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Motivational Correlates of Exercise Behavior Among College Students

Jesenia Nieves[1] and Zachary Zenko[1,*]

[1]Department of Kinesiology, California State University - Bakersfield
[*]Correspondence: zzenko@csub.edu

The purpose of this research was to explore the relations between basic psychological needs satisfaction (autonomy, relatedness, perceived competence), intrinsic motivation, attraction toward exercise, and exercise behavior among college students. In this study, 128 participants (including 91 women and 36 men, mean age: 24 ± 7 years) responded to a questionnaire assessing basic psychological needs satisfaction (autonomy, competence, relatedness), intrinsic motivation, attraction (vs. antipathy) toward exercise, and exercise behavior. Frequency of aerobic exercise, frequency of resistance exercise, and total aerobic exercise behavior are positively associated with autonomy, competence, relatedness, intrinsic motivation, and attraction toward exercise. Three exploratory mediation analyses suggest that attraction (vs. antipathy) toward exercise mediates the relation between intrinsic motivation and exercise behavior. Taken together, these data support and extend previous research on the importance of motivationally relevant variables, including autonomy, competence, relatedness, intrinsic motivation, and affective exercise experiences.

Introduction

Exercise is vital when it comes to living a healthy life. The development of lifelong exercise behavior has a multitude of health benefits such as improved mental health (Callaghan et al., 2011; Vancini et al., 2017) and increased cardiovascular fitness (Lavie et al., 2019). Regular physical activity participation is especially important now with the continuous rise of chronic diseases such as coronary heart disease, type 2 diabetes, and some cancers (Lee et al., 2012). Physical activity plays a key role in the development of chronic disease. Yet, data indicate that only one out of every four adults in the US meets combined aerobic and muscle-strengthening activity guidelines, with males achieving the guidelines at higher rates than females (Bennie et al., 2019).

When moving from adolescence to early adulthood, students are faced with changes in their physical, social, psychological, and structural domains, which play a role in their perception of barriers and motivational regulation towards physical activity (Diehl et al., 2018). Since physical activity is associated with better health and a decreased risk for chronic illnesses, researchers have recognized the importance of motivating college students to participate and maintain physical activity behavior (Gao et al., 2012). Therefore, there is a need to understand motivational factors that may influence the exercise behavior of college students. To better understand motivational factors, we turn to self-determination theory and affective exercise experiences.

Self-Determination Theory

Self-Determination theory (SDT) aids in the meaningful explanation and prediction of exercise behavior through the motivation continuum. SDT differentiates between three categories of behavioral regulation which vary in degree of self-determined motivation: intrinsic motivation, extrinsic motivation, and amotivation (Ntoumanis, 2005; Ryan & Deci, 2000). Intrinsic motivation is the most self-determined and thus the highest form of autonomous motivation (Wallhead et al., 2014). Intrinsic motivation is apparent when an individual participates in an activity with no need for external motivators and performs for the sake of enjoyment and "because of its inherent satisfactions" (Teixeira et al., 2012, p. 2). Extrinsic motivation is composed of integrated regulation, identified regulation, introjected regulation, and external regulation. Each of which has less self-determined motivators and more extrinsic motivators. For instance, integrated regulation is the most self-determined form of extrinsic motivation, but in this type of motivation individuals understand the importance of behaviors or internalizes them (Lauderdale et al., 2015). The last motivational regulation is amotivation which occurs when an individual lacks any motivation to perform a behavior. As a behavior becomes more internalized the individual becomes more self-determined. Intrinsic motivation is positively associated with exercise self-schema (Samendinger & Hill, 2021) and exercise behavior of college students (Wilson et al., 2004).

Basic psychological needs theory is a sub-theory of the SDT in which behaviors are more self-determined when innate needs such as autonomy, relatedness, and competence are satisfied. According to self-determination theory, basic psychological needs include autonomy, competence, and relatedness (Quested et al., 2021; Ryan & Deci, 2000). Autonomy occurs when the participant feels their choice is influential, competence focuses on the ability to perform a task, and relatedness is based on the feeling of social relationships (Leyton-Román et al., 2020). Therefore, satisfaction of the basic psychological needs influences higher forms of self-determined motivation and increases the intention to engage in physical activity (Ntoumanis, 2005). The importance of basic psychological needs for autonomy, competence, and relatedness is robust across cultures (Chen et al., 2014). Needs satisfaction has also been linked to positive affective experiences and with higher forms of self-determined motivation (Ntoumanis, 2005; Wilson et al., 2004) and adherence to physical rehabilitation (Chan et al., 2009). Perceived competence appears to be a meaningful predictor of exercise adherence (Vlachopoulos & Neikou, 2007). In sum, needs satisfaction is a key component in motivation and may affect affective experiences, both of which may influence exercise behavior.

Evidence has highlighted the meaningful relation between self-determination theory constructs (e.g., satisfaction of basic psychological needs, intrinsic motivation) and exercise behavior (Teixeira et al., 2012). In their review, Teixeira et al. (2012) note that interventions based on self-determination theory demonstrate effectiveness, mixed relations between exercise and autonomy, and weak or nonexistent relations between exercise and relatedness. Overall, the role of basic psychological needs and the SDT in

exercise behavior is consistent across the literature. Still, there is a need to understand other potential factors that may influence the exercise behavior of college students.

Affective Exercise Experiences

Maltagliati et al. (2022) have highlighted the limitations of focusing exclusively on health benefits associated with exercise and argued for a more central role of affective constructs to explain physical activity and exercise behavior. Affective responses experienced during exercise predict future exercise behavior (Rhodes & Kates, 2015). Affective processes are increasingly recognized as a predictor of behavior (Dukes et al., 2021), including physical activity and exercise behavior. Ekkekakis (2017) reviewed evidence of affective processes as an important predictor of behavior and conceptualized a dual-process framework that highlights the importance of affective, evolutionarily primitive processes as an influence on behavior, in addition to more rational, deliberative processes (e.g., consideration of benefits of an active lifestyle, and consequences of a sedentary lifestyle). The affective-reflective theory of physical inactivity, a dual-process framework, was formalized by Brand & Ekkekakis (2017). This theory highlights the importance of automatic affective valuations as well as reflective evaluations for predicting exercise behavior. This represents an advance upon prior theories used to predict exercise behavior, which left affective processes noticeably absent (Ekkekakis & Zenko, 2016).

Affective exercise experiences are defined as "summary valenced designation, ranging from pleasant to unpleasant, that reflects the history of associations between exercise over the life course of an individual and the attendant affective responses" (Ekkekakis et al., 2021). Ekkekakis et al. (2021) described attraction-antipathy as a motivational tendency shaped by affective exercise experiences; the researchers found correlations between attraction (vs. antipathy) toward exercise and exercise behavior, where greater attraction toward exercise is associated with more exercise behavior (Ekkekakis et al., 2021). In their conceptual model, attraction-antipathy toward exercise was theorized to be influenced by core affective exercise experiences (e.g., pleasure or displeasure experienced while exercising); which were in turn influenced by antecedent cognitive appraisals (e.g., feelings of empowerment, interest, competence); this conceptual model was supported (Ekkekakis et al., 2021).

Some of the antecedent cognitive appraisals may be related to basic psychological need satisfaction. For example, the subscales of the Affective Exercise Experiences Questionnaire (Ekkekakis et al., 2021) related to showing off and liking group exercise may be related to relatedness and competence may be related to perceived competence. Consistent with (Ekkekakis et al., 2021), we view attraction (vs. antipathy) as a construct that is influenced by both reflective, deliberate processes and automatically activated, heuristic processes. Intrinsic motivation for exercise may also be related to attraction toward exercise, core affective exercise experiences, and antecedent cognitive appraisals. People with more intrinsic and self-determined motivations may have more attraction toward exercise, and in turn may engage in more exercise behavior. Examination of items measuring each construct suggests that attraction toward exercise (e.g., "Exercise is high on my priority list…", "Exercise is a tempting activity…", I would choose exercise over most other activities…") is arguably more likely to be influenced by intrinsic motivation (e.g., exercising for fun, enjoying exercise sessions, getting pleasure and satisfaction from exercise) than the other way around. This highlights the possibility that basic psychological needs for exercise and intrinsic motivation have a strong affective component. Thus, there is a need to study attraction toward exercise and intrinsic motivation together.

The Current Study

The purpose of this research was to add to the literature by further examining the association between exercise behavior and motivational variables, including autonomy, competence, relatedness, intrinsic motivation, and attraction (vs. antipathy) toward exercise. In addition, several exploratory mediation analyses were conducted. These included analyses to determine whether attraction (vs. antipathy) toward exercise mediated the relation between intrinsic motivation and exercise behavior.

Methods

This study was preregistered (See the pregregistration). Predictor and exploratory variables included autonomy, relatedness, competence, intrinsic motivation, and attraction (vs. antipathy) toward exercise. The dependent variable was student exercise behavior. Exercise behavior was measured in three categories, namely aerobic exercise frequency, resistance exercise frequency, and total aerobic exercise.

Measures and Instruments

There was one online survey used in this study to collect data using Qualtrics (Provo, UT). The survey included items to assess demographic characteristics (i.e., age, education level, gender, etc.) and four questionnaires. We assessed gender by asking "What is your gender identity?". Response options included "man", "woman", "I prefer not to say", and "I would rather describe".

Basic Psychological Needs Satisfaction

The fulfillment of students' basic psychological needs (i.e., autonomy, competence, and relatedness) in exercise was measured using the Basic Psychological Needs in Exercise Scale (BPNES; Vlachopoulos et al. (2010)). This was an 11-question section of the survey that assessed the satisfaction of autonomy (4 items), competence (4 items), and relatedness (3 items). All factors were measured on a 5-point scale ranging from "I don't agree at all" to "I completely agree". A few example items are: "The way I exercise is in agreement with my choices and interests" (autonomy), "I feel exercise is an activity which I do very well" (competence), and "My relationships with the people I exercise with are very friendly" (relatedness). See Vlachopoulos et al. (2010) for evidence of validity. In this study, internal consistency for each subscale was acceptable, as indicated by Cronbach's α : autonomy ($\alpha = .866$), competence ($\alpha = .918$), and relatedness ($\alpha = .895$). Thus, scores were highly reliable for the subscales of basic psychological needs satisfaction.

Intrinsic Motivation

Self-determined, intrinsic motivation was measured using the Behavioral Regulation in Exercise Questionnaire (BREQ-2; Markland & Tobin (2004)). The four items of the intrinsic regulation subscale were used in this analysis. Following the stem, "Why do you engage in exercise?" participants answered items related to intrinsic regulation (e.g., "I exercise because it's fun"). Each item is answered on a 5-point scale varying from "not true for me" to "very true for me". Studies have demonstrated the questionnaire to be both valid and reliable to examine college students' motivational regulations in exercise (Lauderdale et al., 2015; Markland & Tobin, 2004). In this study, internal consistency of the intrinsic regulation subscale was high ($\alpha = .926$).

Affective Experiences

To measure affective experiences the Affective Exercise Experiences (AFFEXX) Questionnaire was used to assess affective exercise experiences. This scale includes several statements with bipolar answers on each side that are separated by a 7-point response scale. The primary subscale of interest in this study was the attraction-antipathy subscale, which includes items such as "Exercise is something I look forward to" vs. "Exercise is something I dread". Ekkekakis et al. (2021) reported on the validity and reliability of the questionnaire. The attraction (vs. antipathy) subscale demonstrated strong internal consistency in this sample ($\alpha = .899$)

Exercise Behavior

The International Physical Activity Questionnaire Short Form (IPAQ-SF; Craig et al. (2003)) was modified to assess exercise behavior. The questionnaire has shown acceptable concurrent validity (Meh et al., 2021). See Craig et al. (2003) for evidence of criterion validity. The questionnaire was modified in this study to focus directly on mode (i.e., aerobic or resistance), frequency, and duration of exercise. This section was composed of questions used to assess aerobic and resistance frequency as well as overall, total aerobic exercise (i.e., "How many minutes of planned, purposeful cardiorespiratory or aerobic exercise have you completed in the last 7 days? Do not count activities such as walking to work or completing household chores"). The response format included an open-ended textbox where participants could enter their response.

Aerobic exercise frequency was assessed using the question "In the past 7 days, how many days did you engage in planned, purposeful cardiorespiratory or aerobic exercise? Do not count activities such as walking to work or completing household chores." Resistance exercise frequency was assessed with the question "In the past 7 days, how many days did you complete muscle-strengthening activities, such as weightlifting, strength training, or resistance training?" Response options included 0, 1, 2, 3, 4, 5, 6, or 7, corresponding to anywhere from 0 days to 7 days of aerobic or resistance exercise. We intended to measure frequency as well as overall behavior (minutes) because motivational variables may differently impact frequency and overall behavior. For example, motivational variables may influence choice of whether to exercise today or not (frequency) more than the decision to continue exercising once the task has been initiated (total behavior).

Procedure

Institutional Review Board (IRB) approval was obtained from California State University Bakersfield. One modification was approved to increase recruitment rate; this modification included recruitment through social media which allowed for college students of all ages to participate. Data were initially collected in the Fall 2021 semester. Participants were recruited from a Hispanic-serving Institution in California. A second modification was made to allow for the recruitment of some additional participants in the Spring 2022 semester. Participants were recruited through mass emailing and a recruitment flyer posted on social media (Instagram and Twitter).

Participants clicked on a link to access the informed consent form and the survey. Once consent was provided, students were prompted with questions on their demographic characteristics as well as the questions to assess their basic psychological needs, intrinsic motivation, attraction (vs. antipathy) toward exercise, and exercise behavior. Upon completion of the survey, participants were redirected to another survey where they provided their email to be compensated with $5.00 Amazon electronic gift cards.

Sample Size Calculation

The study was launched with a focus on college students at least 18 years of age. The revised analysis that is presented was not based on that initial power calculation. Based on practical and resource considerations (Lakens, 2022), we aimed to recruit between 120 and 150 individuals to balance resource constraints.

Preregistration, Data Processing, and Data Availability

The preregistration, data, data analysis, and data processing notes are available (See Data Availability). Deviations for preregistration are reported.

All data were cleaned and analyzed using IBM SPSS version 28 (Armonk, NY), JASP (*JASP*, 2022) and jamovi (Selker et al., 2022). Significance levels were set to $p < .05$. Before beginning data analysis, the data were cleaned and processed. This included the removal of ten responses from people who never completed the consent form (and never provided any additional data), 22 participants who consented but never provided additional data, and 7 participants who did not finish the survey. Further, outliers were identified using Tukey's fences and invalid responses were identified, flagged, and removed from relevant analyses and the questionnaire data was appropriately scored. The full notes on the data processing procedure are available (See Data Availability).

Final Sample Characteristics

Data included 128 participants (mean age: 24 ± 7 years). This included 91 women, 36 men, and 1 participant who preferred not to say their gender. Over half of the sample (56.25%) identified as either Hispanic, Latino, Latina, or Latinx. The sample also included 35 White participants, 17 Asian participants, 11 Black or African American participants, 1 Native Hawaiian or Pacific Islander participant, and 3 participants identifying as "Other", which included one "European" and one "Palestinian/Arabic" participant. Finally, most were currently undergraduate students with 91.41% having earned their high school diploma (or equivalent), some college, or Associate degree (2-year degree). Eleven participants completed their Bachelor degree or Master degree. Ten participants indicated extreme amounts of exercise behavior (more than 433 minutes per week), which was determined using Tukey's fences ($IQR \cdot 1.5$). These participants were eliminated from further analysis.

Statistical Analysis

Motivational correlates of exercise behavior

A series of bivariate correlation analyses were performed to determine the relations between motivational variables (autonomy, competence, relatedness, intrinsic motivation, and attraction [vs. antipathy] toward exercise) and exercise behavior (frequency of aerobic exercise, total aerobic exercise, and frequency of resistance exercise). The assumption of normality was violated in multiple cases and thus Spearman's ρ (rho) is reported for each correlation.

Exploratory mediation analyses

A series of three exploratory mediation analyses were completed to test whether attraction (vs. antipathy) toward exercise mediated the relation between intrinsic motivation and exercise behavior. Mediation analyses were performed in jamovi (Gallucci, 2020; 2022; Rosseel, 2012; Selker et al., 2022; Soetaert, 2020; "Structural Equation Modeling Software," 2019) with dependent variables including (a) frequency of aerobic exercise, (b) total aerobic exercise, and (c) frequency of resistance exercise. For each mediation analysis, 95% confidence intervals were calculated using 5000 bias-corrected bootstrapped samples. If the 95% bootstrap confidence interval of an indirect effect did not include 0, it was considered statistically significant.

Results

Motivational Correlates of Exercise Behavior

Results of the correlation analyses used to determine the relations between motivational variables and exercise behavior are presented in Table 1. Notably, motivational constructs were also consistently correlated with each other (Table 2). Further exploratory correlation analyses revealed a strong affective component of autonomy, competence, and relatedness. Autonomy, competence, and relatedness were each correlated with all of ten subscales of the AFFEXX ($p < .001$), including antecedent appraisals and core affective exercise experiences (Ekkekakis et al., 2021). Additional exploratory analyses are included on the study's repository (See Data Availability).

Table 1: Motivational Correlates of Exercise Behavior

	Frequency of Aerobic Exercise	Total Aerobic Exercise	Frequency of Resistance Exercise
Autonomy	.624***	.436***	.565***
Competence	.674***	.471***	.632***
Relatedness	.485***	.385***	.458***
Intrinsic Motivation	.507***	.379***	.515***
Attraction (vs. Antipathy)	.565***	.383***	.596***

Note.
Spearman's rho reported. *** $p < .001$, ** $p < .01$

Table 2: Correlations Between Motivational Constructs

	Attraction (vs. Antipathy)	Intrinsic Motivation	Autonomy	Competence	Relatedness
Attraction (vs. Antipathy)	—	.802***	.665***	.702***	.586***
Intrinsic Motivation	—	—	.683***	.700***	.549***
Autonomy	—	—	—	.864***	.745***
Competence	—	—	—	—	.711***
Relatedness	—	—	—	—	—

Note.
Spearman's rho reported. *** $p < .001$, ** $p < .01$

Attraction Toward Exercise as a Mediator

The first mediation model tested whether attraction (vs. antipathy) toward exercise mediated the relation between intrinsic motivation and frequency of aerobic exercise (see Figure 1). The total effect of intrinsic motivation on the frequency of aerobic exercise was significant (c = 0.744, p < .001, 95% CI: 0.477, 1.012). Participants with greater intrinsic motivation had greater attraction (vs. antipathy) toward exercise (path a = 1.057, p < .001, 95% CI: 0.901, 1.213), and participants with greater attraction toward exercise engaged in aerobic exercise more frequently (path b = 0.702, p < .001, 95% CI: 0.382, 1.016). A 95% bootstrap confidence interval for the indirect effect (ab = 0.742) based on 5000 bootstrap samples did not contain 0 (0.392, 1.131), indicating that the indirect effect was statistically significant. Intrinsic motivation did not have a direct effect on frequency of aerobic exercise when controlling for attraction vs. antipathy (path c' = 0.003, p = .990, -0.449, 0.449).

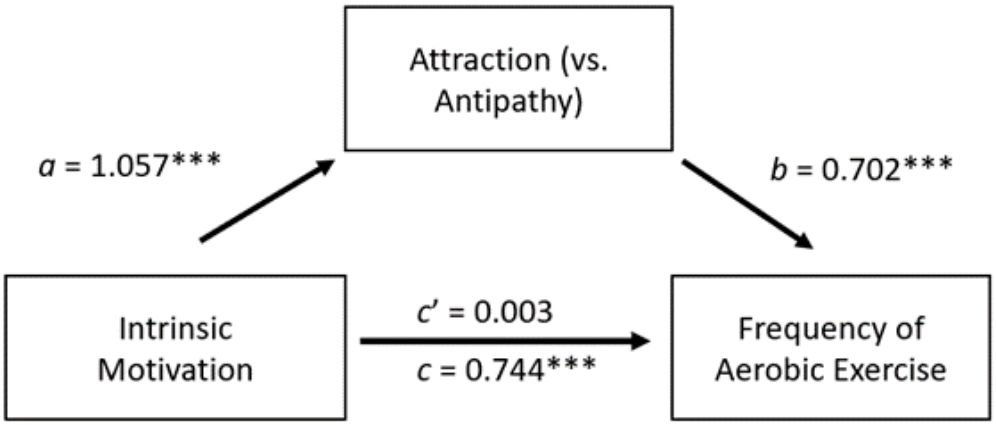

Figure 1. Attraction (vs. Antipathy) toward exercise mediates the relation between intrinsic motivation and frequency of aerobic exercise. ***p < .001.

The second mediation model tested whether attraction (vs. antipathy) toward exercise mediated the relation between intrinsic motivation and total aerobic exercise (see Figure 2). The total effect of intrinsic motivation on total aerobic exercise was significant (c = 30.47, p < .001, 95% CI: 14.37, 46.58). Participants with greater intrinsic motivation had greater attraction (vs. antipathy) toward exercise (path a = 1.05, p < .001, 95% CI: 0.90, 1.23), and participants with greater attraction toward exercise engaged in more total aerobic exercise (path b = 21.31, p = .044, 95% CI: 0.70, 42.44). A 95% bootstrap confidence interval for the indirect effect (ab = 22.46) based on 5000 bootstrap samples did not contain zero (1.14, 46.66), indicating that the indirect effect was statistically significant. Intrinsic motivation did not have a direct effect on total aerobic exercise when controlling for attraction vs. antipathy (path c' = 8.01, p = .540, 95% CI: -16.78, 34.60).

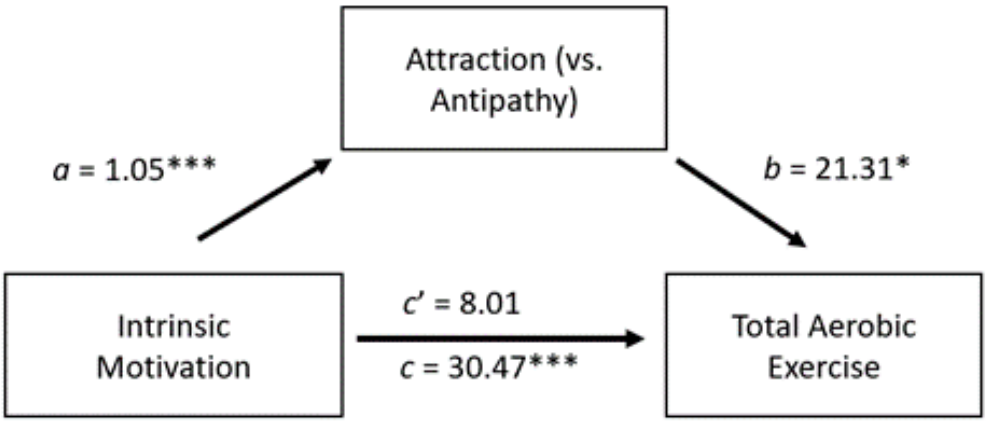

Figure 2. Attraction (vs. Antipathy) toward exercise mediates the relation between intrinsic motivation and total aerobic exercise. ***p < .001, * p < .05.

Finally, the third mediation model tested whether attraction (vs. antipathy) toward exercise mediated the relation between intrinsic motivation and the frequency of resistance exercise (see Figure 3). The total effect of intrinsic motivation on resistance exercise frequency was significant (c = .747, p < .001, 95% CI: 0.483, 1.011). Participants with greater intrinsic motivation had greater attraction (vs. antipathy) toward exercise (path a = 1.057, p < .001, 95% CI: 0.899, 1.209), and participants with greater attraction toward exercise engaged in more frequent resistance exercise (path b = .793, p < .001, 95% CI: 0.494, 1.078). A 95% bootstrap confidence interval for the indirect effect (ab = 0.838) based on 5000 bootstrap samples did not contain 0 (0.515, 1.189), indicating that the indirect effect was statistically significant. Intrinsic motivation did not have a direct effect on the frequency of resistance exercise when controlling for attraction vs. antipathy (path c' = -0.091, p = .656, 95% CI: -0.486, 0.308).

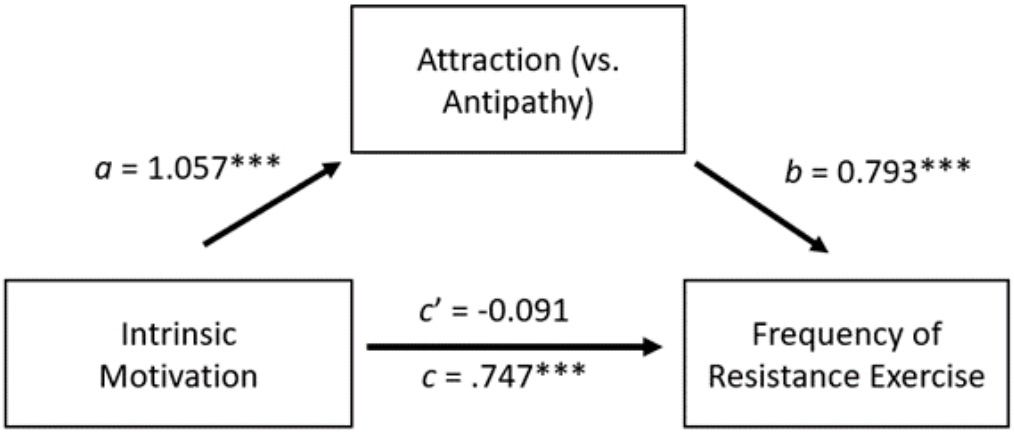

Figure 3. Attraction (vs. Antipathy) toward exercise mediates the relation between intrinsic motivation and the frequency of resistance exercise. ***p < .001.

Deviations from Preregistration

Previous researchers have suggested that autonomous motivation consists of both intrinsic regulations and identified regulations, while controlled motivation consists of external regulation and introjected regulation (Hagger et al., 2014; Nurmi et al., 2016; Sebire et al., 2009). We initially used the relative autonomy index. However, following reviewer comments, we chose to use only the intrinsic regulation subscale of the BREQ-2 as an indicator of intrinsic motivation based on arguments against the relative autonomy index (Chemolli & Gagné, 2014). Thus, intrinsic motivation was used instead of autonomous or controlled motivations or the relative autonomy index.

This study was initially conceptualized with a focus on gender differences in motivation and physical activity. Following reviewer and editor comments, we removed discussion and analyses focusing on gender. The analysis was simplified by removing gender to determine the correlations between the basic psychological needs (autonomy, competence, and relatedness), intrinsic motivation, attraction (vs. antipathy) toward exercise, and exercise behavior (frequency of aerobic exercise, total aerobic exercise, and frequency of resistance exercise). Although, it was specified that attraction (vs. antipathy) would be used in mediation analyses, details of the mediation analyses were not included (e.g., predictor variables), making it difficult to label the mediation analyses as confirmatory. Following reviewer comments, we simplified analyses here and removed perceived variety in exercise as a variable. This is partly because of incomplete data and researcher error related to the perceived variety in exercise questionnaire (we did have an error in the survey) (Sylvester et al., 2014a, 2014b). Finally, we did not anticipate all of the data cleaning steps noted in the supplementary material. For example, we did not anticipate that people would respond with a range for self-reported physical activity (e.g., 6-10 hours), which required manual recoding.

Discussion

Autonomy, competence, and relatedness were consistently associated with exercise behavior, whether behavior was quantified as frequency of aerobic exercise, frequency of resistance exercise, or total aerobic exercise behavior. This adds to existing literature, which has shown mixed associations between autonomy and exercise; it also contrasts with prior literature, which has shown weak or nonexistent relations between exercise and relatedness (Teixeira et al., 2012). In this study, relatedness shared about 14.8% to 23.5% of the variance with exercise behavior.

Further, intrinsic motivation and attraction (vs. antipathy) toward exercise were consistently associated with exercise behavior. Attraction (vs. antipathy) toward exercise explained about 14.7% of the variance in total aerobic exercise, 31.9% of the variance in the frequency of aerobic exercise, and 35.5% of the variance in the frequency of resistance exercise (see Table 2); this extends findings from Ekkekakis et al. (2021) and provides further evidence that attraction-antipathy is a meaningful and motivationally relevant variable. Given that attraction-antipathy is likely influenced by both automatic and reflective processes (Ekkekakis et al., 2021), including appraisals of exercise (e.g., level of interest or boredom, perceptions of competence or incompetence, liking or disliking group exercise) and core affective experiences (e.g., repeated experiences of pleasure or displeasure felt while exercising), this seems to further support the merits of dual-process theories that recognize the influence of both automatic and reflective processes on exercise behavior (e.g., Brand & Ekkekakis (2017); Conroy & Berry (2017); Ekkekakis & Zenko (2016)). Thus, strategies to enhance attraction toward exercise should be included with behavior change interventions.

Following the preregistration, mediation analyses were performed using attraction (vs. antipathy) as a mediator to assess whether this construct mediates the relation between intrinsic motivation and exercise behavior. Our results suggest that attraction (vs. antipathy) mediated the relations between intrinsic motivation and exercise behavior, as indicated by (a) frequency of aerobic exercise, (b) total aerobic exercise, and (c) frequency of resistance exercise. In these mediation models, a 1-unit increase in attraction toward exercise was associated with 0.7 additional days of aerobic exercise, 0.8 additional days of resistance exercise, and 21 minutes of aerobic exercise. Thus, increasing attraction toward exercise may meaningfully increase the likelihood of achieving physical activity recommendations.

Ekkekakis et al. (2021) theorized that attraction-antipathy toward exercise reflects both reflective and automatically activated processes. We suggest that the satisfaction of basic needs (i.e., autonomy, competence, and relatedness) may enhance intrinsic motivation, which in turn may enhance attraction toward exercise and ultimately exercise behavior. The data presented here highlight the possibility that attraction-antipathy might be partially influenced by intrinsic motivation regulations, theorized here to be a reflective process (i.e., dependent upon cognitive appraisals). As indicated in our results, intrinsic motivation predicts greater attraction toward exercise, which in turn predicts more frequent aerobic exercise, more total aerobic exercise, and more frequent resistance exercise. This suggests the possibility that satisfying basic psychological needs and enhancing autonomous and self-determined forms of motivation may also increase attraction toward exercise. It should be noted that in this study, intrinsic motivation and attraction toward exercise were highly correlated (Spearman's rho = .802, $p < .001$), which reinforces attraction toward exercise as a highly motivationally relevant variable and may suggest that intrinsic motivation is driven primarily by affective exercise experiences[1]. Further researchers should investigate this possibility.

Limitations

We mentioned deviations from the preregistration, above. In addition, this study was based on cross-sectional data. Using cross-sectional data in mediation analysis has been criticized (Fairchild & McDaniel, 2017). Indeed, the cross-sectional data presented here are correlational in nature and "cannot offer insight into directionality of a relation between variables (Fairchild & McDaniel, 2017, p. 1265). That said, cross-sectional mediation analyses can still provide meaningful insights (e.g., Bugge et al. (2018)), banning cross-sectional mediation analyses may hinder"progression of scientific theory" (Disabato, 2016; Hayes & Rockwood, 2019), and simply reversing the order of variables in the mediation model is not recommended (Thoemmes, 2015), and thus we are not presenting the mediation models testing whether intrinsic motivation mediates the relation between attraction toward exercise and exercise behavior. We theorize that attraction toward exercise is a direct determinant of exercise behavior, and suggest that intrinsic motivation (i.e., exercising for fun, enjoyment, because exercise is pleasurable, and because of pleasure and satisfaction) increases attraction toward exercise. Further, we suggest that satisfying basic psychological needs (i.e., increasing autonomy, competence, and relatedness) and enhancing core affective exercise experiences may increase intrinsic motivation, and in turn attraction toward exercise. This is supported by further exploratory regression analyses, which indicate that autonomy, competence, and relatedness explain 46.5% of the variance in intrinsic motivation. However, more robust data with more

[1]Additional exploratory analyses revealed that core affective exercise experiences (i.e., pleasure, energy, calmness) explained 71% of the variance in intrinsic motivation.

complex research designs (e.g., longitudinal studies, randomized controlled trials) are warranted to test these hypotheses.

We also recommend that future researchers more specifically assess self-determined motivations (e.g., autonomy, competence, relatedness, intrinsic motivation) as it relates to aerobic exercise and resistance exercise separately, and we appreciate the reviewer for this suggestion. Finally, we recommend that future researchers explore these questions using device-based measures to complement self-reported physical activity.

Conclusions

Using preregistered measures and methods, further evidence is provided to support the importance of basic psychological needs satisfaction, intrinsic motivation, and attraction (vs. antipathy) toward exercise to understand exercise behavior. We recommend further replication attempts on these results using fully preregistered methods. At present, we recommend that researchers and practitioners continue investigating how to (a) promote basic psychological needs satisfaction to maximize autonomy, competence, and relatedness, (b) enhance intrinsic motivation, and (c) ensure that affective exercise experiences are positive across the lifespan of exercise so that people have positive associations with exercise, and experience attraction toward exercise behavior.

Additional Information

Jesenia Nieves completed this work as a graduate student at California State University Bakersfield's Master of Science in Kinesiology program.

Contributions Statement

- Contributed to conception and design: JN, ZZ
- Contributed to acquisition of data: JN, ZZ
- Contributed to analysis and interpretation of data: ZZ, JN
- Drafted and/or revised the manuscript: JN, ZZ
- Approved the submitted version for publication: JN, ZZ

Data Accessibility

The preregistration, data, data analysis, and data processing notes are available at (https://osf.io/y5guj/).

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Preregistration

This study was preregistered. The preregistration can be found at https://aspredicted.org/cw7mu.pdf

Conflicts of Interest

ZZ currently serves as the Publications Chair for the Society for Transparency, Openness, and Replication in Kinesiology (STORK). He previously served as a managing editor and section editor for Communications in Kinesiology. He had no input or involvement with the peer-review or editorial process for this manuscript.

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