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Review

A meta-analytic review of Elliot's (1999) *Hierarchical Model of Approach and Avoidance Motivation* in the sport, physical activity, and physical education literature

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Abstract

Purpose: The purpose of this quantitative review was to summarize the state of Elliot's *Hierarchical Model of Approach and Avoidance Motivation*, specifically the antecedents of the 2 × 2 achievement goals in the sport, physical activity, and physical education literature. In addition, the intercorrelations amongst the 2 × 2 goals were also examined.

Methods: A systematic review of the literature was conducted. Meta-analytic procedures were used with the mean weighted sample correlation (r_w) as the effect size metric. The antecedents were coded by Elliot's (1999) antecedent categories. A number of moderators were coded *a priori*.

Results: Based on a fixed effects model from 47 published studies (total unique n = 15,413) that met inclusion criteria, the 2 × 2 achievement goals were significantly correlated amongst each other ranging from small to medium to large in meaningfulness. Concerning the antecedents, overall they were theoretically correct in associations, but only a few of the relationships were medium in meaningfulness. Most relationships were small in meaningfulness. Heterogeneity was present for the interrcorrelation and antecedent analyses.

Conclusion: Future research is encouraged to grow and enrich the understanding of achievement goals within Elliot's complete *Hierarchical Model of Approach and Avoidance Motivation* to include both antecedents and outcomes simultaneously to improve upon the understanding of achievement motivation in sport, exercise, and physical activity settings.

Keywords: Achievement motivation; Antecedents; Competence; Mastery goals; Meta-analysis; Performance goals

1. Introduction

In the late 1990's, Elliot and Church[1] proposed the approach-avoidance achievement goals and Elliot purposed his *Hierarchical Model of Approach and Avoidance Motivation*.[2,3] Elliot's model theorized a number of antecedents that stimulate adoption of his achievement goals, thereby mediating the link between antecedents and achievement behaviors, cognitions, and emotions. Specifically, Elliot[3] outlined six categories of antecedents: competence-based, self-based, relationally based, demographics, environmental, and neurophysiological predispositions.

Past meta-analytic research has demonstrated that Elliot's approach-avoidance or 2 × 2 achievement goals have been researched in sport, exercise, and physical education (PE) research.[4–6] Stevenson[4] was the first to quantitatively review Elliot's goals in the psychology of sport, exercise, and PE research. Her dissertation, which also examined educational literature, listed nearly 50 studies. In their meta-analytic review of approach-avoidance achievement goals and performance in sport, exercise, and PE, Lochbaum and Gottardy[5] included 17 studies many of which were not in Stevenson's review. Most recently, Jean-Noel[6] summarized the Self-Determination Theory and the approach-avoidance achievement goal literature and identified 17 studies for inclusion with again a number not in the Stevenson[4] or Lochbaum and Gottardy[5] meta-analytic reviews. In short, a literature base exists with Elliot's goals in the sport, exercise, and PE literature. However, a significant knowledge gap remains in

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understanding Elliot's *Hierarchical Model of Approach and Avoidance Motivation* in the sport, exercise, and PE domains to better determine the utility of the model and to help shape future research with approach-avoidance goals.

1.1. Elliot's approach-avoidance achievement goals

Elliot's approach-avoidance goals stem from the dichotomous achievement goal framework.[7,8] In the dichotomous framework, there are two orientations by which personal competency is judged. Individuals endorsing a task orientation are primarily motivated by personal mastery or improvement. Because of their personal mastery orientation, these individuals reflect a self-referenced standard of personal achievement to gauge their personal competency for a desired behavior. In contrast, an ego-oriented person strives to attain high normative standards of ability which is typically defined by winning or beating intended others. Ego-oriented individuals judge their success and failure on other-referenced standards. While the dichotomous task and ego distinction relates to how competence is defined, the approach-avoidance dimension relates to how competence is valenced. Elliot and his colleagues' contribution to achievement goal theory is the approach-avoidance dimension.[1,2]

An approach valence indicates a behavior that is initiated by a positive or desirable event or possibility. In contrast, an avoidance valence indicates a behavior which is initiated by a negative or undesirable event or possibility. Thus, approach goals focus on attaining competence, whereas avoidance goals focus on avoiding incompetence. Initially, Elliot and colleagues[1,2,9] proposed a trichotomous framework with the mastery, performance-approach, and performance-avoidance goals. These three goals were the focus of the hierarchical model of achievement motivation.[1] The trichotomous model[2] was then expanded with bifurcation of the mastery goal into the mastery-approach and mastery-avoidance goals.[10,11]

With the 2×2 achievement goal framework, competence based on the mastery-approach goal is defined by a focus on task-based attainment such as improving upon one's past performance in a marathon, whereas competence based on the mastery-avoidance goal is defined by a focus on avoiding a worsening of task-based attainment. For instance when playing golf, a golfer's focus could be to not get score worse relative to a past performance what was a personal best such breaking 80; thus, the focus is not on scoring a 79, but avoiding to score an 80. From the performance goal perspective, the performance-approach goal defines competence based on normative achievements such as a student in a PE class focusing on scoring more soccer goals than anyone else in class, whereas the performance-avoidance goal defines competence based on avoiding displays of normative incompetence such as not missing more tennis serves than one's opponent.

1.2. Purpose and hypotheses

The key question of course is how one chooses to adopt one or all of the 2×2 achievement goals because achievement goal selection influences important consequences such as performance,[5] intrinsic motivation,[6] and future task selection.[12] Thus, the purpose of the present research was to examine Elliot's *Hierarchical Model of Approach and Avoidance Motivation* in the sport, exercise, and PE literature to determine the relationships of his antecedent categories on goal adoption. To date, the only published quantitative review of antecedents of achievement goals was conducted in the organizational psychology literature with the learning, prove performance, and avoid performance achievement goals.[13] Though important in their own right, organizational psychology achievement goals are not those of Elliot's, which are widely reflected in sport, exercise, and PE. Hence, to date quantitative reviews with Elliot's approach-avoidance goals and his theorized antecedents are nonexistent.

Elliot[3] set forth basic sets of hypotheses for each antecedent category and his approach-avoidance goals. Given the mastery goal was bifurcated after his 1999 article,[14] hypotheses generation was extended upon logically on either the definition or valence dimensions. For competence-based variables such as need for achievement, it was hypothesized that these variables would be positively related to approach while negatively related to avoidance goal adoption. The identical hypotheses were also forwarded for self-based variables such as self-esteem and self-worth. For relationally-based variables such as fear of rejection, it was hypothesized that they would be positively related to the avoidance goals as well as the performance-approach goal. Performance-approach goal adoption was hypothesized to be at a lesser degree compared to both avoidance goals, but it should be related given relationally-based variables inherently orient to others. It was hypothesized that relationally-based variables would be negatively related to a small degree with mastery-approach goal adoption. For demographics, sex and age were examined. As cited in Elliot,[3] researchers with various forms of avoidance motivation constructs have suggested that women are one group that is more susceptible to avoidance motivations.[15] Hence, women were hypothesized to be more likely to adopt avoidance goals compared to men. No hypothesis was forwarded for age. Environmental variables have a long history in achievement goal research stemming from the original implicit self-theories work[16] as well as Ames' goal climate research.[17] To account for differing directional hypotheses because of the constructs themselves, it was hypothesized that incremental and mastery environmental constructs would be positively related to adoption of both mastery goals, whereas, entity and ego environmental constructs would be positively related to adoption of both performance goals. Last for the neurophysiological predispositions, this class of variables was also split on whether they should be positively related to approach or avoidance goals. Specifically, positively valenced neurophysiological predispositions such as extraversion and Gray's[18] behavioral activation were hypothesized to be related to adoption of both approach goals. The negatively valenced neurophysiological predispositions such as neuroticism and Gray's[18] behavioral inhibition were hypothesized to be related to adoption of both avoidance goals.

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2. Materials and methods

2.1. Literature search and inclusion criteria

The literature search included electronic databases, review articles, search of references of articles found, and correspondence to authors that had published in the area. The electronic database search was conducted in EBSCO with the entire range of individual databases selected for inclusions (e.g., PsychINFO, PsychARTICLES, SPORTDiscus, and ERIC). Variants of the following keywords were used in the search: trichotomous achievement goals, 2×2 achievement goals, approach-avoidance achievement goals, sport, exercise, physical activity, PE, performance-approach, performance-avoidance, mastery-approach, mastery-avoidance, and achievement motivation. Articles retained for the current meta-analysis met the following inclusion criteria: (a) published literature in the English and Spanish languages from January 1, 1996 (conceptualization of Elliot's goals) to May 14, 2015; (b) clear use of at least one type of Elliot's approach-avoidance goals (i.e., mastery-approach, mastery-avoidance, performance-approach, and performance-avoidance); (c) a measure of an antecedent variable that from one of Elliot's categories; (d) articles reporting sufficient statistical information between antecedents and the 2×2 achievement goals which in all cases was a correlation and sample size; and (e) articles that failed to report sufficient information but an author provided the sufficient quantitative statistical information via email communication for either the correlation, sample size, or both.

Data extraction procedures were handled by the first author who coded for (a) the domain (sport, exercise/physical activity, or PE); (b) the sex make-up of the sample (male, female, mixed); (c) mean age of the sample (<18 or ≥18 years), (d) the Elliot antecedent category (competence-based, self-based, relationally-based, demographic, environmental, or neurophysiological predispositions). The co-authors as well as two trained research assistants examined the first author's data extraction records as well as emails received from study authors that sent in requested information. Coding of antecedent categories was the most arduous part of the data extraction. First, a list of antecedent examples were written down based on Elliot's writings.[3] For instance, Elliot[3] (p. 175) described a number of neurophysiological predispositions (behavioral inhibition sensitivity, positive or negative temperament, and extraversion-neuroticism). Hence, those neurophysiological predispositions were written down as a guide for data extraction. Likewise, Elliot[3] (p. 175) wrote about a number of environmental variables that fit within this antecedent category such as implicit theories of ability. For both of these antecedent categories, they were split into two further categories that aligned with Elliot's writings[3] concerning hypothesized relationships based on goal definition (i.e., performance or mastery). Specifically, incremental theory and mastery climate were one subcategory of the environmental antecedent as was entity theory and performance climate. Overall, data extraction, though arduous as probably most quantitative reviews, was mostly discrepancy free. Certainly, antecedent data extraction and coding of each category required more discussions than the other data extractions.

2.2. Effect size calculations

The Comprehensive Meta-Analysis (CMA, version 2.2.064, Biostat, Inc., Englewood, NJ, USA) (https://www.meta-analysis.com/index.php) was used for this meta-analysis. Based on Hedges and Olkin's[19] suggestion, r_w was chosen as the measure of effect size as all extracted data were reported as correlations. Given more than one achievement goal exists, strict adherence to independence of the sample is not possible. For instance, given all studies measured at least two of the 2×2 achievement goals in a sample via questionnaire, each participant had a score for at least two achievement goals with the same antecedent. In addition, in many studies there were multiple antecedents so many studies resulted in many samples. Separate analyses were set up for each goal measure by each of the six antecedent categories. Cohen's[20] criteria were used for interpretation of each r_w as follows: ≤0.10 as small, 0.30 as medium, and ≥0.50 as large. Positive effect sizes should be interpreted as the antecedent facilitating adoption of the specific achievement goal, whereas a negative effect size should be interpreted as the antecedent having a detrimental impact on adoption of the specific achievement goal.

Of the two primary models to determine statistical assumptions of error,[21,22] the fixed as opposed to random model was chosen. The fixed effects model assumes that all of the gathered studies share a common effect and differences are a result of within study error or sampling error. The random effects model assumes both within-study error and between-study variation. Thus, the fixed effects model was selected because theoretically antecedents of achievement goal adoptions should be consistent and not vary for any reason(s) though certainly past meta-analytical summaries with achievement goals have reported heterogeneity of variance.

2.3. Heterogeneity of variance

Given that past quantitative reviews have reported heterogeneity, it was considered *a priori* in this meta-analytic review. Two indicators (Q and I^2) were used to determine whether heterogeneity of variance existed for each goal and performance overall effect size calculation and are briefly explained. The Q test is a test of significance based on the critical values for a chi-square distribution. A significant Q value indicates that heterogeneity of variance exists across the individual effect sizes used to calculate the overall effect size. The Q value does not provide information on the magnitude of the individual effect size dispersion. The I^2 statistic is the ratio of excess dispersion to total dispersion. As explained by Higgins and colleagues,[23,24] I^2 may be interpreted as the overlap of confidence intervals explaining the total variance attributed to the covariates. Higgins and Thompson[24] have provided a tentative classification of I^2 values to help interpret magnitude of the heterogeneity of variance: 25 (low), 50 (medium), and 75 (high). In addition, if heterogeneity was present, another purpose was to see if any of the coded moderator variables could account for the heterogeneity. This was done by computing the Q between (Q_B) value that is calculated by subtracting the individual Q values referred to as Q within (Q_W) values for each moderator subcategory from Q total (Q_T) value

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for the overall effect size. For instance, the Q_B for the age moderator was calculated for the performance approach goal and a specific antecedent by subtracting the two subcategory Q_W values for the two mean age of sample categories (from the Q_T for the performance approach goal). To determine significance of the Q_B value, an online chi-square value calculator for the specific degrees of freedom (number of moderator categories–1) was used.

3. Results

3.1. Description of retained studies

Given the popularity of the achievement goal theory across disciplines such as education psychology and organizational psychology as well as in the areas of the present quantitative review, thousands of studies were identified in the initial literature search. By simply determining whether the main domain was either sport, exercise, or PE, this list was pared down to fewer than 100 through abstract screening. A total of 47 published studies found in Table 1 were located that met the inclusion criteria.[25–71] Given self-determination constructs were not in Elliot's antecedent categories,[3] they were not included. This set of 47 studies resulted in 56 datasets as a few had multiple independent datasets. The samples collected represented 14 countries and 15,413 participants. Most of the studies had reported the intercorrelations amongst the achievement goals (k range 48–54) with the most number of samples ($k = 54$) for the performance-approach and performance-avoidance goals. Antecedents fitting all of Elliot's antecedent categories were found within the 47 studies: competence-based[27–29,34,36,37,39–42,47–51,53–56,58–60,64,66–68,70,71] (k range 39–46), environmental-based performance oriented[28,33–35,37,39,41,47–49,52,55–58,62,66–68,71] (k range 24–28) and mastery oriented[28,33–35,39,47–49,52,55–58,62,65–68,71] (k range 23–27), relationally-based[30–32,37–39,41,53,54] (k range 19–20), self-based[25–27,29,32,38,41,56] (k range 16–17), neurophysiological-based approach oriented[41,44,46,63,69] ($k = 10$) and avoidance oriented[27,41,43,44,69] (k range 6–8), and last demographics of sex[33,42,45,48,57,59–62] (k range 8–9) and age[27,33,40,44,45,48,60,62] (k range 7–9).

3.2. Results for intercorrelations amongst the 2 × 2 achievement goals

As found in Table 2, all of the intercorrelations were statistically significant. The performance-approach to performance-avoidance ($r_w = 0.45$), mastery-avoidance to performance-avoidance ($r_w = 0.39$), and mastery-approach to performance-approach ($r_w = 0.37$) intercorrelations were medium to large in meaningfulness. The rest of the intercorrelations were in the range of small to medium, specifically mastery-avoidance to performance-approach ($r_w = 0.27$), mastery-approach to mastery-avoidance ($r_w = 0.28$), and mastery-approach to performance-avoidance ($r_w = 0.17$). The fail safe ns for all of the intercorrelations were quite large (range 3705–43,495). Hence, the overall reported effect sizes appear very "safe" from any file drawer issue. Though the 95% confidence intervals were fairly tight around each r_w, Q_T was significant for each analysis and all I^2 values were large in magnitude (>75).

3.3. Results for competence-based antecedent category

As found in Table 2, all of the weighted correlations were statistically significant. The competence-based antecedents to the mastery-approach and performance-approach goal correlations were identical and medium in meaningfulness ($r_w = 0.32$). The weighted correlations for the two avoidance goals and competence were small in meaningfulness (mastery-avoidance $r_w = 0.16$, $Z = 16.51$; performance-avoidance $r_w = 0.10$, $Z = 10.89$). The fail safe ns for all of the correlations were quite large, ranging from 850 to 8701. Q_T was significant for each analysis and all I^2 values were large in magnitude.

3.4. Results for self-based antecedent category

As found in Table 2, all of the weighted correlations were statistically significant though the avoidance goal results were very small to small in meaningfulness (mastery-avoidance: $r_w = 0.04$; performance-avoidance: $r_w = 0.08$). The self-based antecedents to the mastery-approach ($r_w = 0.27$) and performance-approach ($r_w = 0.21$) goals were small to medium in meaningfulness. The fail safe ns for all of the weighted correlations were large for the approach goals (range 578–844). The avoidance goal fail safe ns were relatively small, consistent with the very small weighted correlations. Q_T was significant for each analysis and all I^2 values were large in magnitude.

3.5. Results for relationally-based antecedent category

As found in Table 2, all of the weighted correlations were statistically significant. The approach achievement goal results were very small to small in meaningfulness (mastery-approach $r_w = -0.05$; performance-approach $r_w = 0.14$). The relationally-based antecedents to mastery-avoidance ($r_w = 0.30$) and performance-avoidance ($r_w = 0.22$) goals were medium to medium small in meaningfulness. The fail safe ns for all of the weighted correlations were large for the performance achievement goals and the mastery-avoidance goal (range 339–1597). The mastery-approach goal fail safe n was relatively small consistent with the very small weighted correlation. Q_T was significant for each analysis though I^2 was considered large (>75) for only the mastery-avoidance goal.

3.6. Results for approach neurophysiological-based antecedent category

As found in Table 2, only the approach achievement goal weighted correlations were significant albeit small in meaningfulness ($r_w = 0.18$ and 0.10 for mastery-approach and performance-approach, respectively). The weighted correlations for the avoidance goals were not significant. The fail safe n for the mastery-approach goal is fairly large as it approached 100 given the relatively few investigations with approach neurophysiological-based antecedents. Q_T was significant for each of the approach goal analyses though the I^2 value was only >75 or for the mastery-approach goal.

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Table 1
Summary information for all studies included in meta-analytic review.

Study	Sample[a]	Goal measure	Country/region	Antecedent category
Adie et al.[25]	424 female (n = 189) and male (n = 235) participants from six team sports (24.25 ± 6.24)	AGQ-S	UK	S
Adie et al.,[26] wave 1	91 male soccer players (13.82 ± 1.99)	AGQ-S	UK	S
Bois et al.[27]	41 male professional golfers (28.80 ± 5.75)	AGQ-S French	France	C, S, NAv, A
Castillo et al.[28]	370 male soccer players (14.77 ± 0.72)	AGQ-S Spanish	Spain	C, EP, EM
Cetinkalp[29]	208 female (n = 120; 16.33 ± 0.47) and male (n = 88; 16.38 ± 0.49) handball and volleyball players	AGQ-S Turkish	Turkey	C, S
Chen et al.[30]	691 female (n = 350) and male (n = 341) undergraduates enrolled in physical education courses (20.17 ± 1.30)	CAGQ-PE	Taiwan, China	R
Conroy et al.,[31] wave 2	356 female (n = 106) and male (n = 250) recreational athletes at a university (21.57 ± 1.92)	AGQ	USA	R
Conroy and Elliot,[32] averaged across waves	356 female (n = 106) and male (n = 250) undergraduates enrolled in various physical activity courses (21.57 ± 1.92)	AGQ-S	USA	R, S
Corrion et al.[33]	477 female (n = 199) and male (n = 278) middle school students (13.60 ± 1.12)	AAQSPE	France	EP, EM, R, X, A
Cury et al.[34]	682 male high school students (14.30 ± 0.70)	AAASQ	France	C, EP, EM
Gao et al.[35]	194 female (n = 101) and male (n = 93) middle school students enrolled in physical education classes (12.40 ± 1.00)	AGQ-S	USA	EP, EM
Gucciardi[36]	214 Australian non-elite male football players (16.80 ± 0.70)	AGQ-S	Australia	C
Gucciardi et al.[37]	423 female (n = 244) and male (n = 179) elite athletes from a variety of sports (25.64 ± 8.57)	AGQ-S	Australia	C, EP, R
Hagger et al.,[38] study 1	243 female (n = 166; 26.6 ± 11.70) and male (n = 77; 28.50 ± 12.80) undergraduates, postgraduates, and university employees	AGQ	UK	R, S
Hagger et al.,[38] study 2	216 female (n = 146; 23.00 ± 2.50) and male (n = 70; 24.30 ± 3.80) undergraduate and postgraduate university students	AGQ	Estonia	
Hagger et al.,[38] study 3	186 female (n = 58; 31.30 ± 13.20) and male (n = 123; 28.80 ± 12.30) and gender not reported (n = 5) self-reported gym users	AGQ	UK	
Hagger et al.,[38] study 3	256 female (n = 69; 35.40 ± 15.60) and male (n = 182; 28.80 ± 12.30) and gender not reported (n = 5) self-reported gym nonusers	AGQ	UK	
Halvari and Kjormo[39]	136 Norwegian Olympic level athletes representing 16 different sports	M-SCAT	Norway	C, EP, EM, R
Halvari et al.[40]	152 female (n = 76) and male (n = 76) physically active junior high students ranging in age from 13 to 14 years	AGQ Norwegian	Norway	C, A
Kaye et al.[41]	372 female (n = 150) and male (n = 221) and gender not reported (n = 1) enrolled in university physical activity classes (21.20 ± 2.70)	AGQ-S	USA	C, EP, R, S, NAp, NAv
Koh and Wang[42]	101 female (n = 40) and male (n = 61) Singaporean athletes (16.70 ± 0.84) competing in the Youth Olympic Games	AGQ-PE adapted to sport	Singapore	X
Lench et al.[43]	96 female (n = 83) and male (n = 13) undergraduates enrolled in a highly competitive university dance program that trained career-orientated students (20.12 ± 2.53)	AGQ-S	USA	NAv
Lochbaum et al.[44]	213 female (n = 116) and male (n = 97 men) community adults (37.21 ± 11.76)	AGQ	USA	NAp, NAv
Lochbaum et al.[45]	804 female (n = 377; 20.88 ± 2.67) and male (n = 391; 21.51 ± 2.12) undergraduate students in fitness and wellness courses	AGQ	USA	X, A
Lochbaum et al.[46]	286 female (n = 131) and male (n = 155) moderately active undergraduates	AGQ	USA	NAp
Moreno et al.[47]	727 female (n = 325) and male (n = 402) exercising adults ranging in age from 16 to 78 years (32.57 ± 11.39)	AGQ Spanish	Spain	C, EP, EM
Morris and Kavussanu[48]	249 female (n = 110) and male (n = 139 male) players from nine team sports (13.57 ± 1.69)	AGQ-S	UK	C, EP, EM, X, A

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Table 1 (*continued*)

Study	Sample[a]	Goal measure	Country/region	Antecedent category
Murcia et al.[49]	727 female ($n = 325$) and male ($n = 402$ males) participants ranging in age from 14 to 78 years (32.57 ± 11.40)	AGQ-S Spanish	Spain	C, EP, EM
Ntoumanis et al.[50]	138 female ($n = 87$) and male ($n = 51$ males) first year undergraduates (19.30 ± 1.20)	AGQ-S	UK	C
Ommundsen[51]	273 female ($n = 148$) and male ($n = 125$) ninth grade student ranging in age from 15 to 16 years	GOS	Norway	C
Partridge et al.[52]	144 (88 female, 56 male) cross fit participants ranging in age from 18–71 years (34.40 ± 11.80)	AGQ-S	USA	EP, EM
Puente-Díaz[53]	204 female ($n = 70$) and male ($n = 134$) tennis players (14.13 ± 2.45)	AGQ-S Spanish	Mexico	C, R
Schantz and Conroy[54]	25 female ($n = 14$) and male ($n = 11$ male) collegiate golfers (19.60 ± 1.20)	AGQ-S	USA	C, R
Skjesol and Halvari[55]	188 female ($n = 90$) and male ($n = 98$) upper secondary school students (16.7 ± 1.70)	AGQ	Norway	C, EP, EM
Spray et al.[56]	491 male and female children (11.29 ± 0.30)	AGQ-S	UK	C, EP, EM, S
Stenling et al.[57]	315 female ($n = 163$; 19.40 ± 3.00) and male ($n = 152$; 20.60 ± 4.00) team sport athletes competing from regional to national level competition	AGQ-S Swedish	Sweden	EP, EM, X
Stevenson and Lochbaum[58]	379 female ($n = 164$) and male ($n = 215$) university students enrolled in physical activity courses (79.3% of participants ranging in age from 18 to 24 years)	AGQ	USA	C, EP, EM
Stevenson and Lochbaum[58]	148 female ($n = 90$) and male ($n = 58$) undergraduate students enrolled in physical activity courses (96% of participants ranging in age from 18 to 24 years)	AGQ	USA	
Stoeber et al.[59]	138 male elite-level ice-hockey players competing to be on the under 16 national team aged 14 or 15 years	AGQ-S	Finland	C
Stoeber et al.,[60] study 1	126 female ($n = 28$) and male ($n = 98$) Half-Ironman distance triathlon athletes (36.50 ± 7.60)	AGQ-S	UK	C, X, A
Stoeber et al.,[60] study 2	339 female ($n = 58$) and male ($n = 281$) athletes at competing in Olympic distance triathlon (37.20 ± 7.90)	AGQ-S	UK	
Su et al.[61]	361 female ($n = 206$; 19.82 ± 1.53) and male ($n = 155$; 20.19 ± 1.90) undergraduate students enrolled in physical activity courses.	AGQ-PE	USA	X
Trenz and Zusho[62]	119 female ($n = 77$) and male ($n = 42$) youth competitive swimmers (14.76 ± 1.72)	AGQ-S	USA	EP, EM, X, A
Turner et al.[63]	42 elite-level national and county male cricketers (16.45 ± 1.38)	AGQ-S	UK	NAp
Wang et al.,[64] study 2	647 female ($n = 277$), male ($n = 256$), and unreported sex ($n = 114$) secondary school student athletes (13.92 ± 1.14)	AGQ-S	Singapore	C
Wang et al.[65]	264 (162 male, 102 female) elite high school basketball players (15.68 ± 0.82)	AGQ-PE	Singapore	EM
Wang et al.[66]	309 female ($n = 184$) and male ($n = 125$) university students in physical activity courses (21.37 ± 1.87)	AGQ-PE	USA	C, EP, EM
Warburton and Spray,[67] wave 1	140 female ($n = 68$) and male ($n = 72$) youth participants ranging in age from 10–11 years (11.37 ± 0.28)	AGQ-S	UK	C, EP, EM
Warburton and Spray,[68] wave 1	511 female ($n = 267$) and male ($n = 244$) high school students in physical education classes (13.00 ± 0.87)	AGQ-S	UK	C, EP, EM
Warburton and Spray,[68] wave 1	203 female adolescent tennis players (13.16 ± 0.86)	AGQ-S	UK	EP, EM
Warburton and Spray,[68] wave 1	227 male adolescent cricket players (13.16 ± 0.86)	AGQ-S	UK	
Yeatts and Lochbaum[69]	258 female ($n = 46$) and male ($n = 212$) university students participating intramural basketball and or a basketball physical activity course (20.46 ± 1.75)	AGQ-S	USA	NAp, NAv
Zarghmi et al.[70]	134 male elite athletes active in a range of 13 different sports ranging in age from 17 to 35 years (23.25 ± 6.24)	AGQ-S Persian	Iran	C

[a] mean ± SD values of participants' age (year) are listed in brackets.

Abbreviations: AGQ-S = Achievement Goal Questionnaire for Sport; CAGQ-PE = Chinese 2 × 2 Achievement Goal Questionnaire for physical education; AAQSPE = validated version of Approach and Avoidance Questionnaire for Sport and Physical Education; AAASQ = Approach and Avoidance in Sport Questionnaire adapted and translated from Elliot (1997); AGQ = Achievement Goal Questionnaire adapted from Elliot and McGregor (2001); M-SCAT = Modified Sport Competitive Anxiety Test; GOS = Goal Orientation Scale from Skaalvik (1997); AGQ-PE = Achievement Goal Questionnaire for Physical Education; C = competence-based; EP = environmental-based performance oriented; EM = environmental-based mastery oriented; R = relationally-based; S = self-based; NAp = neurophysiological-based approach oriented; NAv = neurophysiological-based avoidance oriented; X = sex; A = age.

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Table 2
Fixed effect model results for intercorrelations and Elliot's (1999) antecedent categories by 2 × 2 achievement goals.

Examined relationship	*k*	*n*	Sample weighted mean *r*	95%CI	*Z*	Q_T	I^2	Fail safe *n*
Intercorrelations								
MAp_MAv	48	13,060	0.28	0.26, 0.30	32.84**	246.89**	80.96	11,571
MAp_PAp	48	13,090	0.37	0.36, 0.39	45.07**	390.09**	87.95	23,030
MAp_PAv	47	12,829	0.17	0.16, 0.19	19.71**	516.08**	91.08	3705
MAv_PAp	49	13,128	0.27	0.26, 0.29	32.71**	323.21**	84.84	11,682
MAv_PAv	48	12,867	0.39	0.37, 0.40	47.04**	327.30**	85.33	22,622
PAp_PAv	54	14,402	0.45	0.43, 0.46	58.56**	794.36**	93.20	43,495
Competence-based								
MAp	39	10,942	0.32	0.32, 0.35	36.20**	485.92**	92.18	6846
MAv	40	10,980	0.16	0.14, 0.17	16.51**	354.52**	89.00	1709
PAp	44	12,263	0.32	0.31, 0.34	36.82**	423.53**	89.85	8701
PAv	46	12,529	0.10	0.08, 0.11	10.89**	585.50**	92.31	850
Self-based								
MAp	16	5946	0.27	0.24, 0.29	20.28**	89.12**	83.17	844
MAv	17	5984	0.04	0.01, 0.07	2.92*	220.21**	92.73	18
PAp	17	5984	0.21	0.19, 0.24	16.23**	155.38**	89.70	578
PAv	17	5984	0.08	0.05, 0.11	60.02**	119.60**	86.62	72
Relational-based								
MAp	19	6183	−0.05	−0.07, −0.03	−3.90**	58.36**	69.16	39
MAv	19	6183	0.30	0.27, 0.32	23.93**	111.74**	83.89	1597
PAp	19	6183	0.14	0.11, 0.17	11.20**	57.41**	68.65	339
PAv	20	6316	0.22	0.20, 0.24	17.83**	68.81**	72.39	897
Neurophysiological-based and approach oriented								
MAp	10	2171	0.18	0.14, 0.22	8.27**	107.92**	91.66	98
MAv	10	2171	0.02	−0.03, 0.06	0.69	20.05	55.12	0
PAp	10	2171	0.10	0.06, 0.14	4.53**	28.85**	68.80	35
PAv	10	2171	−0.02	−0.06, 0.03	−0.71	7.20	0.00	0
Neurophysiological-based and avoidance oriented								
MAp	6	1665	−0.07	−0.12, −0.03	−3.04*	40.74**	87.73	0
MAv	8	1741	0.11	0.07, 0.16	4.79**	93.61**	92.52	20
PAp	8	1741	0.06	0.02, 0.11	2.61*	25.55**	72.61	3
PAv	8	1741	0.10	0.05, 0.14	3.97**	87.22**	91.97	4
Demographics-sex								
MAp	9	2665	−0.00	−0.04, 0.04	−0.12	21.86*	63.41	0
MAv	9	2665	−0.10	−0.14, −0.06	−5.23**	42.58**	81.21	42
PAp	10	2814	0.05	0.01, 0.08	2.48	27.92*	67.77	0
PAv	10	2814	−0.06	−0.09, −0.02	−2.92*	14.79	39.18	6
Demographics-age								
MAp	8	2145	−0.03	−0.07, 0.02	−1.18	8.78	31.69	0
MAv	8	2145	−0.05	−0.09, −0.01	−2.33	5.82	0.00	0
PAp	9	2294	−0.07	−0.11, −0.03	−3.35**	37.86**	78.87	6
PAv	9	2294	−0.01	−0.05, 0.03	−0.50	22.55*	64.52	0
Environmental-based and performance oriented								
MAp	26	8886	−0.09	−0.11, −0.07	−8.50**	45.28**	44.79	411
MAv	26	8886	0.10	0.08, 0.12	9.37**	70.31**	64.44	487
PAp	30	10,578	0.23	0.21, 0.24	23.59**	144.72**	79.96	3836
PAv	30	10,578	0.22	0.21, 0.24	23.31**	131.52**	77.90	3801
Environmental-based and mastery oriented								
MAp	25	7918	0.33	0.31, 0.35	30.78**	240.14*	90.00	5475
MAv	25	7924	0.15	0.12, 0.17	12.96**	60.79**	60.51	981
PAp	29	9610	0.08	0.06, 0.10	7.99**	147.83**	81.06	586
PAv	25	8566	0.03	−0.00, 0.04	1.65	214.64**	88.81	3

* $p < 0.01$; ** $p < 0.001$. Abbreviations: *k* = total number of correlations included in the analysis; *n* = total number of participants; CI = confidence interval; *LL* = lower limit; *UL* = upper limit; *Z* = test of null (2-tailed); Q_T = total homogeneity statistic; I^2 = I-squared test of heterogeneity; MAp = mastery approach goal; MAv = mastery avoidance goal; PAp = performance approach goal; PAv = performance avoidance goal; Fail safe *n* = number of studies in which the intervention effect was zero needed to render the results statistically insignificant.

3.7. Results for avoidance neurophysiological-based antecedent category

As found in Table 2, though all of the weighted correlations were significant, each was small in meaningfulness (mastery-approach $r_w = -0.07$; mastery-avoidance $r_w = 0.11$; performance-approach $r_w = 0.06$; performance-avoidance $r_w = 0.10$). The fail safe *n*s were correspondingly very small suggesting the results could quickly sway with studies filed away. Q_T was significant for each analysis and all I^2 values were nearly 75 or >75 in magnitude.

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3.8. Results for demographic antecedent category of sex

As found in Table 2, significant albeit small in meaningfulness resulted for the avoidance goals ($r_w = -0.10$ and -0.06 for mastery-avoidance and performance-avoidance, respectively). The results are interpreted as meaning females scoring higher for both avoidance goals and lower for the performance-approach goal. The fail safe *n*s were 42 for the mastery-avoidance and six for the performance-avoidance goals. Q_T was significant for the mastery-approach and performance-approach achievement goals. Only the I^2 for the mastery-avoidance goal was large.

3.9. Results for demographic antecedent category of age

As found in Table 2, the only significant albeit very small in meaningfulness correlation was for the performance-approach goal ($r_w = -0.07$) suggesting that as age increased scores on the performance-approach goal decreased. The fail safe *n* was also very small suggesting the results could sway with studies in "file drawers". The heterogeneity statistic was significant for both performance achievement goals and I^2 >75 for the performance-approach goal.

3.10. Results for environmental-based antecedent performance oriented category

As found in Table 2, though all of the weighted correlations were significant, each were small in meaningfulness (mastery-approach: $r_w = -0.09$; mastery-avoidance: $r_w = 0.10$; performance-approach: $r_w = 0.23$; performance-avoidance: $r_w = 0.22$). The fail safe *n*s were very large (nearly 4000) for the performance achievement goals results suggesting very little chance of these being changed based on filed away data. Q_T was significant for each achievement goal. The I^2 value was >75 for the performance achievement goals. The I^2 values for the mastery achievement goals were much lower with the mastery-approach I^2 being very low.

3.11. Results for environmental-based mastery oriented antecedent category

As found in Table 2, the weighted correlations for both mastery achievement goals and the performance-approach goal were statistically significant ranging in meaningfulness from medium to small (mastery-approach: $r_w = 0.33$; mastery-avoidance: $r_w = 0.15$; performance-approach: $r_w = 0.08$). The fail safe *n*s for these achievement goals were large (range 586–5475). Q_T was significant for all of the 2 × 2 achievement goals and all I^2 values were greater than 75 for both performance achievement goals and the mastery-approach goal. The mastery-avoidance goal I^2 was medium in meaningfulness.

3.12. Moderator results

Moderator results were examined for mean age of sample, domain, and sex makeup of the sample for both the intercorrelations amongst the achievement goals and the antecedent categories for each achievement goals. For space and readability purposes, only the weighted correlations were presented. In addition, a moderator category needed at least two cases to be reported. Details of all statistics are available from the first author. For domain, the most striking results concerned the two approach goal relationships being higher in the exercise and PE domains compared to the sport domain. In addition, the sport intercorrelation approached zero compared to the small to moderate intercorrelations for the other two domains. For the sex makeup of the sample, differences existed only for two of the goal-to-goal intercorrelations and they were not entirely consistent across the four categories (Table 3).

Concerning moderator of the antecedent categories with each achievement goal, mean age of the sample moderated a number of relationships. As found in Table 4, the approach goals were stronger when the mean age of the sample was less than 18 years of age for the self-based antecedent category. The mastery-approach goals' relationship with competence-based variables was also greater in magnitude for the adolescent compared to adult samples. For the avoidance goals (Table 4), the greatest difference was found for the relational-based antecedent variables with the correlation being nearly 0 for the younger sample, yet small to medium in meaningfulness for the older sample.

As found in Table 5, domain moderated a number of goals to antecedent variable relationships across all of the antecedent categories. The most apparent pattern in the weighted

Table 3
Moderator variable results for intercorrelations amongst each achievement goal.

Moderator categories	MAp_MAv	MAp_PAp	MAp_PAv	MAv_PAp	MAv_PAv	PAp_PAv
Mean age of sample						
<18 years	—	—	0.26	—	—	—
≥18 years	—	—	0.14	—	—	—
Domain						
Sport	0.25	0.31	0.04	0.29	—	—
Exercise	0.28	0.42	0.23	0.24	—	—
PE	0.33	0.39	0.25	0.30	—	—
Sex makeup of sample						
Unreported	—	—	—	—	0.47	0.01
Female	—	—	—	—	0.29	0.52
Male	—	—	—	—	0.30	0.40
Mixed	—	—	—	—	0.38	0.46

Abbreviations: PE = physical education; MAp = mastery-approach goal; MAv = mastery-avoidance goal; PAp = performance-approach goal; PAv = performance-avoidance goal.

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Table 4
Moderator results for each achievement goal for the mean age of sample moderator category.

Moderator category	MAp		MAv		PAp		PAv	
	<18 years	≥18 years	<18 years	≥18 years	<18 years	≥18 years	<18 years	≥18 years
Competence	0.43	0.28	—	—	—	—	0.06	0.10
Self	0.31	0.14	0.12	−0.07	0.30	0.04	0.15	−0.02
Relational	—	—	−0.03	0.31	—	—	−0.02	0.23
Sex	—	—	0.08	−0.11	—	—	—	—
Environmental performance oriented	—	—	—	—	0.26	0.20	—	—
Environmental task oriented	—	—	—	—	—	—	−0.01	0.05

Abbreviations: MAp = mastery-approach goal; MAv = mastery-avoidance goal; PAp = performance-approach goal; PAv = performance-avoidance goal.

correlations were larger in magnitude for the mastery-avoidance goal and the self, relational, and avoidance neurophysiological-based antecedent variables when compared to the sport and PE domains though this was not found within the competence-based antecedent category. For the performance-avoidance goal, the moderation pattern was not similar to the mastery-avoidance goal. Most of the weighted correlations were small to very small in magnitude. Only the performance environmental-based category did the PE moderator category almost reach medium in meaningfulness. For both approach goals, the pattern of moderation supported larger weighted correlations within the PE category for competence, self, and the environmental performance-oriented categories.

For the sex makeup of the sample moderator, overall there were very few moderated results (Table 6). The differences that standout concern the male and mixed sample correlations being approximately twice that of the female only samples for the both performance goals in the environmental-based performance oriented category. In addition, the correlation between the performance-avoidance goal and the neurophysiological-based avoidance antecedents was very different from the mixed sample. But, overall few moderated differences emerged for the sex makeup of the sample moderator.

4. Discussion

The purpose of this investigation was to use meta-analytic techniques to summarize the state of Elliot's *Hierarchical Model of Approach and Avoidance Motivation,* specifically antecedent categories with his 2 × 2 achievement goals. Prior to summarizing those data, the intercorrelations amongst the 2 × 2 achievement goals were meta-analytically summarized. The intercorrelations were small to medium in meaningfulness. In comparing intercorrelations amongst the 2 × 2 achievement goals, the present results were similar to other meta-analytic summaries.[72,73] In particular, across all three sets of meta-analytic findings, only the intercorrelations for mastery-avoidance to performance-avoidance and performance-approach to performance-avoidance were medium in meaningfulness. Hence, each achievement goal

Table 5
Moderator results for each achievement goal for the domain moderator category.

Antecedent category	MAp			MAv			PAp			PAv		
	Sport	Exercise	PE	Sport	Exercise	PE	Sport	Exercise	PE	Sport	Exercise	PE
Competence	0.26	0.37	0.49	0.20	−0.01	0.20	0.32	0.20	0.40	0.16	−0.03	0.06
Self	0.14	0.15	0.33	0.04	−0.31	0.14	0.06	0.07	0.31	0.04	−0.08	0.16
Relational	—	—	—	0.28	0.41	—	—	—	—	—	—	—
Neurophysiological approach	—	—	—	−0.03	0.09	—	0.03	0.22	—	—	—	—
Neurophysiological avoidance	—	—	—	0.07	0.28	—	—	—	—	—	—	—
Sex	—	—	—	—	—	—	−0.06	0.13	0.08	—	—	—
Age	−0.12	−0.10	0.10	—	—	—	—	—	—	0.01	−0.08	0.13
Environmental performance	—	—	—	—	—	—	0.17	0.23	0.27	0.20	0.18	0.28
Environmental task	0.26	0.40	0.32	—	—	—	—	—	—	−0.01	0.06	−0.01

Abbreviations: PE = physical education; MAp = mastery-approach goal; MAv = mastery-avoidance goal; PAp = performance-approach goal; PAv = performance-avoidance goal.

Table 6
Moderator results for each achievement goal for the sex makeup of sample moderator category.

Moderator category	MAp			MAv			PAp			PAv		
	Female	Male	Mixed	Female	Male	Mixed	Female	Male	Mixed	Female	Male	Mixed
Competence	—	0.38	0.32	—	0.22	0.14	—	0.24	0.34	—	0.03	0.12
Neurophysiological approach	—	—	—	—	—	—	0.20	0.24	0.05	—	—	—
Neurophysiological avoidance	—	—	—	—	—	—	—	—	—	—	−0.24	0.11
Environmental performance	—	—	—	—	—	—	0.12	0.25	0.22	0.14	0.24	0.22

Abbreviations: MAp = mastery-approach goal; MAv = mastery-avoidance goal; PAp = performance-approach goal; PAv = performance-avoidance goal.

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appears relatively unique, as overlap between any two across all three meta-analytic summaries was at most 21.11%. Elliot and Murayama[74] some years ago proposed a revised measurement scale in education that seemingly never took hold in the literature. In addition, very recently Strunk[75] reported that Elliot's revised measure actually supported a 3-factor model. To date, the 2×2 achievement goal measurement in sport, exercise, and PE has not undergone a revision though different variants are used. The results of this study suggested that the individual goals are relatively unique as commonly measured.

Of some concern was the heterogeneity present in intercorrelation relationships in the present study as well as in the previously referenced meta-analyses in education. Besides the sex makeup of the sample—as one could hypothesize that the intercorrelations for avoidance goals would be stronger in females and minorities—no theoretical or conceptual reasons exist for moderation of the intercorrelations. The mastery-approach relationship with both performance achievement goals was moderated by domain such that the PE and exercise domain correlations were greater in magnitude than the sport domain correlations with mastery-approach. Perhaps it is the saliency of winning and losing inherent in the sport domain that separates in participants' minds the distinct definitional differences between mastery-approach and both of the performance goals. The sex makeup of the sample was a moderator though the results were conflicting in that the female correlations between performance-approach and performance-avoidance were greater than male correlations, but the intercorrelations for the two avoidance goals were similar in magnitude for females and males. The higher and large in meaningfulness intercorrelation for the performance goals for females, when compared to males, suggests that in a group setting females have both goals of winning/looking good while at the same time not wishing to lose/look bad. Future research should examine this result more closely. Last, when compared to the two published intercorrelations datasets in education and the present study, no consistent finding emerged. These results potentially cloud lines of future inquiry into why heterogeneity is present amongst intercorrelations of 2×2 achievement goals.

Concerning the main purpose of the present review, nearly all of the hypotheses were supported. The deviations were minor and the impact on achievement goal theory inconsequential. For instance, the only unsupported hypotheses concerned the hypothesized negative relationships between both the competence- and self-based antecedents and the avoidance goals. In both instances, the correlations were positive though small in magnitude. The magnitudes of the antecedents to achievement goal relationships were not specifically hypothesized.

When examining how related should an antecedent be to a specific achievement goal, the findings of this review indicated that, for the most part, the relationships were small to medium in magnitude. Even though heterogeneity was present, the significant and hypothesized relationships with competence-, self-, relationally-, and the environmental-based antecedents seem invariant to future work given the large fail safe n values relative to number of samples. Thus, if one is trying to stimulate a specific achievement goal to a large extent or magnitude, the data strongly suggest that antecedents are not the manner in which to do so. This statement is certainly important and has a broad ramification for achievement goal research. For instance, the results for the environmental-based and performance-oriented category are such that the relationships with both performance goals seem very difficult to stimulate. This finding is certainly contrary to basic logic that an emphasis on such an environment would stimulate the corresponding performance achievement goals. Last, concerning the overall findings, the apparent impact of neurophysiological as well as sex is minimal on achievement goal adoption in the sport, exercise, and PE literature, though neurophysiological variables have been purported as building blocks of achievement goals.[76]

Though the overall correlations appear very resistant to change, significant heterogeneity was present in the relationships within the achievement goals for each antecedent category. As was noted in the results section, significant variation existed statistically. But, the differences in magnitude of the correlations between or amongst the specific moderator variables such as sex makeup of the sample were inconsequential. It seemed though the most important and consistent finding was that the domain appeared in many instances to have consequential differences. For instance, for the competence-based antecedent category, both approach goals were more related to this variable category than within the sport or exercise domains. This result suggests that PE instructors should be aware that students devoid of high competence-based self-assessments are more prone to lacking in these two valuable approach-oriented achievement goals. This similar pattern of results was also found for the self-based antecedent variables and domain for both approach goals. Hence, an important next step in PE research should be a concerted effort to determine whether experimental manipulations of competence- and or self-based assessments result in greater stimulation of both the mastery-approach and performance-approach goals. In addition to this more apparent and consistent heterogeneity result, others exist as well. Given space limitations, teasing out the most important or interesting results are a challenge. Thus, the moderator results found should be used as a guide when conducting future research when searching for meaning research questions to enrich the literature.

Even though this was a comprehensive meta-analysis, a few limitations exist. The authors included all articles that were found that met inclusion criteria. In addition to the English language, only a few in Spanish were found. It could be that additional manuscripts in other languages were not found in the searched databases. Another limitation was the limited number of cases found the neurophysiological-based categories and demographics for both sex and age antecedent categories. At times within the moderation analyses, there were few cases for a specific moderator. These aforementioned limitations seem minor as overall the search was comprehensive with 14 countries represented and most antecedent categories and moderator variables had sufficient number of cases. The finite number of cases would have been a much more imposing limitation if specific questionnaires within an antecedent category were

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coded. The literature based in the psychology of sport, exercise, and PE is certainly sufficient for this study's stated purpose. But, in education for instance, meta-analytic data have been reported on 243 correlational studies with over 90,000 participants that compared measures of approach-avoidance goals.[72]

5. Conclusion

This meta-analytic summary provided important findings regarding the state of Elliot's *Hierarchical Model of Approach and Avoidance Motivation* in the psychology of sport, exercise, and PE domains. Based on examining the literature with Elliot's model and achievement goals, the current meta-analysis is the only comprehensive quantitative summary. Thus, this unique study is of great importance in shaping future research. In addition, this study provided confidence that the measures of Elliot's 2×2 achievement goals are relatively independent constructs. In education, the utility of achievement goals has been strongly questioned given their small relationship with academic achievement.[72] However, achievement goals in the psychology of sport, exercise, and PE domains have been demonstrated to be associated with salient and valued outcomes such as performance,[5] affect,[77,78] and intrinsic motivation.[6] The present study confirmed that antecedents were theoretically congruent with the 2×2 achievement goals in almost all instances. The one main issue concerned the heterogeneity present in the data and the small to medium relationships as reported. Future research is encouraged to grow and enrich the understanding of achievement goals within Elliot's complete *Hierarchical Model of Approach and Avoidance Motivation* to include both antecedents and outcomes simultaneously in the psychology of sport, exercise, and physical education to improve upon the understanding of motivation, as well as determine whether achievement goals may be modified or stimulated to a greater magnitude by manipulation of Elliot's antecedents.

Authors' contributions

ML conceived of the study, participated in the search and final studies included, conducted the initial data extraction for coding the moderator variables, examined the extracted data for effect size calculations, conducted the analyses, and wrote the manuscript in full; JJN reviewed all of the coded studies, corrected initial coding discrepancies, prepared the reference list in accordance to the JSHS style, assisted in drafting of the tables and in manuscript draft finalization; CP lead the extensive search for articles including emailing authors for missing information, assisted in the conceptualization of the data analyzes, confirmed data extraction decisions, prepared the initial draft of Table 1 contents and of the meta-analyzed references; TG assisted in confirming the study methodology, the data extraction decisions and provided extensive manuscript editing. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

None of the authors declare competing financial interests.

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