themselves are not very different in their relationship with physical activity.

Our review also identified 14 intervention studies that featured affective judgment. Ten of these were included in the meta-analysis which yielded an effect of d=0.25. None of the proposed moderators emerged as significant. This likely resulted from the small sample size and heterogeneity of studies; thus, it was imperative to include a qualitative analysis in order to obtain a deeper understanding of the intervention studies. Most of the studies that manipulated affective judgment were able to increase choice to be physically active or value placed on physically active options. In teens, manipulating affective judgment via text messaging was effective at increasing affective judgment and physical activity. In children, affective judgment was best manipulated by taking into consideration competing sedentary options in well-controlled conditions. These studies with the best internal validity employed behavioral economic theory. Most of these studies were conducted in a laboratory setting, with comparison groups and aimed to change choice, such as physical activity over sedentary activity. Although most of these were not adherence studies, they are viable first steps, and show promise in showing how affective judgment affects choice. Other studies had greater ecological validity. They were conducted either in the home or school, with longer interventions, and aimed to change physical activity across time. These studies were more difficult in attempting to disentangle the specific effects of intervening on affective judgment in comparison to other constructs. Furthermore, the studies with mediation tests of affective judgment yielded mixed results for the utility of affective judgment at present [12, 127]. Continued mediation tests of affective judgment and other critical constructs are recommended in interventions in order to decipher the changeability of the affective judgment construct and its subsequent effect on physical activity.

In order to provide a context from which to understand the results, these findings are limited to the databases, search terms, and time frame described in the "Method" section. Future work on affective judgment and physical activity should use gender-specific samples or analyses, and employ both direct and indirect measures of physical activity assessment. For self-reported physical activity measures, it would be worthwhile to delve into exactly what type of physical activity is being recalled. Intervention research on preadolescents with behavioral economic theory, measuring adherence of physical activity is warranted. Further, affective judgment should be targeted on its own and if it is not, mediation tests are absolutely necessary.

In summary, the results of this meta-analysis in youth point to a medium effect size relationship between affective judgment and physical activity. This relationship was invariant to study quality, design, country, and measure of affective judgment employed. Gender, measure of physical activity, and recruitment location emerged as significant moderators among correlational studies. Single-component interventions targeting affect show promise; and when implementing interventions with children, competing sedentary activities should be considered.

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