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Comparative Analysis Between Physical Activity Affect and Discrete Emotions in College Students

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Abstract

Objective: The purpose of this study was to investigate empirical distinctness and overlap between physical activity (PA) affect and emotions as well as potential unique relationships with PA beliefs and behaviors. Specifically, researchers wanted to explore the level of shared variance amongst discrete emotions and affect, which in effect tested the jingle-jangle fallacy that can be present in psychometric evaluation of related constructs.

Participants: College students (*N*=519; *M*age= 20.47) enrolled in PA courses at two universities in the Southeastern United States completed questionnaires concerning their PA related emotions, affect, self-efficacy, and self-reported PA.

Methods: Confirmatory factor analysis and structural modeling were used to evaluate factor structure and hypothesized relationships.

Results: Sound factor analysis was identified with affect related to several emotions, including strong correlations between enjoyment and positive affect, suggesting some construct and measurement intersection. Regression results showed emotions produced stronger relationships with self-efficacy and PA compared to affect.

Conclusions: While conceptual overlap did exist, measuring several discrete emotions over the dichotomous affective measure may be more insightful and provide specificity in explaining PA decisions. More research is needed on the use of PA emotions.

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Introduction

Despite the known health benefits of physical activity (PA), including the physical, psychological, and social aspects related to the health-related quality of life (United States Department of Health and Human Services, 2018), college students experience a disproportionate decline in PA behaviors as they transition into adulthood (Deforche et al., 2015; Kwan et al., 2012). In fact, recent reports found that less than 50% of college and university students in the U.S. meet PA recommended guidelines (American College Health Association, 2020). This is particularly concerning given the impact that the lifestyle choices that young adults develop can have on their lifelong health (Crozier et al., 2015; Loprinzi et al., 2018). One common approach used to explore this decline has focused on understanding one's motivation to engage in healthy lifestyle choices. Specifically, investigators have explored how subjective experiences relate to PA thoughts, behaviors, perceived efficacy, and affective feelings (Ekkekakis & Brand, 2019; Farren et al., 2017). Research typically shows that positive affect leads to increased PA intentions and greater behavioral adherence (Biddle et al., 2003). In addition, positive affect is also associated with increased intrinsic motivation (Teixeira et al., 2018), engagement (Aelterman et al., 2012), and mastery-oriented climates in PA and physical education (PE) settings (Barkoukis et al., 2012; Biddle et al., 2003).

A dualistic approach to understanding PA and PE related affect has traditionally been viewed as general pleasantness/unpleasantness, or positive and negative affect, felt by an individual toward the task and context (Teixeira et al., 2018; Thompson, 2007; Watson et al., 1988), in this case related to PA behaviors. The taxonomy of individual affect beliefs has grown to be more complex including sub-concepts like anticipatory, within, and post behavior affect (categorized as affect proper) as well as affective processing (automatic and reflective affective beliefs (Williams et al., 2018). In addition, reflective and reflexive views of affect have become more prominent in both explaining how behaviors may impact affect and how affective experience will impact behavior (Ekkekakis & Brand, 2019). However, some researchers suggest that measuring discrete emotions in lieu of the forms of affect (Ekkaekakis, 2013), which is often measured in a binary and/or global fashion, may provide more nuance when exploring PA motivation and PA-related behavior for lifelong health (Garn et al., 2017; Garn & Simonton, 2020). Specifically, Ekkekakis (2013) provided a thorough description on the issues and misconceptions of using affect and emotion conceptualizations interchangeably when exploring PA and other health related behaviors. While it is inherent that emotional experiences are embedded within affective proper and processing concepts, and that positive and negative affective dimensions are present within all emotions, the distinction of discrete emotions may provide subtle information that explains individual motivation and behavior not distinguished by current taxonomies of affect (Ekkekakis, 2013; Mouratidis et al., 2009). However, this distinction has not been explored although there may be significant ramifications in understanding PA related behaviors and beliefs impacted by affect and discrete emotions.

The concept of affect has widely been accepted in research to expand in assisting with our understanding of intention, behavior, and in being both a predictor of behavior and result of behavior (Williams et al., 2018). However, there have been several conceptual and theoretical limitations identified in using affect to explain all cognitive and psychosocial feelings that help in dictating motivation and engagement (Mouratdis et al., 2009; Pekrun, 2006; Ekkekakis, 2013). In this paper, it is argued that it is necessary to explore the potential overlap and distinctness of PA related affect and discrete emotions in relation to the jingle-jangle fallacy (Kelley, 1972; Marsh, 1994), as researchers tend to relay on preferred measures without regard to testing whether or not measures are similar or different (Marsh et al., 2019). The jingle-jangle fallacies (Kelley, 1927) suggest that (a) two measurements scales conceptualized to be similar might in fact measure different constructs (jingle fallacy), and (b) while two measurements scales that are suggested as distinct might in fact measure similar constructs (jangle fallacy). In similar studies exploring distinction between task/performance orientation scales, researchers found underlying common factors, with only one dissimilar item area, although these scales were conceptual described as distinct (Marsh, 1994). In research about other self-belief related measures, Marsh and colleagues (2019) explore differences between self-concept and self-efficacy, which are two constructs often used interchangeably, although they are conceptually different. Results showed that while these concepts overlap, there are clear distinctions when they are conceptualized accurately, and they measure two separate ideologies in self-beliefs (internally/externally referenced; prospective vs. retrospective accuracy; social vs. personal comparison). Authors in these studies, and others, conclude that labels of constructs may not be sufficient in stating how constructs relate to one another, care needs to be pursued in asserting proper constructs are being measured and disguised within other variables, and there are likely measurement problems throughout psychometric evaluation in describing conceptually similar measures that are then operationalized to fit the research projects agenda, leaving interpretation up to readers (Marsh, 1994; Marsh et al., 2018; Pajares, 2009).

Common approaches to exploring PA affect include measuring positive and negative beliefs towards PA behaviors, which has been frequently accepted yet provides less specificity and nuance on motivational profiles of the participants. Many affective approaches hold several major assumptions including the binary evaluation of one's feelings towards PA and the focus on activating affect states without regard to deactivating states. For example, negative affect may encompass an all-around average score of several discrete emotions such as anxiety, shame, anger, and boredom, yet these emotions typically result in distinct behaviors/reactions and are related to unique cognitive appraisals of the task/event. In short, individuals who experience anxiety often report extrinsic motivation and cautious approach behaviors while boredom generally leads to the amotivation and avoidance behaviors (Ryan & Deci, 2020). Yet these two emotions are often indistinguishable when evaluating negative affect. Similarly, negative emotions like anxiety or anger may be connected to PA behavior and while both are negative and share similar arousal levels, the specific cognitive appraisals that influence these emotions and reactions to them are quite different.

Thus, current measures of affect may omit essential activation tendencies that discrete emotions capture (Garn et al., 2017; Simonton, 2021) for explaining PA behavior. Differences between affect and emotions have been identified in educational psychology (Pekrun et al., 2009), PE literature (Mouratidis et al., 2009; Simonton & Garn, 2019), and other PA arenas (Ekkekakis, 2013; Hogan et al., 2015; Garn et al., 2017; Simonton, 2021) however, these terms are often used interchangeably. Thus, the importance of this exploration is twofold in that taking

deliberate steps to understand potential differences/similarities between affect and emotion is critical for measurement accuracy and secondly, if distinctions are identified then this may impact how researchers understand affect/emotions impact on broader PA related behaviors and beliefs. Therefore, this study investigated potential distinctness and overlap of PA affect and discrete emotions as well as their relationships with PA motivation and PA behavior. Specifically, although measuring and distinguishing affect and emotion is quite difficult, there may be theoretical and practical advantages for taking a nuanced approach provided by discrete emotions, as opposed to measures of affect, when it comes to understanding PA related beliefs and behaviors.

PA Affect and Related Outcomes

Affect, a broader concept than emotion, refers to the "neurophysiological state consciously accessible as a simple primitive non-reflective feeling most evident in mood and emotion but always available to consciousness" (Russell & Feldman-Barrett, 2009, p. 104) and includes the range of possible feelings from pleasure to displeasure. Affect combines emotions of single valance with primarily activating levels of arousal such as excitement, alertness, and feeling inspired for positive affect and nervousness, feeling upset, and hostile for negative affect. As conceptualized by Stevens et al. (2022) and Williams and colleagues (2018) affect can be categorized and organized by the Affect and Health Behavior Framework (AHBF) including affective responses (how one feels after behavior), incidental affect (how one feels through the day, unrelated to behavior), affective processing (associations, attitudes, remembered/anticipated affect, and affect judgments), and affectively charged states (motivation, fear).

As previously mentioned, positive PA affect are associated with increases in PA participation, typically as a result of increases in pleasure and in engagement (Ekkekakis & Brand, 2019). There is also evidence that the rise in positive affect increases in exercise motivation including self-efficacy and basic psychological need satisfaction (Teixeira et al., 2018). On the other hand, negative affect refers to the “general dimension of subjective distress and unpleasurable engagement” (Watson et al., 1988, p. 1063) and includes anger and calmness at its bipolar ends. Negative affect has been associated with adopting goals that are externally referenced and uncontrollable (Mouratidis et al., 2009) and higher levels of perceived stress (Watson et al., 1988). Additionally, Leone and colleagues (2005) determined that negative affect experienced during exercise could lead to future exercise avoidance. However, as pointed out by Ekkekakis and Petruzzello (2002), the spectrum of positive affect dimensions reflects pleasant states at the highest level and unpleasant states at the lowest levels. Additionally, the negative affect spectrum includes unpleasant and high activation at the highest levels yet more pleasant states and less activation at the lowest level. The assumptions are that as one level raises the other lowers and that the two dimensions are orthogonal, which is problematic for measurement and theory (Ekkakais, 2013). In recent research, it has been suggested the different affective constructs may show promise for different health related behaviors under investigation and that PA affect may assist in the intention to behavior gap currently identified in the literature (Stevens et al., 2022). The first two categories within the AHBF are commonly referred to as core affect, or what has been commonly understood as affect, per se. While the cognitive and motivational charged concepts of affect have received less attention, they help distinguish between beliefs about affect and in affect related to physiological states. The focus of this study is grounded in the rotated circumplex model of affect as defined by Watson and Tellgen (1985) and later further by Russell and Feldman-Barrett (2009) as the measurement of affect begins to expand, it may be

limited when it comes to specificity in behavior, particularly within an individual, in which positive and negative feelings may limit exploration, even when parceled by the components within AHBF.

Grounded in the circumplex model, the assessment of affect has predominantly utilized the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988), which is often used as the exercise-specific measures of affect, yet this measure has been criticized for the lack of theoretical grounding (Ekkekakis, 2012, 2013). For example, the PANAS only assesses affect of high activation, while it is well-known that low-activation affect is possible in exercise settings (Ekkekakis, 2012). Another concern with the measurement of affect is the idiosyncrasies of each tool. Since every inventory item is uniquely different, this makes it difficult to generalize findings among measurement instruments. Additionally, the selection of an inventory is often justified only by mentioning that these methods have "previously been used before" (Ekkekakis, 2013; Ekkekakis & Brand, 2019). Lastly, affect as a generalizable state may lack specificity and connection to specific tasks or domains (Pekrun, 2006) yet, it is often measured in relation to specific tasks, domains, or behaviors. For example, Pekrun (2006) suggests difficulty in categorizing affective states due to not having a clear focus and those which may be more or less intense, and, more or less focused. Thus, the dichotomous viewpoint of defining affect and general inability to be task and domain specific is limiting compared to a multi-dimensional and specific approach (Ekkekakis & Brand, 2019). Overall, the binary nature of measuring affect seems to be limiting as, with many facets of human life, the array of choices is multifaceted as opposed to being, one or the other. The nuance of ones' feelings is likely more informative when conceptualized in a specified manner as provided by discrete emotions. However, discrete emotions also provide challenges when it comes to psychometric measurement.

Conceptualizing and Measuring PA Emotions

To highlight the distinguishability of emotion from affect, an emotion-centric theoretical framework was used to ground this study called the Control-Value Theory (CVT; Pekrun, 2006). Within CVT, emotions are conceptualized as an affect-related measure that provides specificity to understanding subjective experiences due to their unique attributions and action tendencies (Fredrickson, 2001; Pekrun, 2006). Specifically, key differences identified between emotions and affect that are founded withing the CVTAE include that emotions are experienced in shorter durations (e.g., specific moments in time), they are typically more intense in their magnitude and impact and are tied to a distinct set of cognitive appraisals (Ekkekakis, 2013; Pekrun, 2006). In opposition, the conceptualization and measurement of affect has been suggested as a global, less intense, long-term feeling that can have non-cognitive and non-reflective characteristics (Russell & Feldman-Barrett, 2009).

Grounded in CVT (Pekrun, 2006), emotions are defined as a multi-dimensional feeling connected to a task or domain that results in psychological and physiological reactions which impact one's motivation, expression, thoughts, and behaviors (Shuman & Scherer, 2015). Within CVT, a taxonomy of discrete emotions is suggested as a result of specific control-value beliefs that one has in response to their experience within a specific domain/task/event. These judgements facilitate specific emotions. Thus, the emotions then mediate the relationships between the environment/event one experiences and the resulting outcome behaviors/actions/achievements. Emotions are categorized, by basic valence (positive and negative), in addition to their physiological activation levels (i.e., activating or deactivating) and object focus (i.e., in-activity; outcome-related). One of the most significant determinants in

defining and conceptualizing emotion is that each emotion is uniquely tied to a specific domains/task (Ekkekekis, 2012; Pekrun, 2006). In other words, individuals will feel unique emotions for different experiences as opposed to having generalized emotional states as a result of a personality trait, for instance. This is suggested as one of the major advantages of conceptualizing and measuring emotions, for its specificity, intensity/spectrum of activation, and unique and distinct action tendencies that allow researchers to distinguish one's experience (Fredrickson, 2001; Pekrun, 2006). In this sense, one's motivation works in conjunction and is explained through her or his emotions. Lastly, a practical perspective worth noting is that individuals utilize emotions to interpret, explain, and understand their experience as common language (Pekrun, 2006; Simonton et al., 2021).

Some emotions that have received attention regarding PA or PA-related experiences include enjoyment and boredom (Barkoukis et al., 2010; Simonton, 2021; Yli-Piipari et al., 2013). Enjoyment is considered a positive and activating emotion that happens within an activity with little to no emphasis on outcomes or performance (Pekrun, 2006). Similar to positive affect, enjoyment is associated with intrinsic levels of motivation (Ryan & Deci, 2020), mastery orientations, PA self-efficacy, and increased PA behaviors (Barkoukis et al., 2010; Dishman et al., 2005; Yli-Piipari et al., 2013). In motivational opposition, boredom represents a negative and deactivating emotion which is associated with having little to no situational interest (i.e., activity appeal sparking arousal) in the task/activity (Ntoumanis et al., 2004). Boredom has been found to be representative of amotivation (Ryan & Deci, 2020), less engaged individuals (Garn et al., 2017), as well as being predictive of low levels of PA behavior (Yli-Piipari et al., 2009). In order to further distinguish and go beyond positive and negative affect (Mouratidis et al., 2009), researchers suggest other related but distinct emotions should also be considered within any investigation to enhance our ability to capture a greater variety of experiences (Simonton, 2021). As captured above, the composite view of affect may collapse several unique positive and negative emotions with varying motivational tendences into one explanation providing limited induvial nuance that discrete emotions may capture and have been shown empirically in the research (Mouratidis et al., 2009). Thus, other emotions that deserve strong consideration and that are included in this study, but have received less attention in the literature, include relief and anger.

Relief is a positive deactivating emotion that has strong links to avoidance forms of motivation (Mouratidis et al., 2009; Pekrun, 2006). In other words, individuals are motivated extrinsically to complete tasks as a way to avoid consequences. Although these individuals pursue goals/behaviors and often succeed at a minimal level, their emotional and psychological state to pursue the activity are not likely to be sustained over time and may lead to strongly held negative beliefs long term (Ryan & Deci, 2020). The motivational tendencies connected to relief align importantly which a common phenomenon in PA and exercise behaviors that are prompted in short bursts of motivation (i.e., for 6 months in a row of regular exercise) and then extreme reductions in behavior and eventually intention (Teixeira et al., 2018). Those pursuing PA and feeling relief on a consistent basis will likely not show continuation of PA in habitual form, which is an underserved area of needed research. Anger, which would more likely be related to negative affect as its defined, is considered a negative and activating emotion that is linked to extrinsic forms of motivation and aggressive/disruptive behavior (Pekrun et al., 2002; Simonton & Garn, 2020). Additionally, anger can result from misalignment between individuals' goals/values and the reality of one's experience. Although individuals may feel competent to engage in a goal pursuit, they often attribute lack of success to external causes such as bad luck

or environmental barriers (Mouratadis et al., 2009; Pekrun, 2006). The common form of anger expressed in PA and PE is that of frustration (considered a more socially acceptable term; Linnenbrink-Garcia et al., 2016; Simonton & Garn, 2020), which leads reduced perceived competence and is viewed as a psychological barrier for PA engagement (Gil-Piriz et al., 2021).

One important note offered when measuring a spectrum of distinct emotions such as this, is the ability to decipher both a wide range of motivation as well as action outcomes not distinguished by affective measures (Simonton, 2021). In other words, emotions capture both one's motivation (i.e., beliefs of competence, drive, and directional pursuit) and explain the coordinated physical and psychological feedback that enact behavior and thought (Linnenbrink-Garcia et al., 2016). Overall, the four emotions included in this study represent a spectrum of motivational responses including both positive and negative valence, high and low activation, and intrinsic, extrinsic, and amotivated action tendencies. Lastly, the conceptual and psychometric measurement of discrete emotions is still evolving and while other emotions may still need consideration, the emotion measures is the current study are currently more established, providing more confidence in interpreting results at this time.

Purpose

The purpose of this study was to explore the potential overlap and distinctness between PA affect and emotions in college-aged students, in addition to investigating the participants' perceived efficacy to engage in PA and their current PA behaviors. Specifically, researchers wanted to explore the level of shared variance amongst discrete emotions and affect. In addition, we examined how affect compared to discrete emotions related to self-efficacy and self-reported PA behaviors. Considerations for balancing ease of measurement and nuance captured between the affective and emotion variables is discussed as well. The following research questions (RQ) guided this study:

RQ1: How much overlap exists between PA affect and PA emotions (enjoyment, boredom, anger, and relief)?

RQ2: To what degree are PA affect and PA emotions (enjoyment, boredom, anger, and relief) unique predictors of PA efficacy and self-reported PA behaviors.

Method

Participants and Settings

College students (*N*= 519) from two universities in the Southeastern United States volunteered to participate in the study. Participants were 63% male and reported mean age was 20.47 (SD= 2.19). All participants were enrolled in university PA courses at their respective universities in which students were required to attend regularly and complete basic physical skills test and cognitive evaluations on the sport/activity. Approximately 20 class sections were recruited to participate ranging in content from classes on tennis, jogging, weight training, golf, Tai Chi/martial arts, aerobic dance, and swimming. Students reported year in school included seniors (34%), juniors (27%), sophomores (20%), and freshman (18%). Additionally, the majority of students were white/Caucasian (59%), followed by Latino/Hispanic/Latin-American (17%), Black/African American (15%), multi-racial (5%), and four groups at 1% each.

Procedures

Initially, Institutional Review Board (IRB) approval was obtained to conduct the study at the respective universities. Next, researchers recruited university PA-course instructors via email and provided a summary of the study procedures and purpose. Researchers then scheduled two visits to each class for all instructors who agreed to participate. The first meeting consisted of distributing consent forms and explaining the study to students, followed by a second visit during the next class session to collect forms and administer the survey. During data collection students were reminded to not put their names on the survey and that their information was to remain completely anonymous. Also, participants were reminded there were no incorrect answers, and they had the option to stop the survey at any time without penalty.

Measures

PA-related emotions. Students perceptions of enjoyment, boredom, anger, and relief as it relates to participating in PA were collected using a modified version of the Discrete Emotions in Physical Education Scale (Simonton et al., 2021). Participants were prompted for these emotion items and the other affect and behavioral items with, "Physical Activity relates to the leisure time and/or recreational activity you engage in that includes exercises or movements you do that increase your heart rate for extended periods of time. These may include biking, running, playing sport, and or doing activities at home." Instead of directing emotion items targeting PE specifically, students were asked to reflect on their emotions specific to PA-behavior that they chose to engage in. Example items for the emotions include, enjoyment, "I enjoy being physically activity", boredom "I get bored during physical activity", anger, "I feel frustrated during physical activity", and relief, "After physical activity, I feel relieved." Each emotion evaluated consisted of four items each. All items were measured on a five-point Likert scale ranging from 'strongly disagree' (1) to 'strongly agree' (5). Previous research has found these items to be valid and reliable with college students (Garn et al., 2017; Garn & Simonton, 2022; Simonton, 2021).

PA-related affect. To measure students' positive and negative affect towards PA experiences, the Positive and Negative Affect Schedule Short-From (PANAS-SF; Thompson, 2007; Watson et al., 1988) survey was used. The questionnaire consists of 10 total words, five of which are positive emotions, feelings, or mood descriptors and five words representing the negative factor. Participants were prompted regarding the PA prompt mentioned previously. For this tool, participants were asked to indicate the extent they felt the following descriptors based on their PA during the past week. Example positive items were, "excited", "proud", and "strong", whereas negative items were, "distressed", "upset", and "guilty" for example. Participants were asked to indicate the extent to which they felt each item during physical activity experiences within the last week. Response items were on a five-point Likert scale ranging from 'very slightly/not at all' (1) to 'extremely' (5). This tool has consistently shown to be valid and reliable in this population for measuring PA positive and negative affect (Hogue et al., 2019; Stevens et al., 2020; Thompson, 2007; Watson et al., 1988)

PA-behavior. Participants self-reported their weekly moderate to vigorous PA behaviors using the PA subscale of the Global Physical Activity Questionnaire (GPAQ; Chu et al., 2015). Items focused first on moderate-intensity activities and then on vigorous-intensity activities. Each section asked participants to record estimated frequency (e.g., number of days) and

duration (hours; minutes) for each component per week. Results were combined to represent average number of moderate-to-vigorous PA in a typical week as recommended within the GPAQ manual (Chu et al., 2015).

PA self-efficacy. The self-efficacy for exercise scale (SEE; Resnick & Jenkins, 2000) was used to evaluate participants self-efficacy to engage in leisure time PA. The original SEE tool was adopted from targeting exercise to ask participants to answer items specific to their self-efficacy to engage in PA behaviors. The measurement tool focuses on individuals' expectations to their ability to continue exercising regardless of current situations. Subjects are prompted by, "how confident are you that you can", followed by asking to rate nine statements on their current confidence to exercise 3 times a week for 30 minutes given a variety of potential obstacles. An example statements include, "You had to exercise alone", or "You were too busy with other activities." The answer scale ranged from 'not at all confident' (0) to 'highly confident' (10). This tool has been previously validated in college aged students (Rodgers et al., 2008)

Data Analysis

Initially all data was screened and used to calculate descriptive statistics and correlations. The full information maximum likelihood (FIML; Enders, 2010) method was used for missing data as it is recommended over listwise and pairwise methods for maintaining reliable estimates and analytic power. In addition, the CLUSTER function in Mplus 8.0 (Muthen & Muthen, 2017) was used to account for natural nesting of students within the two schools. To account for potential non-normality of data the Robust Maximum Likelihood procedures were also used (Satorra & Bentler, 2001).

First, a confirmatory factor analysis (CFA) was conducted to evaluate construct validity (Brown, 2015) and explore potential overlap of the multiple PA emotions (enjoyment, boredom, relief, and anger) and PA affect (positive and negative) measurement tools simultaneously. In addition, convergent reliability of the latent variables was explored by calculating the Cronbach's Alpha reliability scores for all latent variables, evaluation item factor loadings, composite relatability (ρ_c) scores, and average variance extracted (AVE) scores. Standardized factor loadings that are .50 or higher are considered acceptable while ρ_c scores of .70 and AVE scores of .50 or higher are also considered acceptable (Brown, 2015; Kline, 2016).

Next, structural equation modeling (SEM) was performed to evaluate predictive tendencies among PA emotions and PA affect to self-efficacy and self-reported MVPA. The SEM includes evaluating both a measurement model and a structural model of the data. The measurement model provides data fit and the structural model provides regression estimates between predictive variables (Kline, 2016). SEM is ideal as it allows for simultaneous evaluation of multiple related independent variables as predictors of multiple dependent variables, as opposed to individual variable evaluation, without increasing measurement error. All independent or exogenous variables were allowed to covary knowing they shared moderate relationships (Kline, 2016). Additionally, within the final SEM model of PA affect and emotions predicting PA self-efficacy (latent variable) and MVPA (observed variable), researchers included participant gender as a covariate to account for and investigate any potential differences in gender within the exogenous variables.

Model fit criteria used for judging acceptance are similar for both the CFA and SEM results. The robust chi-square estimate (χ^2) is typically used to report absolute fit index (Hu & Bentler, 1999); however, it can be sensitive to sample size and highly related constructs thus

other global fit indices are also used to evaluate model fit. The Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), root mean square error of approximation (RMSEA), and the standardized root mean (SRMR) are recommended global fit indices to use (Kline, 2016). The CFI and TLI indices are used to compare data with poor fitting models. Scores of .90 and .95 or higher are considered acceptable to good on a scale from 0-10. For RMSEA and SRMR comparison to perfect fitting models, scores of .08 and .06 are lower are considered acceptable to good fit. Overall, the effect size of the model is determined by the amount of variance accounted for on the dependent variables (R^2).

Results

Descriptive statistics and correlations amongst all variables can be found on Table 1. Initial Cronbach's alpha reliability scores were acceptable for all latent variables. The reported time spent in MVPA was calculated into a daily average, thus mean scores represent an average amount of time spent per day (in minutes) in activity as reported by the participants. Overall, students on average reported engaging in approximately 43 minutes of MVPA per day. As expected, participants reported higher levels, well above the midpoint for enjoyment, self-efficacy for PA, positive affect, and interestingly, relief. It is important to note that correlations between positive affect and the positive discrete emotions of enjoyment (r= .606) and relief (r= .382) suggested that while these constructs are moderately related, they appear to be distinct from one another. The same was found for negative affect and the negative emotions of boredom (r= .293) and anger (r= .396).

Table 1.
Bivariate correlations and reliability scores for all variables.

	Variable	1	2	3	4	5	6	7	8
1	ENJ	1							
2	BOR	-.570**	1						
3	REL	.354**	-.249**	1					
4	ANG	-.470**	.562**	-.320**	1				
5	POS.Aff	.606**	-.456**	.382**	-.413**	1			
6	NEG.Aff	-.217**	.293**	-.090*	.396**	-.230**	1		
7	SE	.408**	-.289**	.126**	-.268**	.290**	-.018	1	
8	MVPA	.438**	-.229**	.114*	-.188**	.284**	-.099*	.415**	1
	M	3.77	2.21	3.87	1.83	3.41	1.37	4.69	43.32
	SD	.76	.75	.64	.63	.95	.54	2.03	37.67
	Alpha	.861	.802	.701	.813	.945	.831	.874	n/a
	Scale	1-5	1-5	1-5	1-5	1-5	1-5	0-10	n/a

Note. ENJ= enjoyment; BOR= Boredom; REL= Relief; ANG= Anger; POS.Aff= Positive Affect; NEG.Aff= Negative Affect; MVPA= Self-report moderate-to-vigorous physical activity time; SE= Exercise self-efficacy.
**p< .01, *p< .05

Next, the CFA including four emotions and the positive and negative affective variables showed an acceptable fitting model ($\chi^2(283)$= 727.913, p<.001, CFI= .928, TLI= .917, RMSEA= .055, SRMR= .041). All item statistics for each of the three emotions and positive/negative affect

latent variables can be found on Table 2. The factor loadings for each variable were found to be reliable with a border line exception for relief item 4 (λ= .455) slightly falling below the .50 threshold. In addition, the majority of the ρ_c and AVE scores exceeded acceptable marks except for relief (.385) and negative affect (.397), falling below the recommended cut point. In addition, the final model included a correlated unique variance between negative affect item 4 (nervous) and item 5 (afraid). This overlap is not surprising considering the similarity between these two descriptors.

Measurement model results of the SEM supported an adequate fitting model ($\chi^2(346)$= 875.850, p<.001, CFI= .919, TLI= .905, RMSEA= .054, SRMR= .041). Results of the model also showed strong factor loadings for each of the latent variables with all indicators exceeding the .50 threshold except relief item 4 at .465 (ENJ range: .737-.821; BOR range: .632-.786; REL range: .465-.738; ANG range: .674-.786; POS.Aff range: .686-.852; NEG.Aff range: .539-.771). Additionally, measurement results of covariance by gender found significant differences in three of the four emotions, but no differences in reported positive and negative affect. Specifically, males reported higher levels of enjoyment (β= .198, p= <.001) whereas females reported higher levels of PA boredom (β= -.097, p= .019) and relief (β= -.167, p= <.001), with no differences for anger.

Table 2.

CFA results of the latent variable indicators for all PA affect and emotions variables.

	M (SD)	*λ* (SE)	λ	*δ*	Skewness	Kurtosis	ρ_c	*AVE*
ENJ							.864	.614
Enj1	4.10 (.814)	.648 (.057)	.797	.364	-1.032	1.356		
Enj2	3.63 (.951)	.718 (.010)	.756	.428	-0.562	-1.158		
Enj3	3.51 (.932)	.692 (.019)	.744	.447	-0.432	-0.413		
Enj4	3.81 (.886)	.737 (.001)	.834	.305	-0.703	0.289		
BOR							.809	.516
Bor1	2.36 (.962)	.754 (.033)	.785	.384	0.763	0.082		
Bor2	2.23 (.978)	.765 (.074)	.783	.387	0.848	0.239		
Bor3	2.40 (.999)	.632 (.012)	.633	.599	0.682	-0.213		
Bor4	1.84 (.841)	.554 (.029)	.659	.565	1.129	1.620		
REL							.707	.385
Rel1	3.65 (.947)	.495 (.008)	.523	.727	-0.561	-0.291		
Rel2	4.14 (.782)	.569 (.039)	.728	.471	-1.041	1.520		
Rel3	3.85 (.848)	.618 (.096)	.729	.468	-0.685	0.244		
Rel4	3.84 (.997)	.453 (.111)	.455	.793	-0.926	0.358		
ANG							.812	.521
Ang1	1.85 (.824)	.561 (.026)	.681	.536	1.089	1.482		
Ang2	1.96 (.853)	.628 (.072)	.737	.457	1.062	1.316		
Ang3	1.85 (.762)	.599 (.012)	.787	.381	0.942	1.233		
Ang4	1.65 (.720)	.486 (.059)	.676	.543	1.198	1.803		
POS.Aff							.897	.636

Pos1	3.15 (1.15)	.788 (.010)	.686	.529	-0.293	-0.671		
Pos2	3.25 (1.20)	.948 (.038)	.790	.376	-0.332	-0.760		
Pos3	3.63 (1.10)	.935 (.045)	.852	.274	-0.651	-0.166		
Pos4	3.31 (1.12)	.939 (.048)	.838	.299	-0.320	-0.524		
Pos5	3.71 (1.16)	.903 (.061)	.811	.343	-0.735	-0.066		
NEG.Aff							.766	.397
Neg1	1.45 (.802)	.458 (.006)	.571	.674	1.931	3.571		
Neg2	1.21 (.578)	.356 (.078)	.617	.618	3.090	10.100		
Neg3	1.32 (.724)	.507 (.016)	.700	.510	1.321	0.524		
Neg4	1.60 (.900)	.551 (.022)	.613	.624	1.598	0.808		
Neg5	1.26 (.664)	.425 (.090)	.641	.589	1.261	0.440		

Note. A 1-13: physical activity attitude item indicators. λ (SE): Unstandardized factor loading and standard error; λ : Standardized factor loading; δ : Unique variance; α: Cronbach's alpha; $\rho_{c:}$ Composite reliability; AVE: Average variance extracted; POS = Positive Attitude toward Physical Activity; NEG = Negative Attitude toward Physical Activity

Table 3.
SEM model fit and direct effect results.

Measurement Model	χ^2	df	p-value	CFI	TLI	SRMR	RMSEA (90% CI)
	875.850	346	<.001	.919	.905	.044	.054 (.050-.059)

Direct Effects	*B*	*SE*	β	*p*-value	R^2
MVPA					.262
ENJ	.503	.063	.652	< .001	
BOR	.148	.069	.189	.038	
REL	-.106	.033	-.136	.003	
ANG	-.020	.021	-.025	.338	
POS.Aff	.003	.012	.004	.790	
NEG.Aff	-.010	.083	-.013	.906	
SE					.248
ENJ	.464	.060	.473	< .001	
BOR	.080	.053	.081	.119	
REL	-.152	.014	-.154	<.001	
ANG	-.216	.103	-.215	.028	
POS.Aff	.042	.016	.042	.012	
NEG.Aff	-.160	.005	-.159	<. 001	

Emotions: ENJ= Enjoyment; BOR= Boredom; REL= Relief; ANG= Anger;
Outcomes: MVPA: Moderate-to-vigorous physical activity; SE: Self-Efficacy for PA.
χ^2: Chi-square value; df: Degrees of freedom; CFI: Comparative fit index; TLI: Tucker-Lewis index;
RMSEA: Root mean square error of approximation; *B*= Unstandardized beta coefficient;
SE= Standard error; β= Standardize beta coefficient; R^2= Amount of variance accounted for.

All covariance was accounted for in the final model. Structural model results for the SEM can be found on Table 3. For MVPA, three emotions were found as significant predictors while neither form of affect was significant. Specifically, enjoyment was a positive predictor and relief, a negative predictor. Interestingly, boredom was also found as a positive predictor of MPVA, albeit at a much lower magnitude. For PA self-efficacy, three of four emotions and both positive and negative affect were predictors. Enjoyment and positive affect were positive predictors of efficacy while relief, anger, and negative affect as negative predictors. In summary, the model accounted for approximately 26% of the variance in self-reported MVPA and 25% of the variance in PA self-efficacy.

Discussion

The purpose of this study was to explore the potential overlap and distinctions between PA affect and emotions, in college students, as well as their relations with PA self-efficacy and self-reported behavior. This type of investigation is important because of close links among PA related affect/emotions, motivation, and health related behaviors and beliefs (Biddle et al., 2003; Ekkekakis & Brand, 2019; Garn et al., 2017). A major goal of this study was to examine potential overlap between discrete emotions and affect. On one hand, affect provides a simple and general approach to measure one's feelings toward PA. On the other hand, it may be too broad and fail to capture less information compared to discrete emotions.

Measuring and Distinguishing Emotions and Affect

Factor analysis confirmed PA affect and emotion measurement items showing adequate model fit and respective factor loadings which provided evidence that each emotion and affective variable was found to be a reliable construct. As identified in the review of mean scores, the intensity of reported scores appears to be stronger for each emotion (positive and negative) as opposed to their respective affective counterpart. In addition, when looking at the relationship of these constructs, it is clear they are related, but only at a moderate degree. The one exception to this was the relationship between enjoyment and positive affect. Since both enjoyment and positive affect are activating and positive in valence, it is not surprising that there is considerable overlap (or shared variance) between the two constructs. For example, they are highly positive and activating variables and the PANAS uses terms like enjoyment such as, "excitement" as descriptors of affect. The same was not true for anger and negative affect (which are both conceptualized as activating and negative) as the relationship was moderate.

The deactivating emotions of relief (positive) with positive affect as well as boredom (negative) with negative affect also shared moderate relations. These moderate relationships may also provide support a masking effect of positive/negative affect over deactivating or simply less activating discrete emotions that fall within the positive/negative classification. Ultimately, this may reduce the understanding of unique positive/negative emotion characteristics. In other words, the specificity in which emotions are categorized and defined may provide deeper meaning into one's experiences and subsequently provide more details into their motivation and behavior (Mouratidis et al., 2009; Simonton & Garn, 2019).

Relations with Self-Efficacy and PA Behavior

To further explore differences and similarities between PA emotions and PA affect, SEM analysis revealed that when accounting for both constructs, emotions tended to strongly predict PA behavior and efficacy. When evaluating participants self-reported MVPA, enjoyment was

found to be the strongest and most significant predictor. This aligns with previous research that throughout adolescents (Dishman et al., 2005; Yli-Piipari et al., 2013) and adulthood (Garn et al., 2017), PA enjoyment plays one of, if not, the most significant roles in PA behavior. Enjoyment appears to be highly related to general positive affect, thus, when trying to capture positive and activating feelings, both seem sufficiently related as expected. With that being said, it is also suggested that many individuals' beliefs and feelings may not be accurately captured with enjoyment alone and, thus, measuring additional discrete emotions is essential for providing a holistic perspective on individuals' choices and habits (Mouratidis et al., 2009).

One anomaly in the findings was boredom's positive predictability for MVPA. This does not align with theory or previous findings, suggesting boredom reduces PA behavior and engagement (Garn et al., 2017; Ntoumanis et al., 2004; Simonton & Garn, 2020). One potential explanation here is that individuals may be obligated to engage in certain PA behaviors via school or job requirements, or even peer pressure from peers. However, these experiences lead to repeated bouts of boredom, however, due to the inevitable sense of obligation to participate one may also be gaining a simultaneous negative and deactivating connection to the PA activity. Due to boredom's limited motivational tendencies and the external forces of obligated PA, it would be reasonable to assume that sustained MVPA levels are not likely, but more research is warranted. Thus, deactivating and extrinsic/amotivated feelings should not be disregarded but should continue to be evaluated and considered in the research as they may impact human behavior, even if they are not ideal.

In addition, relief, a positively valanced emotion, was a weaker but significant negative predictor of MVPA. Again, a further nuance that is lost or misunderstood potentially with a generalized affective measure are avoidance forms of motivation, which play a tangible role in explaining volitional behavior (Ryan & Deci, 2020). Yet, without emotions like relief, it would not likely be identified in popular and commonly used affect measurement tools (Simonton, 2021). This is especially important as relief following PA completion, for example, would fall under positive affect but likely has long term negative influences on motivation and volitional behavior. Part of the distinction within the discrete emotions presented here also opens unique opportunities for intervention, prediction, and behavior modification. The more diversity that is captured within motivational measures can lead to highly individualized programs that meet the unique demands of more people.

Furthermore, when exploring potential similarities and differences between emotions and affect as predictors of PA self-efficacy, results showed both emotions and affect had significant influences. Similar to MVPA, enjoyment was the strongest and most significant predictor and relief was a negative predictor. Also, anger (negative valence) was a significant negative predictor of self-efficacy. However, both positive affect and negative affect also predicted self-efficacy, which aligns with previous research and the closely related classifications of these constructs (Ekkekakis & Brand, 2019). Although rationale for enjoyment and relief's relations with self-efficacy are similar to those found with MVPA, anger's significant influence was unique to self-efficacy. In some ways this is contradictory to previous work on the categorization of anger in school motivation (Pekrun, 2006; Pekrun et al., 2009) and PE environments (Mouratidis et al., 2009; Simonton & Garn, 2020) which suggests that those who feel anger view themselves as competent but do not value the tasks or find them meaningful. However, the similar predictive relations of negative affect and anger by show potential overlap in measurement. In either sense, the onset of externally driven goals or negative activating experiences cannot be ignored relegated as simple opposition of positive affect/enjoyment.

Specifically, anger may be tied to wanting to be physically active, but frustration arises from knowing one is not engaging in PA at an acceptable level and subsequently reduces their perceived efficacy to engage. In other words, anger in volitional practice could come from frustration of inability in not meeting one's self-expectations, or repeated bouts of failure and misalignment from previous experiences which may all blend into the reduction of self-efficacious beliefs to be active. Overall, however, measuring emotions in addition too, or in lieu of, generalized affect has the potential to enhance our understanding of PA behaviors and beliefs.

The motivational differences represented by enjoyment versus relief and boredom versus anger cannot be understated enough. The motivational tendencies of those experiencing enjoyment have relations with intrinsic motivation and cognitive and physiological activation (Garn et al., 2017; Yli-Piipari et al., 2013) whereas relief is associated with avoidance motivation (Ryan & Deci, 2020; Pekrun, 2006) and likely represents those who are simply engaging in PA due to external pressures such as fear of weight gain or potential criticism from a peer group, for example. Thus, specific forms of *positive* emotions likely cannot be identified within a general affective measure. Similarly, deactivating relief and boredom also suggests that the variation and specificity of emotions provides deeper nuance. Boredom is a deactivating emotion associated with a genuine lack of interest and amotivation (Ntoumanis et al., 2004; Pekrun, 2006) that may not be captured properly within negative affect. Relief is extrinsically driven and deactivating, yet the action tendencies are not separated using a positive affective measure (Garn et al., 2017; Simonton, 2021).

In summary, it is clear that positive affect and enjoyment share strong conceptual and statistical relations however, less evidence of similarities between negative affect and the respective emotions and the deactivating categories of emotions was present. Therefore, researchers would not necessarily recommend that discrete emotions like enjoyment are a better measure than positive affect. However, in totality, measuring several discrete emotions over the dichotomous affective measure may be more insightful. The major advantage may be that discrete emotions provide specific information on one's subjective association with PA. The greater focus and specificity that emotions provide may help to clarify and maximize our understanding of engaging/disengaging in health-related PA behaviors. Using affective measures may prohibit our ability to breakdown feelings that explain relationships in more specific ways. In other words, when using a set of discrete emotions, researchers are likely capturing the scope of individuals in explaining the array of behaviors beyond basic dichotomous views of pleasure and engagement.

Limitations and Future Research

There are limitations that should be recognized when interpreting this explorative study. The first is the cross-sectional nature of this study does not allow for temporal relations and true predictability to be captured, thus, further longitudinal research is needed. Secondly, although the data was collected from a multitude of courses, with diverse student populations, from two separate universities, generalizability for college students throughout the entire U.S. is limited and the fact all students were recruited from PA-related courses may not represent the general college level population. Thirdly, although not every affective and emotional response can be captured in one study, more discrete emotions and other affective-related tools need consideration. As, Simonton (2020) alluded, emotions can fluctuate in intensity and frequency, thus including a more diverse set of emotions and their defining antecedents would improve future investigation. Lastly, although emotions provide greater specificity than affect, the type of

PA activities one chooses may be a major contributor to understanding affect and emotional differences amongst participants. For example, one may hold different affect-related beliefs toward distinct PA activities such as enjoyment for running and anger when swimming. Additionally, this study did not control for one's state motivational profile or current choices/habits for exercises which needs to be considered in future work. More research is needed on conceptualizing PA options and participants affect tied to those distinct opportunities. Future considerations should include tracking emotions over time as they related to specific PA outlets. In addition, exploring key environmental and personal attributes that explain volitation PA emotions is needed.

Conclusion

Overall, understanding the affective side of motivation is integral for assessing and intervening on the health-related PA behaviors of individuals. However, the traditional views of affect may be limiting in understanding the specificity and nuance provided by exploring a spectrum of discrete emotional experiences connected to PA beliefs and behaviors. Both positive and negative affect were related with several positive and negative discrete emotions, yet the correlational patterns suggest clear separations except for positive affect and enjoyment. Although measuring specific emotions is more complex, they may provide nuances in explaining motivational tendencies and induvial differences which may be limited or omitted using affect. Specifically, positive deactivating and negative activating emotions need further consideration as they explain volitional PA choices. More research is needed to support PA emotions and the distinct, individualized, and interpretable, constructs they provide researchers and participants.

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