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What Predicts the Physical Activity Intention-Behavior Gap?

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Running Head: Intention-Behavior Moderators

What Predicts the Physical Activity Intention-Behavior Gap?

A Systematic Review

### Abstract

**Background:** Intention is theorized as the proximal determinant of behavior in many leading theories and yet intention-behavior discordance is prevalent. **Purpose:** The purpose of this review was to theme and appraise the variables that have been evaluated as potential moderators of the intention-physical activity (I-PA) relationship using the capability-opportunity-motivation-behavior model as an organizational frame. **Methods:** Literature searches were concluded in August 2020 using seven common databases. Eligible studies were selected from English language peer-reviewed journals and had to report an empirical test of moderation of I-PA with a third variable. Findings were grouped by the moderator variable for the main analysis, and population sample, study design, type of PA, and study quality were explored in sub-analyses. **Results:** The search yielded 1,197 hits, which was reduced to 129 independent studies (138 independent samples) of primarily moderate quality after screening for eligibility criteria. Reliable moderators of the I-PA relationship were present among select variables within sociodemographic (employment status) and personality (conscientiousness) categories. Physical capability, and social and environmental opportunity did not show evidence of interacting with I-PA relations, while psychological capability had generally mixed or inconclusive findings. By contrast, key factors underlying reflective (intention stability, intention commitment, low goal conflict, affective attitude, anticipated regret, perceived behavioral control/self-efficacy) and automatic (identity) motivation may hold the most promise as moderators of I-PA relations. Findings were generally invariant to the variability of study characteristics explored in our sub-analyses. **Conclusions:** Traditional intention theories may need to better account for key I-PA moderators. The findings support action control theories that include these moderators and identify individuals at risk for not realizing their PA intentions. Prospero # CRD42020142629.

Keywords: theory of planned behaviour, socio-ecological model, personality, exercise, adults, children, action control

### **Background**

The health benefits of physical activity (PA) are well-established (1-3). Moderate to vigorous intensity PA, performed 150 minutes or more per week is linked to the reduced odds of developing over 25 chronic health conditions, with relative risk reduction between 20 and 40 percent (2-4). Despite long-standing general public knowledge of these benefits (5, 6) many adults do not engage in this recommended level of PA (7, 8). Engaging in regular PA during childhood is also associated with better physical and mental health profiles (9-13), yet few children and youth are active enough to optimize these health outcomes (7, 14). Clearly, effective PA promotion efforts are needed.

An understanding of the determinants behind PA to improve the effectiveness of promotion has been a line of research inquiry for over half a century (15). While debate about the utility of various theoretical approaches has been growing (e.g., 15, 16-21), models that feature intention as a proximal determinant of PA have been among the most popular (22-24). The intention construct has also served many important functions in understanding and promoting PA, which include the creation of decisional stage algorithms (25), examination as a grand mediator of other predictors of PA (26), and use as a proxy variable for conscious decision-making in dual process models (27).

These multiple applications of the intention construct in PA research have had considerable support. For example, intention is a reliable mediator of PA interventions, albeit with a very small effect size (28). More convincing, intention is a strong predictor of PA in the medium to large effect size range that does appear to mediate most social cognitive (26, 29),

personality (30) and built environment (31) correlates of PA. Finally, nearly all people engaging in PA possess an intention to perform PA (32). This provides clear support that intention is a marker for the likelihood of performing PA (25, 33).

Despite the utility of the intention construct, there is certainly room for improvement in theoretical fidelity and the advancement of PA promotion effectiveness. While the relationship between intention and PA is substantial (26), there are several streams of research that demonstrate a sizeable “intention-behavior gap” (34, 35). For example, experimental manipulations that increase PA intention ( $d = .45$  or  $r = .22$ ) result in much lower, and clinically less meaningful increases in PA ( $d = .15$  or  $r = .07$ ) (36). A meta-analysis of the dichotomization (e.g., those who intended to engage in regular PA but did not follow-through, those who did not intend to engage in PA and subsequently followed through with no PA, etc.) of the intention and PA relationship around public health guidelines also showed that 48% of intenders failed to follow-through with PA (32). Thus, much of the stability of the intention-PA (I-PA) relationship is derived from non-intenders not engaging in PA (37). Of further concern, this I-PA gap appears magnified for those who are beginning PA (66%) compared to those who are maintaining PA (29%) (38) and when accelerometry is used as the PA measure compared to self-report (62% to 79%) (39). Perhaps most important is the limited practical value of theories that place intention as the proximal antecedent of health behavior (24). It is extremely common for inactive participants in PA interventions to report to the trial with high intentions at baseline, a function of volunteering in the first place, yet an extraordinary contradiction for any theory that places intention as the proximal predictor of behavior change (27).

In response to the evidence of I-PA discordance, several models have started to emerge, which focus on constructs that may bridge this “gap” between intention and PA (see 40 for

review). Some of these models focus on mediators of intention (e.g., 41, 42), based on the premise that intention is not the proximal determinant of PA but an antecedent in a longer causal chain, while others include the possibility of moderating mechanisms between intention and PA (40). Moderators are variables that facilitate or inhibit I-PA relationships (43), and may be important to understand, and consequently improve the successful translation of an intention into PA, otherwise known as action control (44). A prior systematic review of moderators of the I-PA relationship identified 57 studies, representing 38 different potential moderators (45). Intention stability proved to be the most studied and reliable moderator with some additional evidence that anticipated affective reactions (regret) and the personality trait of conscientiousness also moderated the intention-PA relationship. There was mixed and very preliminary evidence that perceived control/self-efficacy, planning, extraversion, habit, and environmental proximity to recreation were moderators, while some other factors (gender, body mass index, ethnicity, personality traits of agreeableness and openness) did not appear to moderate the I-PA relationship.

While the findings of this review helped to suggest where future research was needed, the review search date is now more than a decade old in an area of much continuous research. Replication or revision of the findings and recommendations from this prior review with a larger set of studies is critical to ascertain the stability of the prior findings on moderators of I-PA relations. Some of the results of the prior review were based on a small number of samples ( $k = 3$ ). There has also been a shift in theoretical research since the time of the first review to acknowledge the importance of moderators of the intention-behavior gap (see 21 and response commentaries). Action control theories that specifically include constructs to account for the I-PA gap are now receiving considerable research testing and evaluation (40), and a shift to dual-

process theories that include interactions between social cognitive constructs like intention and automatic/implicit factors (e.g., implicit attitudes, habits, affective response to PA) are more prominent in exercise and health psychology (15, 46, 47). An update to this prior review would assist in highlighting these additional variables that have been tested as moderators of I-PA relations and provide more conclusive findings about many of the preliminary results noted in the prior review.

Thus, the purpose of this paper was to re-review, and appraise the evidence for moderators of the I-PA relationship. We employed the Capability-Opportunity-Motivation-Behavior (COM-B; 48) approach as a basic organizational framework to categorize disparate variables related to capability, opportunity and motivation, within the larger backdrop of sociodemographic and individual difference variables (e.g., income, age, education, personality). The COM-B represents a meta-theory that was designed from an amalgamation of 19 frameworks distilled to the essential conditions responsible for behavior at multiple levels of influence (48). Capability (C) refers to the physical (e.g., skills, abilities acquired through practice) and psychological (e.g., knowledge, attention, behavioral regulation) ability to enact PA. Opportunity (O) refers to the social (e.g., social support, social comparison, social pressure) and physical (e.g., context, resources, equipment) environment that enables the behavior. Finally, Motivation (M) refers to the reflective (e.g., beliefs about capability and consequences) or automatic (e.g., affective valuations, habits, incentives) mechanisms that activate or inhibit behavior.

### **Methods**

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analysis (PRISMA) guidelines (49) and has

was registered under Prospero # CRD42020142629. The review was conducted between January 2020 and August 2020.

### **Eligibility criteria**

Eligible studies met the following inclusion criteria: a) a measure of PA (self-report or objective) as the dependent variable; b) a measure of intention as the independent variable; c) a moderator analysis of a third variable on the I-PA relationship; d) were not duplicate datasets; and e) quantitative results. Reports were published in English language peer review journals or theses to be eligible. No specific restrictions on population, types of moderators, or duration of study were imposed. Physical activity was defined as any movement by skeletal muscles of the body that requires energy expenditure, and included activities done during leisure time, transportation, and occupational duties (50).

### **Information sources, search strategy and study selection**

The template electronic search strategy for this review involved the procedures developed by Rhodes and Dickau (45), and was executed for the current paper by two independent reviewers (AC, RS). Literature searches were conducted in the following seven databases: Academic Search Complete, Education Resources Information Center, Medline, PsychINFO, SPORTDiscus, Embase, and Web of Science, using keywords and phrases associated with I-PA moderation (Supplementary Table 1). Publication date of the review was restricted to July 2020. The searches were restricted by English language and those using human participants, but did not limit study design. In addition, we included all prior papers retrieved in Rhodes and Dickau (45) to ensure inclusion of all past reviewed papers, as well as specific searches for all the authors with  $\geq 2$  retrieved papers in our search process. Finally, we used a manual cross-referencing of all bibliographies.



We managed study selection using Covidence software ([www.covidence.com](http://www.covidence.com)), a web-based screening and data extraction tool recommended by the Cochrane Collaboration. After identifying and removing duplicate records, two reviewers (AC, RS) screened the citation information for each record using the set criteria. Covidence allows each reviewer to select “Yes”, “No”, or “Maybe” to include or exclude imported articles. Two ‘maybes’ move the citation to the full text screen. After citations were reviewed and conflicts resolved, included citations moved into the full-text screen. Full-text screening was completed by all authors (RR, RS, AC). Disagreements between reviewers were resolved through discussion until consensus was reached. When consensus was not reached, the first author (RR) provided a final decision. Studies found to be ineligible during the full-text screening were recorded along with reasons for exclusion. Study selection was completed at the end of August 2020.

### **Data collection process and data items**

One reviewer (RR) conducted the initial data extraction using a 13-item data extraction form (see Supplementary Table 2), which was independently fact-checked by the other two authors. The extracted data included authors, sample size and population, study design and setting, theory, measurement tools, and outcomes. As well, data items specifically sought were 1) intention measure, 2) PA measure, and 3) moderator, and 4) moderation findings.

### **Risk of bias assessment**

An assessment of variability in study reports was conducted to gauge risk of bias and complete reporting in the included studies (Supplementary Table 3). A six-criterion methodological quality assessment used in the prior I-PA review (45) was applied to the papers in this review. This assessment was based originally on the STROBE statement (51) and scoring was conducted for each study independently by RR and RS. The instrument included core

content coverage (52) of appropriate selection of participants (participant eligibility criteria, participant selection criteria), appropriate measurement of variables (acceptable reported measurement details of physical activity, intention, and the moderator), and appropriate analysis considerations (adequate power to detect the hypothesized relationships, acceptable attrition). The six criterion were answered with a yes (1) or no (0) format. High quality (low risk of bias) was considered with a score of five or six, moderate quality was considered with scores of three or four, and low quality (high risk of bias) was considered with scores of zero to two. Any differences in scores were reconciled among the authors.

### **Analysis**

Following initial read-throughs of the studies, themes for the types of interactions were developed. Themes were created where at least three studies had investigated a similar interaction (e.g., similar sociodemographic, capability, opportunity, motivation factor). This approach has been used previously in reviews (53-55).

Our analysis across studies collated the results of each I-PA moderator. Studies were coded as meeting 1) positive moderation (increase in the moderator corresponds to larger I-PA relationship), 2) negative moderation (increase in moderator corresponds to smaller I-PA relationship), or 3) no significant interaction. An overall assessment of the results was adapted from Sallis et al.'s (56) rubric for determining valence and consistency of findings. A particular interaction was considered to be supported if greater than 59% of studies were congruent with any given finding. No interaction was similarly supported when more than 34% of studies reported null findings. The results were considered inconclusive if between 34% and 59% of studies aligned with any particular finding. Statistical significance ( $p < 0.05$ ) needed to be present to conclude there was a positive or negative interaction. The main analyses were

presented collectively. A further sub-analyses of these results was also conducted by sample population (adult, child/youth; and designations of clinical vs. community when possible), study design (cross-sectional, prospective; and designations of length of prospective 1 month, 3 month, 6+ months when possible), type of PA (aerobic, resistance training; and designations of aerobic by walking cycling and other when possible), and study quality (low, medium, high) where possible.

Meta-analysis was precluded for two main reasons. First, there was extensive heterogeneity in the measures (e.g., format of measurement, mode), statistical tests employed (e.g., multi-group structural equation models, linear regression, group partitions and analysis of variance), definitions of predictors (e.g., baseline, change), and study designs (e.g., cross-sectional, longitudinal, experimental), all of which impact the ability to accurately pool the studies for quantitative synthesis (57). Second, a descriptive synthesis is most appropriate when there are caveats or other idiosyncrasies specific to some studies that could change the outcome in a meta-analysis.

## **Results**

### **Study Selection**

As shown in Figure 1, the electronic database search yielded 1,197 potentially relevant records. Of those, 439 duplicate records were removed, and the remaining 758 records were screened by titles and abstracts. In the remaining 512 records, 383 studies were excluded because they did not a) examine the I-PA relationship (k=145), have a test of moderation of intention and PA with a third variable (k=152), have a measure of intention (k=35), have an empirical test of PA (k=27), did not have PA as a dependent variable (k=13), were duplicates (k=9), and had a study design that could not examine moderation (k=2). A total of 129 studies with 138

independent samples passed the inclusion criteria and were included for analysis (see Supplementary Table 4).

### **Study Characteristics and Measures**

Table 1 describes the characteristics of the 129 studies (138 samples) included. These eligible studies represented a total of 59,661 unique participants, with the sample sizes ranging from 46 to 4,395. Most of the studies used longitudinal designs ( $k=109$  samples). The majority of studies comprised of adult populations ( $k=109$ , age range = 18-59), yet six studies included older adults (age range = 60+) and 13 studies included children ( $k=3$ , age range = 0-12) and adolescents ( $k=10$ , age range = 13-17). The majority included both males and females ( $k=129$ ), with 6 samples specifically addressing women. Geographical representation was broad including Canada ( $k=46$ ), United States ( $k=30$ ), United Kingdom ( $k=21$ ), Netherlands ( $k=12$ ), Australia ( $k=11$ ), China ( $n=8$ ), and other countries like Iran, Switzerland, Malaysia, Japan, France, Estonia, Greece, Hungary, Singapore, Germany, Austria, Lebanon, and Norway ( $k=10$ ). Risk of bias analyses showed that 35 samples were high quality, 93 samples could be considered medium quality, and 10 were rated as low quality (see Supplementary Table 3).

Assessments of PA included validated self-reported measures like the Godin Leisure-Time Exercise Questionnaire and the International Physical Activity Questionnaire ( $k=39$ ), accelerometer data ( $k=6$ ) and study-created questionnaires ( $k=12$ ). The most applied theoretical frame was Theory of Planned Behavior ( $k=114$ ), with small applications of Multi-Process Action Control Approach ( $k=2$ ), Health Action Process Approach ( $k=2$ ), The Theory of Reasoned Action ( $k=1$ ), the Transtheoretical Model ( $k=1$ ), Protection Motivation Theory ( $k=1$ ), and Social Cognitive Theory ( $k=1$ ), while some studies used multiple frameworks ( $k=13$ ) and a small number of studies did not report the framework that they used ( $k=3$ ).

## Main Analyses

### Sociodemographic Variables

Our review identified 39 studies that had evaluated the I-PA relationship with 19 different sociodemographic and/or medical diagnostic variables (see Table 2). Of these, seven variables had the requisite number of studies to be appraised in our review. Employment status showed some evidence of a positive moderation of the I-PA relationship (i.e., those who were employed had a larger I-PA association than those not employed) in two studies (58, 59), yet one additional study found no moderation effect (60). There were no apparent differences in study quality or design that could differentiate these results; however, the Rhodes and Lim (60) study featured dog walking, which may be different from the personal PA behaviors estimated in the other studies (58, 59).

There were several studies where researchers investigated ethnicity/race (58, 61-67), gender (58, 60, 64, 67-85), income (60, 64, 72, 85), and body mass index (58, 86-90) and found no evidence of I-PA moderation. Of these variables, only gender had some studies that reported variations from a null effect, with three studies in support of males having a larger I-PA relationship compared to females (91-93), and two studies showing that females had a larger I-PA relationship than males (66, 94). Upon sub-analyses of these studies by design, quality, population sampled, and type of PA, there was nothing to demarcate this variability from the large proportion of studies that showed a null effect (see supplemental Table 3).

Age and education showed mixed effects for I-PA moderation. Specifically for age, studies showed that older participants had larger I-PA relations than younger (86, 94), younger participants had larger I-PA associations than older participants (58, 66, 88, 95), as well as several studies that reported null effects (60, 67, 72, 74, 78, 81, 85). Sub-analyses of these

studies found no evidence that study quality, design, age of sample or type of PA could account for the differences, although it is noteworthy that three (58, 88, 95) of the four studies showing that younger participants had larger I-PA associations than older participants were among cancer survivors. Finally, of the four studies that had evaluated education as a moderator of I-PA, two showed that higher educational attainment was associated with larger I-PA relations (58, 72), while two studies found no effect (60, 85). Sub-analyses by design, type of PA, sample, and study quality could not explain the discrepant findings.

### Personality Variables

Four studies (96-99) supported conscientiousness (i.e., tendency to be responsible, organized, self-disciplined, goal-directed), as a positive moderator (higher conscientiousness, larger I-B relationship) of I-PA relations and one study found no such effect (100). Two studies supported a similar positive moderating relationship for extraversion (i.e., tendency to be sociable, assertive, lively) and I-PA (98, 100), yet two studies also found no moderation effect (96, 101). There were no apparent differences in the study sample (all were undergraduate students), the design, study quality, or measures employed that could explain these deviations. By contrast, three studies (98, 100, 101) found no moderation effect for neuroticism (i.e., tendency to be emotionally unstable and experience negative affect, self-consciousness), while only one study identified an (negative) effect (102); and all three studies that had investigated openness to experience (i.e., tendency to embrace new things, fresh ideas, and novel experiences), and agreeableness (i.e., tendency to be warm, friendly, and tactful) as moderators of I-PA relations found no evidence of an effect (98, 100, 101).

### Physical Capability

Eleven studies (12 independent samples) were designed to explore the I-PA relationship with five different behavioral variables that were indirect indicators of skills or practice (see Table 2). Of these, however, only two variables had the requisite number of studies to be appraised in our review. Specifically, the intensity of PA had no moderating effect on I-PA in two studies (103, 104) but vigorous intensity PA was related to larger I-PA associations than walking and moderate-intensity PA in another study (105). The three studies had similar sampling, measurement, and designs so there was no particular indicator to suggest why the findings might have differed.

The other behavioral variable with sufficient studies to appraise as an I-PA moderator was past PA. Results were mixed with two studies showing support for moderation in a positive direction (106, 107) (i.e., the higher reports of past PA, the larger the I-B relationship) and three studies reporting no moderating effect (71, 85, 108). There were no differences in study design, type of physical activity or study quality among this group of studies to distinguish the mixed findings, yet the three studies reporting null findings had older populations (middle-aged, older adults) than the two studies that reported moderation by past behavior (youth, undergraduate students).

### Psychological Capability

*Behavioral Regulation of Intentions.* Planning to fulfil an intention was investigated as a moderator in of I-PA relations in 18 independent samples across 17 studies. These showed mixed results, with 9 samples (58, 60, 109-114) supporting moderation of higher planning resulting in larger I-PA relations, and nine samples (95, 99, 106, 115-120) with null effects. Fifteen of these studies examined action planning (i.e., detailed planning of performance of PA), of which six samples supported moderation of higher action planning resulting in larger I-PA relations (58,

109-112, 114), while nine samples found null results (95, 99, 106, 115-120). For coping planning (i.e., plans to overcome barriers and/or increasing facilitators), two studies supported moderation of higher planning resulting in larger I-PA relations (112, 113), while two other studies found no moderation (106, 114). Sub-analyses by study population, design, quality, and mode of PA provided no clear indication for the differing results.

Behavioral processes of change (behavioral activities and tactics that individuals engage in to modify PA) showed evidence as a moderator of I-PA relations, while cognitive processes (cognitive and affective experiential processes used to modify PA) did not. Specifically, two (38, 121) of three (122) studies showed positive moderation of behavioral processes (increase in behavioral processes was related to higher I-PA relationship), yet all three of these studies showed no effect for cognitive processes. For the behavioral processes, the population samples and the design may explain the differences in these findings. The two studies that found significant I-PA moderation were samples of community dwelling middle-aged adults with six-month prospective prediction of PA (38, 121), while the null study was comprised of young-adult undergraduate students and employed a cross-sectional design (122).

### Social Opportunity

Our review identified five social opportunity variables across 19 studies (22 samples) that were applied as moderators of the I-PA relationship (see Table 2). Of these, three variables had the requisite number of studies to be appraised. Specifically, the three studies (81, 111, 123) that have investigated social support (i.e., perception of instrumental and emotional aid provided by others to assist in PA) as a moderator of the I-PA relationship have yielded non-significant findings, and a similar outcome was noted for the eight studies with subjective norm (i.e., perceived social pressure to engage in PA) (58, 74, 100, 107, 116, 121, 124, 125). Relatedly,



Godin et al. (126)'s study of moral norms (i.e., perception of moral rules that people ought to follow) contained three samples, all of which showed null moderation effects on the I-PA relationship.

### Environmental Opportunity

We classified nine environmental opportunity variables among 15 studies that have been applied as moderators of the I-PA relationship (see Table 2). Of these, five variables had the requisite number of studies to be appraised. All were constructs of the built environment, and sub-classified using the system outlined by Alfonso (127). Environmental convenience/accessibility (i.e., ease and efficiency of moving from one destination to another) showed mixed evidence of I-PA moderation, with five studies supporting a positive moderation effect (99, 128-131) (i.e., greater convenience, larger I-PA relationship), yet four studies showed no relationship with I-PA (81, 132-134). There were no study population, design, quality, or PA mode differences among these studies that could explain the discrepancies. By contrast, the four studies using an omnibus measure of major aspects of the built environment (85, 117, 135, 136), five studies measuring quality PA infrastructure (e.g., quality of sidewalks, bike lanes) (128, 130, 132-134), and five studies on aesthetics (e.g., pretty scenery, trees, well-kept houses and gardens) (128, 130, 132-134) all showed null findings. Six studies focusing on environmental safety (e.g., perceived crime rate), also had null effects (81, 128, 130, 132-134), where one study (137) identified a negative moderation effect with I-PA (less safety, increased I-PA).

### Reflective Motivation

*Characteristics of Intention.* Three variables featured characteristics of intention and the effect on the I-PA relationship. There was considerable evidence that people who have stable intentions across time are more likely to have a higher I-PA relationship than those who do not

have consistent intentions. Nine studies featuring 10 independent samples (59, 72, 107, 138-143) supported this finding, while three studies found null effects (144-146). Sub-analyses in grouping these 13 studies by design, PA behavior, sample, and study quality did not suggest there was any underlying differences that could explain the three null studies from the 10 studies with significant findings.

Two studies found those scoring higher on intention commitment (determination to hold to one's intention) had larger I-PA relations than people who scored lower (107, 147), while one study did not (143). There were no noteworthy differences among these studies in the population samples (all undergraduate students), the designs (all short prospective designs), and PA measured, but the discrepant study was of lower quality and may have been underpowered to detect differences.

Finally, six samples (58, 114, 122, 145, 148, 149) showed that goal conflict (i.e., when the pursuit of one goal undermines the pursuit of another goal) moderated I-PA relations in a negative direction (i.e., more conflict, lower I-PA relationship), while three samples showed no effect (144, 145, 150). Sub-analyses showed that the studies with significant effects tended to be of higher quality ( $M = 3.67$ ) compared to those with null effects ( $M = 2.67$ ) largely from small and potentially underpowered samples, but there was little overall noteworthy differences by design, population, and no variation in the type of PA assessed.

*Beliefs about Consequences.* Affective attitude (i.e., expectations of whether PA would be enjoyable/pleasant) had four studies (60, 100, 124, 148) supporting positive moderation (higher affective attitude, larger I-PA), while two studies (116, 121) showed null findings. Similarly, anticipated regret (i.e., perception of regret that we may feel in the future, based on current decisions) was found to moderate I-PA relations in a positive direction in four studies

(58, 107, 138, 151), with only one study showing null findings (85). Sub-analyses by design, measures employed, and study quality, did not show deviations that could explain these discrepancies.

By contrast, seven (60, 74, 116, 121, 124, 125, 148) studies showed null effects for instrumental attitude (i.e., expectations that PA would be useful/beneficial) as a moderator of I-PA relations and only one study supported (positive) moderation (100). A similar majority null effect was identified for measures of the pros of physical activity (i.e., perceived positive outcomes from PA participation), with two studies showing null effects (38, 121), and one reporting a significant (positive) moderation of I-PA relations (111). Finally, a majority null effect was also found for measures of the cons of physical activity (i.e., perceived negative outcomes from PA participation), with two studies showing null effects (38, 121) and one reporting a significant (negative) moderation of I-PA relations (111).

*Beliefs about Capability.* Twenty-one studies were designed to explore the I-PA relationship with self-efficacy/perceived behavioral control (i.e., perceived capability to perform PA). These findings favored a positive moderation (higher self-efficacy/control, larger I-PA relationship) but there was considerable variability among the studies. Specifically 13 studies identified this positive moderation on I-PA (38, 58, 100, 111, 116, 121, 124, 147, 148, 152-155), while eight studies had null findings (60, 74, 82, 85, 86, 115, 117, 156). There were no underlying differences in study population, design, analyses, measure (i.e., PBC, self-efficacy, type of PA), or quality that could explain the variability of these findings.

#### Reflexive/Automatic Motivation

PA Identity (i.e. self-categorization of oneself in the role of a physically active person) was investigated as a moderator of I-PA relations in seven studies. Five of these studies

supported (60, 107, 124, 157, 158) a positive moderation (as identity increases, I-PA relations are larger), while two had null effects (159, 160). There were no noteworthy differences among these findings that could be attributed to sampling (six of the samples are undergraduate students), or design, yet both of the studies with null findings had small samples that were likely underpowered to detect an interaction effect (see supplementary Table 3).

Habit (i.e., behavior performed automatically from learned associations with the contextual pairing of cues) showed extremely mixed findings in our analyses of the 14 studies that explored its interaction with the I-PA relationship. Four studies reported a positive relationship (60, 110, 116, 148), seven studies identified a negative relationship (103, 161-166), and three studies showed no relationship (141, 167, 168). Sub-analyses showed no evidence that study design, mode of PA, habit measure, study quality, or population sample could explain these deviations. We did note that all studies that found positive moderation (i.e., higher habit, larger I-PA association) were for samples that specifically investigated profiles of intenders and this relationship with PA; by contrast all of the studies that found negative moderation or null effects used a linear regression approach to moderation analyses.

### **Discussion**

The purpose of this paper was to review and appraise the evidence for moderators of the I-PA relationship, in order to further our theoretical understanding of action control and identify key constructs that might need targeting in intervention. We employed the COM-B (48) approach as a basic organizational framework to categorize our findings within the larger backdrop of sociodemographic and individual difference variables. The results expand upon a prior review (45) by incorporating the large volume of new research on this topic within a

focused lens of how constructs of capability (psychological, physical), opportunity (social, environmental) and motivation (reflective, automatic/reflexive) interact with I-PA relations.

To this end, our review identified 129 studies (and 138 independent samples) that met inclusion criteria. Our analyses revealed 77 different variables that have been tested for moderation of the I-PA relationship, across all categories of the COM-B model. Further, in comparison to the prior review that evaluated 15 variables as moderators of I-PA (45), our analyses appraised 37 variables. The reports collectively represented 59,661 participants from 19 countries in mostly longitudinal designs, of moderate quality. The studies were extremely heterogeneous in their assessments of PA ranging from active transportation, to the number of exercise days/week to leisure time PA, as well as in the age group. Thus, the available sample of studies represents a rich data-set to appraise the state of current evidence.

First, sociodemographic variables that moderate the intention-behavior relationship are very important because they may represent potential population-level socio-structural inequities (169), particularly among those who may desire to engage in a health behavior like PA but cannot realize this goal. Overall, we found that only employment status had convincing evidence as a moderator of I-PA relations, where those who were employed were more likely to have a larger I-PA relationship compared to those who were not employed. This is a new finding when compared to the prior review of I-PA moderators (45), yet the result is difficult to disentangle on its own and so future research may need to explore mediators of this interaction, such as any physical or mental health differences between the samples, among other possibilities. No other sociodemographic (e.g., gender, income, marital status) or health (e.g., BMI) variables moderated I-PA relations in our review, although age and education had mixed evidence. Taken together, there is support for the invariance of I-PA relations by most sociodemographic

variables, which is in-line with the prevailing theory that intentions are a robust predictor of behavior (170, 171).

Personality traits represent enduring background individual differences that are associated with health behaviors such as PA (30). Parallel to the prior review of I-PA moderation (45), we found convincing evidence that those higher in conscientiousness were more likely to follow-through with intentions compared to those low on conscientiousness. Conscientiousness represents a tendency to be ordered, dutiful, self-disciplined, and achievement oriented (172, 173). This disposition likely keeps high conscientiousness individuals from slipping in their original PA goals (174). There was mixed evidence for whether extraversion moderated the I-PA relationship and our findings did not support neuroticism, openness to experience, or agreeableness as moderators. Thus, interventions may need to consider those low in conscientiousness as an ‘at risk’ group for successful action control and attend to additional intervention, yet other personality traits of the five factor model (openness to experience, extraversion, agreeableness and neuroticism) may not be particularly noteworthy to interventions.

Using the COM-B (48) as an organizing framework, capability refers to the physical and psychological ability to enact PA. Our review of PA behavioral skills and characteristics that represent indicators of physical capability resulted in limited evidence to support I-PA moderation. Limited I-PA moderation findings were also available for other behaviors and behavioral characteristics such as sedentary behavior or variation in physical mobility. These generally null findings are congruent with the prior review on I-PA moderators (45) and a related review of physical activity characteristics and behavior change (175). Overall, there is little

evidence at present to suggest that behavioral characteristics of PA, and thus physical capabilities, are important to action control.

Psychological capability refers to the knowledge, attention, and behavioral regulation skills used to enact PA (48). From a theoretical standpoint, behavioral regulation constructs, such as planning, are the hallmark of most action control theories (40), so they should be key moderators of I-PA relations. Implementation intentions (i.e., if-then action planning) in particular, is a construct commonly theorized as a critical connector of the intention-behavior gap in psychology (176, 177). Interestingly, our results found mixed evidence for whether planning moderates the I-PA relationship. The results further substantiate past equivocal findings on the effect of planning as a moderator of I-PA relations in the PA domain (45, 178-180). A recent review by Kompf (180) on implementation intentions and PA, showed that the effectiveness of this form of planning was dependent on strong self-efficacy. Thus, the mixed findings in our review may be a result of a more complicated underlying interaction.

Planning has received support as a mediator of I-PA relationships (42, 178), so that may be the better conceptualization of the intention-planning-PA relationship (41). Still, we did show that the behavioral processes of change, but not the cognitive/experiential processes of change, from the transtheoretical model (181) moderated the I-PA relationship in a positive direction (i.e. higher use of behavioral processes were associated with larger I-PA relations). This suggests that a construct that includes a cluster of behavioral regulation tactics, such as the behavioral processes of change, may best discriminate who translates intention into PA over any single tactic. The finding is congruent with meta-analyses of behavior change techniques and PA interventions, where a cluster of behavioral regulation techniques best discriminate intervention success over any single change technique (182, 183). We recommend further prospective and

experimental research into key clusters of behavioral regulation tactics and their role in the I-PA relationship to elucidate the most effective composition of these techniques.

Opportunity in the COM-B model refers to the social (e.g., social support, social comparison, social pressure) and physical (e.g., context, resources, equipment) environment that enables the behavior (48). From a socioecological theory standpoint, social and environmental opportunities are proposed to interact with factors like intention to determine behavior (184). Interestingly, we showed little evidence that opportunity moderated I-PA relations. Our results showed consistently null effects for social opportunity variables of subjective norm, moral norm, social support, and also limited evidence for the importance of cultural norms, or intergenerational norms. An appraisal of social opportunity variables was not present in the prior review on the moderators of I-PA relations (45), so these findings represent a novel contribution. Social opportunity variables often have weak multivariate associations with PA more generally (26, 185), and it appears this is also the case when investigating their potential role in I-PA moderation. While some additional social variables (e.g., social networks, social identity) may be worthy of study, the current evidence shows that intervention upon these variables is unlikely to improve I-PA relations.

Our analyses of environmental opportunity showed similar null findings to the social opportunity variables. An aggregate built environment variable, safety, infrastructure quality, aesthetics, and limited analyses of weather did not support I-PA moderation. The only exception was environmental convenience/accessibility, where some studies showed evidence of positive moderation (increased accessibility, larger I-PA relationship), particularly those with greater testing power (i.e., larger sample sizes), compared to other studies that showed no moderation effect. This variable was identified as a moderator of the I-PA relationship in the prior review



(45) and in a recent review focused on interactions between the built environment and PA social cognition (55). Overall, however, there appears there are few interactions between the built and natural environment and the I-PA relationship so further testing and applied interventions in action control may have limited utility.

COM-B organizes motivation into reflective (e.g., beliefs about capability and consequences) or automatic (e.g., affective valuations, habits, incentives) mechanisms that activate or inhibit behavior (48). Both categories of motivation had variables with evidence of I-PA moderation. Intention itself is a proximal indicator of reflective motivation (186), yet conceptual (27, 35) and empirical (45) reviews of the I-PA relationship have suggested that characteristics of intention itself are key moderators of I-PA relations. Our review supported this premise by showing that increases in intention stability (participants who respond with intention scores of similar magnitude across time) and intention commitment, and low goal conflict are reliable moderators of larger I-PA associations. Intention stability is likely a marker of several characteristics of an intention, including its strength (143) and may be the grand mediator of most I-PA moderators (107). Like intention stability, low goal conflict is likely a characteristic of the focus of the intention (187), which was supported by recent work by Conner and colleagues (145) showing goal conflict is likely a consequence of goal priority. Of course, it is still important to understand the underlying causes of intention stability, commitment, and priority to inform interventions and develop action control theories, and the other moderators identified in this review serve this purpose.

Reflective motivation variables, such as attitude and perceived behavioral control, are generally considered the antecedents of intention formation (186, 188), but they have also been examined as potential moderators of I-PA relations. There was convincing evidence that

affective judgment variables (i.e., social cognitive variables that involved thoughts about feelings), specifically affective attitude and anticipated regret, moderated the I-PA relationship. By contrast, instrumental judgments (outcome expectations, instrumental attitude, pros and cons) did not moderate I-PA relations. These variables were not included in the prior I-PA moderator review so these are novel findings (45), but the results support prior theorizing on how affective judgments may influence action control (189). Specifically, Rhodes and Gray (189) suggest affective judgments primarily serve as moderators of intention-behavior relations by creating more stable initial intentions over time. The applied aspects of this finding highlight the importance of maximizing the enjoyment and pleasure of PA in interventions as well as valuing the consequences of inaction (i.e., to induce regret) to potentially improve action control (190).

Our review also found that those with higher self-efficacy/perceived behavioral control reported a larger I-PA relationship, albeit with some studies that showed null findings. Self-efficacy (191) and perceived behavioral control (192) are related constructs that focus on one's perceived capability/ability to execute regular PA. Interestingly, Ajzen (193) originally postulated that higher perceived control would improve the translation of intention into behavior compared to lower control, to the extent that perceived control approximated actual control. The findings of our review generally support this theorizing and highlight that perceived control/self-efficacy is not only the most important antecedent of intention (26), but may also be important to the follow-through of intentions into PA. Continuing to improve PA interventions that focus on assisting participants with perceived behavioral control/ self-efficacy are recommended (194).

The specific consideration of automatic/reflexive motivation factors is a strength of using the COM-B model as a framework because these variables have seen considerable attention in the psychology of physical activity over the last decade (15). Our review contained

enough studies to appraise two reflexive (i.e., constructs purported to determine behavior via triggered cues) constructs. First, the habit construct showed considerably mixed results. This is commensurate with prior reviews (45, 195, 196). Habit theory has traditionally positioned habit as a negative moderator (i.e., as habit increases, the I-PA relationship becomes smaller) of I-PA relations, but this position is changing (195). Rebar et al. (37) have demonstrated that the habit findings from regressions that result in negative moderation of PA are likely an artefact of collinearity. This helps with our interpretation of these mixed findings, because we noted that all of the habit studies with positive moderation of I-PA were analyzed using profiles of I-PA, where intention was dichotomized by its decisional direction. By contrast, all studies where habit was a moderator of I-PA in a negative direction used linear regression approaches. The notion that a strong habit assists in the follow-through of positive intentions is congruent with both the multi-process action control approach (34) and temporal self-regulation theory (in which habit is referred to as behavioral prepotency;197). Future studies should be mindful of collinearity in the habit-intention-PA relationship and follow procedures accordingly (37).

In contrast to the diverse findings of habit, identity was a convincing moderator of the I-PA relationship in a positive direction (i.e., higher identity, larger I-PA relationship). Physical activity identity was not appraised in the prior review on moderators of the I-PA relationship (45), but our finding is commensurate with a prior review on the identity construct in the PA domain (198). The results are correspondent with identity theory (199) as well as certain action control theories (34, 200-202). From a theoretical perspective, the moderation effect is likely a selection bias toward choosing identity-based behaviors, where those with a PA identity are attuned to seize opportunities to be active and thus fulfil their intentions (203). For example, in the Maintain IT model of identity (202) and the multi-process action control approach (34), both

sets of authors suggest that a strong identity will assist in a reflexive self-regulating system of behavioral maintenance, that helps alleviate the burden of ongoing conscious self-regulated action. Given the support for identity as a moderator of I-PA relations in this review, we recommend sustained research on PA identity change.

Despite notable findings in this review, there are additional limitations to our evidence base at present. First, the available studies are primarily samples of adults. We noted no differences between adult and youth samples in our analyses but future research testing I-PA interactions should continue with youth samples in particular to provide evidence that is more conclusive. Second, our review focused on the available literature of factors that have been tested for interactions with intention and PA. This represented a large scope (77 possible moderators), yet there are notable limitations in some areas of testing. For example, several theoretical approaches have suggested that the affective response to PA may have a critical role in how cognitions such as intention and behavior relate to each other (19, 189, 204), yet this (and other more implicit measures) has seen limited testing (123, 205) and thus requires more study. Discrepancies in how moderators are operationalized, may also affect the findings (e.g., a continuous measure of educational attainment vs. a dichotomous college degree/no college degree variable) so sustained research examining different forms of conceptualization would be helpful to ensure measurement is not affecting the results of I-PA interaction tests.

There were also some limitations of the review methods. This literature review is limited by the search terms and search engines employed as well as studies in English. Furthermore, our reviewed literature is limited to published work and theses, which has strengths in the base level of quality that accompanies the peer review or thesis defense process and the reliability of search access on the topic, yet is limited because of the potential positivity bias/aversion to the null that

results from the peer-review system (206). Finally, our analysis methods were also biased toward flagging interaction effects around statistically significant findings. We believe this is an appropriate assessment of the current heterogeneous analyses and frequent lack of effect size reporting (because I-PA moderation analyses are often secondary or tertiary analyses) in this literature, but statistical significance may not be equivalent with clinical significance and sample size is certainly a potential biasing factor that we pointed out in our results. Future work in this area should include the regular reporting of effect sizes of these interactions as a matter of transparency for readers.

In conclusion, our review appraised 129 studies, representing 77 different potential moderators of the I-PA relationship. The I-PA relationship was invariant of most sociodemographic factors, but the personality trait of conscientiousness was a robust underlying individual difference that predicted those who followed through on their PA intentions compared to those who did not. Using Com-B as an organizing framework, we further showed that social and environmental opportunity had little evidence as moderators of the I-PA relationship, suggestive that few of these types of factors hold utility in action control theories or intervention on the I-PA relationship. Similarly, physical capability did not show evidence of interacting with I-PA relations, while psychological capability had generally mixed or inconclusive findings at present. By contrast, some key factors underlying reflective (intention stability, intention commitment, low goal conflict, affective attitude, anticipated regret, perceived behavioral control/self-efficacy) and automatic/reflexive (identity) motivation may hold the most promise as moderators of I-PA relations. These factors may help assist in the refinement of PA action control theories and practical interventions to lessen the infamous “I-PA gap”.

#### Figure Captions

Figure 1 PRISMA flow chart of study retrieval and selection

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*Table 1. Overall study characteristics*

Characteristic	Number of studies	Percentages
Total sample size (N = 59,661)		
<b>Location</b>		
Canada	46	33.33%
United States	30	21.73%
United Kingdom	21	15.21%
Netherlands	12	8.69%
Australia	11	7.97%
China	8	5.79%
Others (Iran, Switzerland, Malaysia, Japan, France, Estonia, Greece, Hungary, Singapore, Germany, Austria, Lebanon, and Norway)	10	7.24%
<b>Study design</b>		
Longitudinal	109	78.98%
Cross-sectional	29	21.01%
<b>Age</b>		
Children (0-12 yrs.)	3	2.17%
Adolescents (13-17 yrs.)	10	7.24%
Adults (18-59 yrs.)	109	78.98%
Older adults (60+ yrs.)	6	4.34%
Mixed	10	7.24%
<b>Gender</b>		
Mixed	129	93.47%
All female	6	4.34%
Not reported	3	2.17%
<b>Theoretical framework</b>		
TPB	114	82.60%
M-PAC	2	1.44%
HAPA	2	1.44%
TRA	1	0.72%
PMT	1	0.72%
TTM	1	0.72%
SCT	1	0.72%
Multiple Frameworks	13	9.41%
Not reported	3	2.17%
<b>Physical activity measures</b>		
# of Exercise days/week	31	22.46%
GLTEQ	26	18.84%
IPAQ	13	9.42%
Custom-made for the study	12	8.69%
LSI of GLTEQ	9	6.52%
LTEQ	6	4.34%

PAQ-C	6	4.34%
Accelerometry	6	4.34%
SQUASH	3	2.17%
Pedometry	2	1.44%
Attendance	2	1.44%
CHAMPS	2	1.44%
Whether/not exercising regularly	2	1.44%
Other	18	13.04%
<b>Risk of bias assessment</b>		
High quality	35	25.36%
Moderate quality	93	67.39
Low quality	10	7.24%

*Note.* CHAMPS, Community Health Activities Model Program for Seniors; GLTEQ, Godin Leisure-Time Exercise Questionnaire; HAPA, Health Action Process Approach; IPAQ, International Physical Activity Questionnaire; LSI of GLTEQ, Leisure Score Index of Godin Leisure-Time Exercise Questionnaire; LTEQ, Leisure Time Exercise Questionnaire; M-PAC, Multi-Process Action Control Approach; PAQ-C, Physical Activity Questionnaire for Older Children; PMT, Protection Motivation Theory; SCT, Social Cognitive Theory; SQUASH, Short Questionnaire to ASsess Health enhancing physical activity; TPB, The Theory of Planned Behavior; TRA, The Theory of Reasoned Action; TTM, Transtheoretical Model.

Table 2. Common Themes of Moderator Variables of the Intention-Behavior Relationship.

Correlate	Moderators with a Positive Association	Moderators with a Negative Association	Moderators with No Association	Overall Association
<b>Demographic Variables</b>				
Age	[1, 2]	[3-6]	[7-13]	?
Adjuvant Cancer Therapy			[4]	NA
Gender (1 = Female, 2 = Male)	[14-16]	[2, 5]	[6-13, 17-30]	0
Months Since Cancer Diagnosis			[3]	NA
Race/Ethnicity (1 = Minority, 2=White)	[19]		[5, 6, 12, 21, 31-34]	0
Material Deprivation	[1]		[7]	NA
Income	[10]		[7, 11, 13, 21]	0
Social Deprivation			[7]	NA
Education	[6, 7]		[11, 13]	?
Cancer Treatment (1=Treat, 2=No Treat)			[3, 6]	NA
Presence of a Dependent Child			[6, 26]	NA
Diabetes (Type 1, Type 2)			[35]	NA
Cancer Type			[6]	NA
Mental Health			[10]	NA
BMI			[1, 3, 6, 36-38]	0
Comorbidities	[6]		[39]	NA
Physical Health	[6]		[10]	NA
Employment Status	[6, 40]		[11]	+
Marital Status			[6]	NA
<b>Personality Variables</b>				
Conscientiousness	[41-44]		[45]	+
Extraversion	[43, 45]		[41, 46]	?
Neuroticism		[47]	[43, 45, 46]	0
Openness to Experience			[43, 45, 46]	0
Agreeableness			[43, 45, 46]	0
Honesty			[46]	NA
Mental Toughness			[48]	NA
<b>Physical Capability</b>				
Competitiveness of the Physical Activity	[49]			NA
Intensity of Physical activity (1=MPA/walking, 2= VPA)	[50]		[51, 52]	0

Sedentary Behaviors		[53]	NA
Past Physical Activity	[54, 55]	[13, 20, 56]	?
Mobility		[17]	NA
<b>Psychological Capability</b>			
Planning (amalgam)	[11]		NA
Action Planning	[6, 57-61]	[4, 44, 54, 62-67]	?
Coping Planning	[60, 68]	[54, 61]	?
Behavioral Processes	[69, 70]	[71]	+
Cognitive Processes		[69-71]	0
Mindfulness	[72]	[73]	NA
Action Orientation		[74]	NA
Fatigue		[75]	NA
Ego Depletion		[76]	NA
Executive Function	[77]		NA
<b>Social Opportunity</b>			
Social Support		[10, 59, 75]	0
Moral Norm		[78]	0
Intergenerational Intentions		[79]	NA
Cultural Norms		[24, 80]	NA
Subjective Norm		[6, 8, 45, 55, 63, 70, 81, 82]	0
<b>Environmental Opportunity</b>			
Built environment (omnibus measure)		[13, 64, 83, 84]	0
Convenience	[44, 85-88]	[10, 89-91]	?
Quality		[85, 87, 89-91]	0
Safety		[10, 85, 87, 89-91]	0
Aesthetics		[85, 87, 89-91]	0
Travel Distance (1 = Remote, 2= Close)		[2]	NA
Weather		[10, 93]	NA
Indoor		[75]	NA
Time of Day		[75]	NA
<b>Reflective Motivation</b>			
Intention Stability	[7, 40, 55, 94-99]	[100-102]	+
Intention Commitment	[55, 103]	[99]	+
Goal Conflict		[6, 61, 71, 101, 104, 105]	-
Goal Facilitation		[100, 101, 106]	
Goal priority	[101]	[61, 107]	NA
Intention accessibility		[99]	NA
Attitude	[6]		NA

Affective Attitude	[11, 45, 81, 104]		[63, 70]	+
Anticipated Regret	[6, 55, 94, 108]		[13]	+
Instrumental Attitude	[45]		[8, 11, 63, 70, 81, 82, 104]	0
Risk Perceptions			[70]	NA
Pros of Physical Activity	[59]		[69, 70]	0
Cons of Physical Activity		[59]	[69, 70]	0
Perceived Behavioral Control/self-efficacy	[6, 45, 59, 63, 69, 70, 81, 103, 104, 109-112]		[1, 8, 11, 13, 28, 62, 64, 113]	+
Motivational coherence	[114]			NA
Autonomous motivation			[115, 116]	NA
Controlled motivation			[115]	NA
<b>Reflexive/Automatic Motivation</b>				
Identity/Schema	[11, 55, 81, 117, 118]		[119, 120]	+
Habit	[11, 58, 63, 104]	[51, 121-126]	[97, 127, 128]	?
Positive Affect (in-task)	[75]		[129]	NA
Negative Affect (in-task)	[129]		[75]	NA
Positive Affect (post-task)			[129]	NA
Negative affect (post-task)	[129]	[59]		NA

Note: At least three studies were required for a theme and an estimate of effect. + = positive association (>59% of studies), - = negative association (>59% of studies), ? = indeterminate (34-59% of studies showing an association) and 0 = no association (<34% of studies showing any association).

Please see Supplementary Table 4 for the corresponding references.

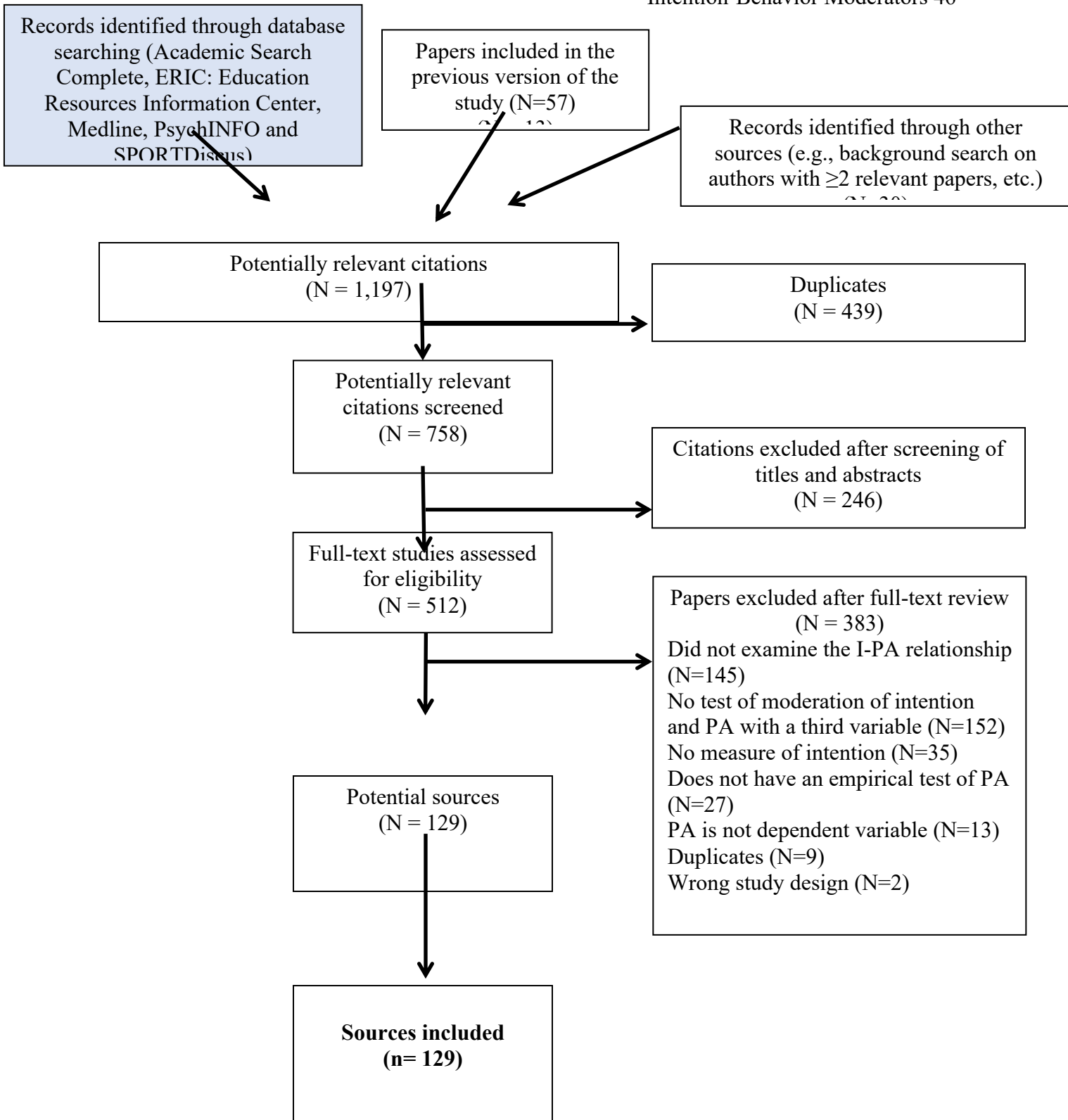


Figure 1. Source inclusion process. Adapted from PRISMA Statement, Moher et al., 2009